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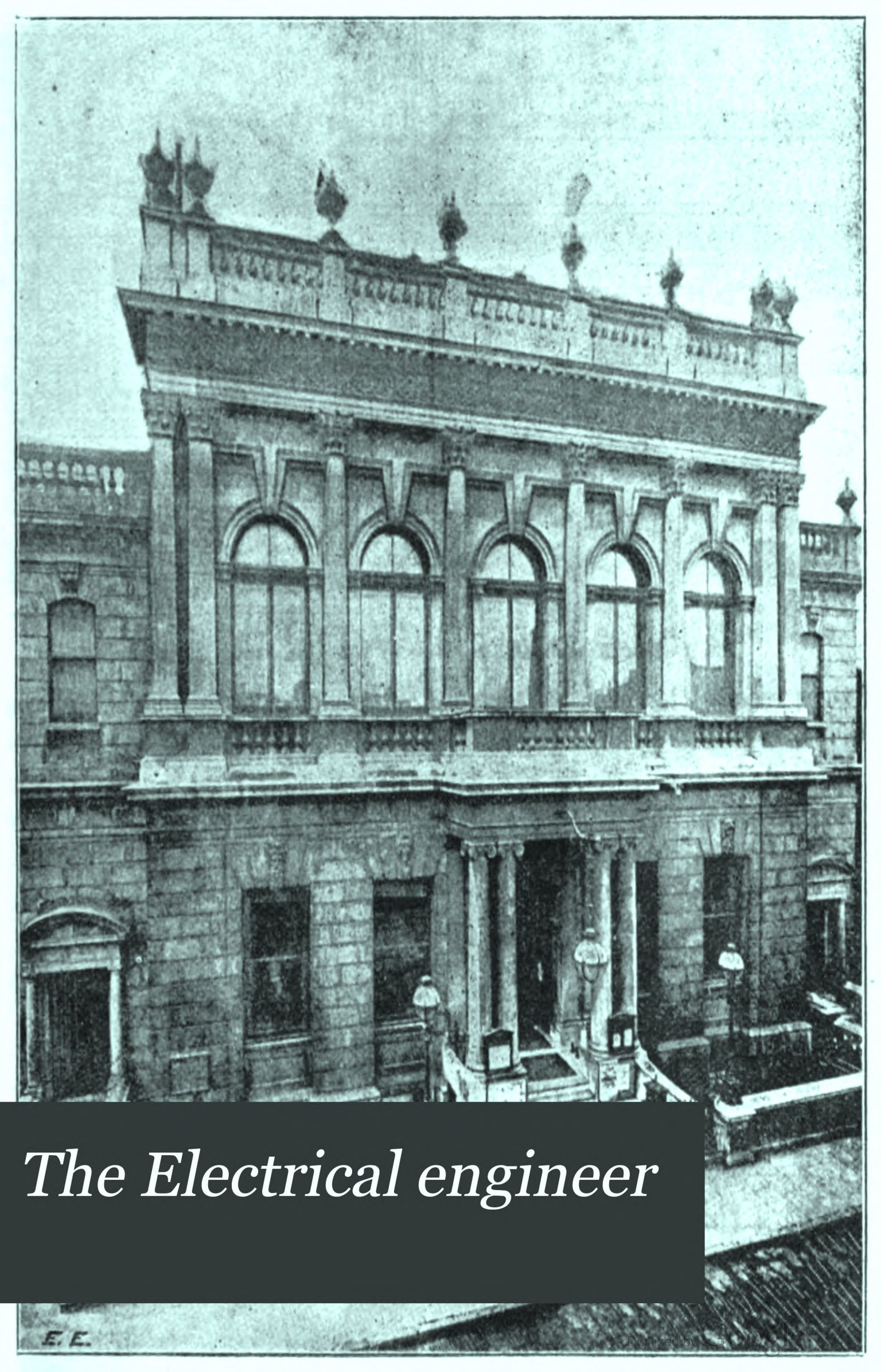

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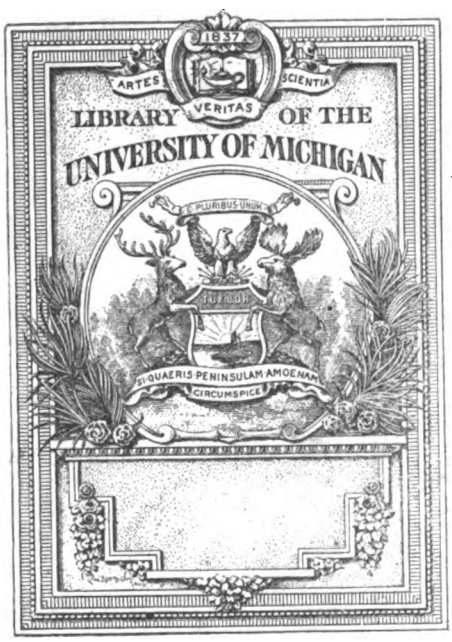

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THE

ELECTRICAL ENGINEER.

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NOTES.

Steam Turbines.—The "Turbinia," which is propelled by the Parsons steam-turbine engines, has been doing 33 knots at Spithead.

"Aluminographs."—In view of the anticipated exhaustion of the quarries of lithographic stone at Solenhofen, in Bavaria, the use of aluminium as a substitute in engraving has been suggested, and the *Neueste Erfindungen und Erfahrungen* enumerates the qualities that it is supposed render that metal suitable for the purpose. There are, however, lithographic quarries in America and elsewhere.

King's College Students' Dinner.—Lord Kelvin presided on Monday night at the Holborn Restaurant over the thirty-seventh annual dinner of the old students of King's College, London. The Duke of Cambridge, life governor of the college, was present, and the company also included Mr. W. H. Preece, C.B., Sir Alexander Binnie, Sir J. Lubbock, M.P., Prof. H. G. Seeley, and Prof. W. G. Adams.

Alternating-Continuous.—The *Zeitschrift für Elektrotechnik* has had a long description of the Déri alternating-continuous system for tramway work. The arrangements and connections of this remarkable system would be hardly intelligible without reproducing our contemporary's diagram. It is said that it is to be tried shortly, so it is said, by a well-known Viennese company. It appears to be safe to await results.

Obituary.—From Paris is announced the death, at 67 years of age, of the French chemist Prof. Schutzenberger. He was born in Strasburg. After having been attached to the chemical laboratory at the Conservatoire des Arts et Metiers, assistant director at the Sorbonne Laboratory, he became in 1876 professor of chemistry at the Collége de France. He was also at the head of the Paris Municipal School of Physics and Chemistry.

Yet Once More.—In a Swiss consular report the old complaint is made about price-lists. Those which find their way to Switzerland are neither drawn up in the vernacular nor converted into metric weights and measures, and the prices are given in sterling without the equivalent value in the currency of Switzerland. The Swiss resent also the want of confidence of the British manufacturer in requiring prepayment of goods to be despatched to Switzerland. We think the British manufacturer might have something to say as to this latter point.

The Crehore Quick Telegraph.—It has been stated in the New York *Electrical Engineer* that Senator Pettigrew has introduced a Bill in the United States Senate authorising the Postmaster-General to acquire for the United States the invention of Prof. Crehore and Lieut. Squier for rapid telegraphing by alternating currents, and also to construct a line between Washington and New York for the purpose of experimenting with and perfecting the use of rapid telegraphy. Whether anything further will come of this depends upon many things.

International Submarine Telegraph Memorial. A public meeting will be held at University College, Gower-street, to-day, at 4 p.m., to inaugurate the personal memorial to the late Sir John Pender, Mr. Onslow Ford's bust of whom will be on view, and a cheque for £5,000 to endow the electrical laboratory of University College will be handed over to the trustees. The Marquis of Tweeddale will preside, and Lord Kelvin is expected to be present and speak.

Physical Society.—Attention may be called to Mr. Searle's paper last Friday. The usual summary will be given elsewhere, from which the curious results obtained can be gathered. They may possibly have a bearing on many out-of-the-way matters. Fortunately, the people who seem most immediately concerned are necessarily good mathematicians, although their mathematics are not quite of the same kind as Mr. Searle's. The engineer, fortunately for him, does not usually have to do with motions which are comparable to the velocity of light.

Telephone Athletics.—The members of the Telephone Athletic Association had an athletic *fête* in the grounds of the Grove Hotel, Dulwich, on Saturday, and got about as good weather for that sort of thing as they could have asked for. There was a mixed programme of sports, a prize fund having been subscribed by the chiefs of the head office staff. Mr. Gane distributed the prizes. Afterwards there was an *al fresco* concert and dance. The band was that of the 2nd Kent Volunteer Artillery. There were a very large number of people there.

Carborundum.—It is stated that the Physikalisch-Technische Reichsanstalt is now using carborundum crystals to a great extent to replace diamonds in the production of finely-divided scales. Small flat hexagonal crystals are chosen of from ½mm. to 1mm. size and mounted in a steel holder by means of a drop of shellac. The lines are said to be much more even than those produced by a diamond; they have been examined when magnified 50 times and found to be still sharply defined. Carborundum, it need hardly be said, is the carbide of silicon produced in the electric furnace.

Gas Explosion.—Instead of happening in connection with the temporary installations for Jubilee illuminations, the usual gas explosion required to keep up the statistical average came off in the ordinary way on Friday between two and three o'clock in the morning at a private house in Stokenchurch-street, Fulham, tenanted by Mr. L. Delbous. The ground floor was occupied by a family of the name of Cloetens. A strong smell of gas had been observed all night, but it appears that no precautions were taken to discover the leakage. In the morning a tremendous explosion occurred, terribly burning Mr. and Mrs. Cloetens all over the hands, face, and body, and also injuring their daughter Elsa, aged eight years. While some of the neighbours endeavoured to extinguish the fire which had broken out, others procured a conveyance and took the sufferers to the Westminster Hospital.

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Cable Interruptions.—The official list published in the Berne *Journal Télégraphique* gives the following interruptions on "international" cables and lines in which communications had not been restored up to June 25: the Grenada and Trinidad cable (failure June 2), the Ecuadorian land lines from March 13, the Jamaica and Colon cable (February 5), the Amazon cable beyond Obidos (December 7), the Santa Catherina and Larissa land line (December 5), the Ste Croix and Trinidad cable (November 29). The African Transcontinental interruption beyond Mazoe is more than a year old, and there are two others listed of still more ancient date. The only cable repair completed during the month is that of the Lourenço Marques and Durban link of the East African cable on June 5, after six days' interruption. Some interruptions in Asiatic land lines are listed, but they were repaired at once.

Condensers in Alternating Arcs.—In *L'Industrie Electrique* there is an article by Mr. Georges Claude suggesting the addition of a condenser as a means of securing better regulation in alternating-current arc lamps. Alternating arcs, he says, work badly because of the increased impedance that results from the advance of the core. To remedy this, he adds the condenser. He has been experimenting with Brianne lamps and a periodicity of 42. With reference to the practical objections to the use of condensers, he contends that these only apply to potentials measured in thousands of volts. With the low voltage of arc lamps the dielectric might be made very thin, and as the capacity is nearly proportional to the inverse square of the thickness, the condensers required need not be very big (the author says 4in. in diameter). In a final paragraph Mr. Claude presents his idea to the construction of arc lamps.

Carbon Electrodes.—It is remarked by the *Scientific American* that the extension of electrolytic processes in industrial chemistry has created a demand for terminals which shall be inexpensive and permanent, and numerous patents in this line have been taken out, especially in connection with the electrolytic production of the alkaline chlorides. Gas carbon is not available in large sheets, such as are commercially required, and hence these have been made of powdered coke, baked with a cementing material in the same manner as electric light carbons are made. Such carbon plates, however, are not permanent, but soon become disintegrated by the action of the solutions, and especially by the action of the liberated gases. Dr. Alber Lessing, in the *Elektrochemische Zeitschrift*, claims to have solved the problem by producing carbon sheets entirely homogeneous and free from cracks, by a fusing process which not only insures the permanence of the sheet, but also increases its conductivity. The new product is said to be harder than steel, readily scratching glass, and proof against the emery-wheel, and possesses a metallic ring which testifies to its homogeneity.

Tramways in the Transvaal.—The *Financial News* says: "The Boer Government may be said to be the enemy of progress in two senses of the word. Not content with placing every difficulty in the way of the development of the mining interest, the idea of rapid and improved means of transit appears to be repugnant to the phlegmatic burghers of the Transvaal Republic. The Johannesburg Tramway Company has in the past in vain requested permission to use electricity as a motive power, and although a syndicate last year obtained a concession for the establishment of electric tramways in the mining capital, the Raad, despite the President's advocacy of the arrangement, declined to confirm it. No blame can be attached to the Raad for declining to ratify this concession. It would have been a gross injustice to have granted what had previously been refused to the Johannesburg Tramway Company. This was one of the reasons given by the Raad for its refusal, the first being that the Government, in signing the contract, was exceeding its powers. It is evident, however, that the last reason is the chief ground for the Raad's action. It feared that the use of electricity would deprive the Boer farmers of a market for their forage. Such is the benign care of the Raad for its farmers. It would bar, if it could, the progress of the world to enable its burghers to sell a few tons of forage!"

Artificial Lights.—Prof. D. S. Jacobus, of the Stevens Institute of Technology, Hoboken, New Jersey, in a lecture to the Franklin Institute on the comparison of various artificial lights, comes to the conclusions that it would not be profitable, as has been suggested in some literature on the subject, to convert electric lighting plants into plants for producing calcium carbide, the gas from which could be used for lighting, because the light given by the carbide so produced will be but one-half that obtainable by using the electricity directly in incandescent lamps. The incandescent electric light has held its own against the gaslight on account of its superior qualities, which are its brilliancy, cleanliness, and adaptability. In spite of its high cost, acetylene, producing as it does a more brilliant light than any now used for interior lighting, and having the quality of showing the complexion in life-like tints, will have its own field, even should it be the most costly system of illumination. Again, acetylene is now used in place of the calcium light for lantern projections, etc. Were it not for the explosive character of the compressed acetylene, it would be useful for cases of isolated lighting, such as for beacons and light-buoys. The whole situation may be summed up by saying that each system of lighting has its own field of usefulness on account of properties peculiar to itself, which make it more desirable than the others for certain classes of work. The lecture is to appear in full in the *Journal* of the Franklin Institute.

Armature Heating.—Writing in the New York *Electrical Engineer*, Mr. George Moffat says that while an armature has been defined as a bundle of wires cutting magnetic lines, with suitable connections for carrying off the induced current, it is this "bundle of wires" which is the vital part of our electric systems to-day, and has given more trouble and study than all the rest of the system combined. The working capacity of armatures, according to Mr. Moffat, may be said to be limited by two things, sparking at the brushes and heating of the armature itself. Of these, the heating of the armature has been found the more troublesome of the two on account of the difficulty in overcoming it. To stop sparking at brushes, unless a structural defect, is much easier accomplished. Besides the element of risk accompanying undue heating there is a large waste of power, and power means money. In some machines tested Mr. Moffat has found it necessary to reduce the load almost 50 per cent. before reasonable heating loss was met with. The maker's guarantee that the machine's capacity is 100 per cent. above what is found safe will not bring back the power thus wasted. The heating arising from the friction of brushes, if excessive, may be remedied by better brushes, springs no stronger than necessary to make perfect contact, a true commutator, and, if necessary, a little light-bodied oil applied occasionally which will quicken the polish. The main requisites for cool running would then seem to be: machines run at their true capacity, properly insulated, laminated cores, and thorough ventilation.

The Wellington Series Engine.—The Wellington series engine, which has been claimed "as the greatest of

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original creations in the field of the transformation of heat into mechanical work," consists of five engines in series, each having its separate boiler and tubular condenser. At one end is a heater, at the other a cooler, and a circulating fluid is pumped through the heater, the boilers, the cooler, and the condensers to the heater again. This is an American invention, and therefore we will only reproduce an American comment on it. The *Street Railway Review* remarks that as the heater in the series engine has all the functions of the boiler in the ordinary plant and must itself have a source of heat, it is not apparent why the heater should not transfer heat to steam instead of to hot water. In any event, that which heats the heater must leave it at a temperature in excess of the latter, with consequent loss. "The same applies to a Wellington series engine receiving its heat from the jacket of a gas-engine, why not generate vapour and work it to better advantage in a 'non-series' engine? The use of liquids with a low boiling point is not new, but if we expand much below the lower limit of the engine it would soon be necessary to erect a refrigerating plant (driven by a steam-engine) to condense the volatile gas. The prediction was made that, if a practical success, the Wellington engine promises the highest economy in the conversion of heat into work of any heat engine ever made. Having shown that the maximum efficiency of this engine to be about two-thirds that of a non-series engine working between the same limits, we do not have any faith in the prediction."

Rontgen Radiations.—According to a note in the *Engineer* a Röntgen society has been formed, with Prof. S. P. Thompson as the president. The intention of the founders is that the society shall occupy a position between those devoted purely to medicine, to physics, or to photography. Some of the members will study the sources of the Röntgen rays, others the applications; some the induction coils, others the tubes and the various forms and adaptations of the apparatus used in the production of the rays. Röntgen photography has been found serviceable in so many branches of scientific investigation that the society appeals to a large constituency for support. It should be the means of increasing the efficiency and application of the rays, and should also be of assistance to surgeons and others who have entered the new field of work without previous training in physics. According to the Paris correspondent of the *Daily News*, the Röntgen rays are now being pressed into the service of the French revenue. "It is hoped that by their means some branches of smuggling will be effectively checked, to the benefit of the French Treasury and of the protected French industries. Mr. Pallain, the Director-General of French Customs, has directed that Crookes tubes for the purpose shall be kept at all the larger Customs offices. It will no longer be easy to smuggle watches and jewellery which pay 15 per cent. and more *ad valorem*. Hundreds and even thousands of pounds' worth of such articles have from time to time been found stowed away in such unlikely places as the legs of a deal table. All the inspectors of Customs in Paris have been summoned to the Customs House, where the new method has been explained to them."

European and American Practice.—In contrasting, in *Cassier's Magazine*, the nondescript character of the larger number of American electric light stations with the substantial, well laid-out installations of Europe, and especially Germany, Mr. J. E. Woodbridge says European cities are already of established size, or are growing at a slow rate which can be definitely foretold. The proverbial slowness of the European—from an American standpoint—in establishing new enterprises prevents the construction of lighting plants until the demand to be supplied is known definitely. There is also a greater proportion of municipal lighting systems in Germany than in America, and in all these plants, of course, the tendency for the best, as opposed to the cheapest, is greater than under private ownership. "Then those municipalities now owning their own plants have been so stringent in their franchise limitations as to prevent the establishment of any wildcat or speculatively inclined companies, or any, in fact, but those with the most substantial backing and serious intentions. The difference in the nature of investors in America and Europe is also a prominent factor. While the investment in the United States is generally speculative, calling for quick and large returns, the demand in Europe is for a safe investment, which shall pay a small interest continuously for many years. The result is that, before ground is broken for a European plant, the whole system is laid out with due allowances for everything that can be foreseen in the next quarter century. The best engineering talent available is employed, and all the possible alternatives in plans and details are thoroughly discussed. First cost is not considered if running expenses or depreciation can be reduced in any way. Any increase in capitalisation that will effect a saving sufficient to pay 5 per cent. or even less on that increase is immediately undertaken."

A Fire-Engine Tramcar.—The *Scientific American* says, with the enormous extension of the trolley road (in the States), it has been rendered possible to furnish fire protection to outlying districts without the maintenance of expensive fire companies in the immediate neighbourhood. Several cases have lately occurred in which the trolley has enabled fire apparatus to be quickly transferred to the scene of the conflagration. Our contemporary then goes on to illustrate a truck intended for this purpose, and is made by the Wason Manufacturing Company, of Springfield, Massachusetts. It consists of two trucks, surmounted by platforms, on which men can ride with hose, tools, and other equipments. To the rear truck is attached a platform which connects the two trucks upon which the fire-engine is carried. The length over the platform railings is 28ft. 8in. The extreme length from the edge of the footboard to the fender is 30ft. 10½in. The height from the rail to the top of the engine platform is 9½in., the length and width of the engine platform is 13ft. 9in. by 6ft. 11in. The width of the car over the channel beam is 7ft. 10in. The extreme width over the hoisting wheels is 8ft. 6½in. The weight of the car is 14,000lb. The electric motor can be attached directly to the axle of either truck, or the car propelled or drawn by electric locomotive or snow-plough. To load the engine, the platform is lowered to the rail, the front truck is disconnected, and is run far enough away to admit of the engine being backed into position, when, by means of a winch attached to the rear truck, the engine is easily and readily drawn into place. The front truck is then brought back, and, by means of chain hoists, operated by right and left screws, the front end of the platform is raised and the side girders securely locked into place, thus making both trucks and platform practically one piece. At a recent test by fire-department officials a steam fire-engine was loaded in 2¼ minutes from the time the car was run into position until its being ready for service. In unloading, the front truck was detached in 45 seconds, and the horses were attached and ready for starting off in 1¼ minutes.

Magnet Cutting.—It is usually stated early in the text-book that when a magnet is cut so as to divide it into two parts, two complete magnets are formed, whose poles are arranged in the same way as in the large magnet before cutting. It has occurred to Mr. J. F. Smith to ascertain the effect of cutting from the ends of a wide thin

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magnet strips whose width is small compared with their length. His experiments are described in a recent issue of the *Western Electrician*, and are illustrated by diagrams showing the effect of removing the ends of the magnet in various ways. These experiments seem to indicate that when a wide thin magnet is cut or broken so that the part removed has a length greater than its width, the arrangement of the poles is different from that ordinarily obtained by cutting the magnet. The explanation seems to be as follows: At the regions where the lines of force enter or leave the magnet the poles are located. Each line of force is a closed circuit running from pole to pole through the magnet, and making the return circuit through the air. When the magnetised strip of steel has got almost across, the lines of force are diverted from their usual path through the magnet, and are crowded together, the narrow portion joining the small strip at the end to the larger magnet. Since the strip furnishes a better path for the lines of force than the air in the gap where the metal is cut, the lines are thus shifted, so that they run lengthwise of the strip instead of crosswise. The lines of force then leave the strip at the ends or near the ends. When the small strip is being broken from the main strip, the lines of force leap across from the larger strip to that point of the small strip which is nearest the large one, and thus the formation of a separate pole begins. When they are completely separated, this lost point, at which the strips were joined, becomes a separate induced pole, permanent and of opposite kind to the adjacent pole of the larger magnet. Essentially the same thing takes place when the strip is cut from the sides towards the middle, the results being the formation of a north-seeking pole at each end, while the consequent south-seeking pole is induced at the middle, where the lines of force leap across from the larger magnet.

Mr. Siemens on Merchandise Marks.—At the sitting of the Select Committee of the House of Commons enquiry into the working of the Merchandise Marks Act on Monday evidence was given by Mr. Alexander Siemens, who stated that he was a director of Messrs. Siemens Bros. and Co., Limited, of 12, Queen Anne's-gate, Westminster, and was giving evidence on behalf of the Machinery Users' Association and of the London Chamber of Commerce (Incorporated). In Mr. Siemens's opinion the aim of the Merchandise Marks Act, 1887, to protect the public against fraud, received the cordial support of every honest merchant and manufacturer; but one of the effects of the Act had been to disclose to customers abroad the fact that a great part of the commerce of Great Britain was carried on by buying and selling foreign-made goods. On finding this out it had been easy for travellers of foreign firms to secure the trade in such goods, and as a consequence they had been able to extend their dealings to other goods formerly supplied by and still manufactured in Great Britain. The best proof of what a powerful aid the working of this Act had been to foreign competitors was the fact that it was now the custom of German manufacturers to mark all their goods for export "made in Germany," or even "warranted made in Germany." The administration of the Act thus damaged the shipping and transit trade without in any way detecting fraud or preventing the introduction of foreign goods with English marks to customers abroad. Difficulty had arisen through the interpretation of Article 16 in conjunction with the definition of "trade description" in Article 3, 1 (*b*). If paragraph (*b*), "as to the place or country in which any goods were made or produced or," were struck out, and a corresponding paragraph inserted in Article 2, Section 1, between paragraphs (*d*) and (*e*), the British manufacturers would be protected as under the present Act against the fraudulent marking of British origin, and the British trader could put his name on imported goods as long as he did not apply to them false statements as to the place or country in which any goods were made or produced.

Power Transmission.—In California the conditions for electric power transmission over long distances are exceptionally favourable. But long distance means high voltage. In discussing the barriers limiting the range of this, the San Francisco *Journal of Electricity* says: "Not to that most trustworthy servant, the transformer, may the present limitations of electric transmissions be ascribed, but the appliance that now bars the way to the use of higher voltages is the insulator. Lightning, static discharges, and grounds will probably constitute troubles that will always beset aerial lines to a greater or less extent. When the perfect insulator has been devised, the overcoming, or rather the alleviating, of grounding troubles will find its best ally in thoroughness of mechanical construction, but the trusty transformer alone presents the hardihood to defiantly refuse and withhold admission to lightning and its attendant effects. Generators are inclined to flirt with the 'forked flash,' though they extend no encouragement to static discharges, but the flirtation is generally manifested only in a flutter of the needle or the flicker of the lights. Science has well in hand the control of lightning, of static effects, and of the mechanical features that give permanence, safety, and reliability to overhead transmission lines, nor is difficulty experienced in the handling of line voltages at present used, but the barrier—thus far insuperable—to the employment of higher potentials is, as stated, embodied in the insulator alone. Climate exerts a potent influence on the reliability of insulators, and so great is this influence that to it rather than to the insulator itself may be attributed the existing limitations to the commercial use of higher voltages. In addition to being a practically perfect non-conductor, the insulator should be wind, rain, snow, sleet, dust, and insect proof. Its reliability as a sure preventive against all possible sources of trouble should be absolute, for, if susceptible to breakdowns, its weakness necessitates the duplication of the transmission lines that no interruption to service may occur in making repairs. The saving in copper which will result from the invention of a perfect insulator would be two-fold, in that it would enable the use of higher voltages and require only a single transmission line."

Illuminations.—The special correspondent of the *Times* on board H.M.S. "Powerful" gets quite enthusiastic about the illumination of the fleet at the Spithead review. "At the appointed moment, a quarter-past nine, the fleet, whose individual features had been gradually fading away in the gloaming, suddenly burst into an exquisite glare of universal but ordered light. The effect was enchanting alike in its suddenness and in its unexampled beauty. Every British ship was uniformly illuminated with lines of electric lamps tracing out the main outlines of her hull, bridges, funnels, and masts, the flagships showing the admirals' flags represented in the proper colours—a red St. George's cross on a white ground—and conspicuous miles away." The foreign warships present followed for the most part the same system, though with many variations of detail. Uniformity of effect was the thing aimed at in the British lines, "but the apparent severity of decoration which the description might seem to imply was entirely mitigated in spectacular effect by the immense length of the lines." For some reason or other the illumination of the "Victorious" was generally thought on board the "Powerful" to be specially effective, and the correspondent says, "in

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the 'Terrible' a device, due, I believe, to the electrical ingenuity of the 'Vernon', attracted attention not unmixed with amusement. On the quarterdeck was shown a device exhibiting the numerals 1837 in white lights, with V.R. in red between the figures 8 and 3. At intervals the numerals were eclipsed while the letters remained, and immediately afterwards the numerals 1897 appeared, while simultaneously an I. in green was added to the Royal monogram. The changes from one monogram and one set of numerals to the other was made with rapid alternation throughout the evening, and the ingenuity of the device was generally recognised, though the dignity of its effect was somewhat marred for London visitors, at any rate, by its resemblance to certain familiar but not particularly impressive advertisements." A somewhat similar device appeared to be displayed from the American flagship "Brooklyn." Another characteristic and very beautiful feature of the "Brooklyn's" system of illumination was the continuous lighting up of the British and American ensigns displayed from the mast-heads by the fixed beams from electric search-lights. "The last Royal salute was the formal close of this memorable day. The illuminations were still continued for a short space, but at midnight the flagship switched off, and in little more than a minute all the fleet was dark." Then the other illuminations, presumably not electric, got noticed. "We saw what we had scarcely noticed before—that the steamers, large and small, and the yachts and other vessels which surrounded the warships on all sides had contributed not a little to the splendour of a spectacle which no one who witnessed it is ever likely to forget." Another correspondent who was not on board says: "During the day all the ships had been dressed in rainbow fashion, and the flags were hauled down at sunset, but when the flags were taken in on the Royal yacht electric lamps took their place, the 'Victoria and Albert' being the only ship so illuminated." It is evident that practice is still wanted to tell the incandescent lamps from any other if only you are far enough off, but one would have thought there could be no doubt about "extinguishers" or arcs.

Condenser Heating.—An account of a valuable investigation by Mr. Richard Threlfall into the subject of the conversion of electric energy in dielectrics, is published in the *Physical Review*. The account is a very long one, and considerations of space have compelled its division in the middle, so that at present we are without Mr. Threlfall's full conclusions on the matter of what is usually called, for short, "dielectric hysteresis." There is a useful summary of previous work on the subject. Mr. Threlfall having used Prof. Riccardo Arnò's method of a revolving field produced by the composition of harmonic fields has discarded it as not in practice giving accurate results, and fallen back on mechanical rotation. The whole matter is exceedingly interesting from a theoretical point of view, and the following extract will at once show the practical importance of the matter, and so far as they are at present accessible, indicate Mr. Threlfall's conclusions: "A certain condenser of a capacity of 0·123 microfarad was tested at an alternating potential difference of 3,000 volts and with a frequency of 60 periods per second. This condenser when packed in a box and thermally insulated was found to rise in temperature by an amount certainly less than $\frac{1}{2}$deg. C. per hour. Compare this with some tests by Messrs. Bedell, Ballantyne, and Williamson on a waxed paper condenser. This condenser was tested at a potential difference of 500 volts and with a frequency of 160. The loss was ascertained to be from 2 to 3 per cent. of the power transmitted; and the rise of temperature, under circumstances similar to my own tests, was at the rate of about 1deg. C. per hour. In order to see what this comparison means, it is more convenient to consider that energy moves first in and then out of the condenser, than to begin by writing down the activity equation, which, in the case of no condenser loss, is equivalent to saying that no energy is supplied. Looking at it in the way I propose, it appears that the energy supply in the case I tested was, per unit capacity, about 13 times greater than in the case treated by Messrs. Bedell, Ballantyne, and Williamson. In making a comparison, the actual capacity is, roughly, immaterial, since the volume of condenser matter to be heated and the capacity of the condenser increase together. Assuming that the specific heat of the condenser materials and the heat insulation was the same in both cases, we find that the percentage losses are in the ratio of about 1 to 60—or the condenser I tested was only losing energy to an extent of clearly less than $\frac{3}{60}$ per cent. = 0·05 per cent. of the energy supplied. I mention this chiefly as an illustration of the immense effect which small quantities of air or moisture have on the apparent behaviour of dielectrics. Of course, it is evident that no information as to the purely dielectric action of dielectrics as opposed to their conducting action can be drawn from such experiments, unless it be known with certainty that the conduction losses may be neglected, and this, in general, it is next door to impossible to ascertain. I need only refer to the experiments of Koller on the specific resistance of oils for a justification of this statement, for this investigation shows how the specific resistance is a matter of previous history, voltage, etc., a conclusion entirely in accordance with my own experience where the resistance of insulators is in question. The question which I desired to approach experimentally in 1893 was this: Is it true that when surface action is properly guarded against, and an elementary volume of a dielectric is carried round a cycle of electric polarisation, that some of the energy of electrification is converted into heat, or, at all events, disappears? Assuming that this question is answered in the affirmative (it is), the further question arises as to whether this loss can be explained on the lines suggested by Maxwell, and more recently elaborated by Hess. Although I cannot claim to have finally answered this question, I think the experiments which will be described lead to the conclusion that Maxwell's explanation, though a possible one, is not sufficient in all cases. A third question arose during the investigation—viz., as to whether dielectric loss under prescribed circumstances is a fixed physical property of the dielectric, or whether it is of the nature of an accidental circumstance depending on such minute peculiarities that we are unable in any particular case to predict what the loss will be. Does it, in fact, resemble the problem of the prediction of hysteresis loss in an untested specimen of iron? This question is finally resolved in the sense that the dielectric loss, though perfectly determinate in any given specimen, is exceedingly variable in passing from one specimen to another, even though every care be taken to secure uniformity. Thus, the loss in the outer layers of a rod of ebonite is different to the loss at the centre (per unit volume, of course), and two spheres of resin cast at the same time from the same melting of resin may behave quite differently. The investigation has been extended to very rapidly-varying electric forces, produced by the use of oscillating discharges, in the hope that some light may be thrown on the curious opacity of certain dielectrics—black waxes, for instance—but with the unexpected result that dielectric losses become either zero, or, at least, get too small for detection at frequencies of the order of 10^7 per second."

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SHOREDITCH ELECTRICITY WORKS.

The Vestry of Shoreditch celebrated on Monday last the completion of their electricity works and refuse destructor.

"E PULVERE LUX ET VIS."

The occasion was improved upon by having a large number of ratepayers present to inspect the works and witness the opening ceremony. During this function, and after the dinner, which was held in the town hall in the evening, repeated references were made to the spirit of progress in municipal work shown by the Shoreditch Vestry. Thus the inhabitants of the parish, now numbering about 125,000, are most of the artisan class engaged in the various manufactories in the parish. Rich and high-class residential districts are not to be found in the parish, and yet every municipal improvement possible has been taken up promptly, and as promptly executed. Thus, on the site on which the refuse destructor and electricity works have been built, there are also to be erected public baths and wash-houses and a public library and museum. On an adjacent site it is proposed to erect a large technical institute and museum, into which will be moved the municipal technical schools of the Shoreditch Vestry. The ground adjoining the latter's site will be used as a recreation ground. On this wise policy in carrying out these improvements the Vestry is to be congratulated, and the clerk of the Vestry, Mr. H. Mansfield Robinson, who also acts as their solicitor, deserves special commendation for his consistent good advice on the new departures.

The history of the electric lighting scheme is not unlike that of some other places. The Vestry were stirred into action at first by the fear that powers to supply electric light would pass into the hands of a private company. After this risk had been averted there was some delay owing to the large expenditure involved, but the matter was put before the ratepayers at the election of 1894, and from that time the scheme has gone on more rapidly. The Vestry decided to retain Mr. E. Manville, of the firm of Messrs. Kincaid, Waller, and Manville, to advise them on the best means of lighting the parish, and as to the feasibility of combining a refuse destructor with the electric plant. Mr. Manville pointed out that although the district was, comparatively speaking, a poor one, it offered several advantages from the electric supplier's point of view. Thus the shops keep open late of a night, and there are a number of small manufacturers in the district who require power in their workshops. As this demand for power would be during the daytime it was specially advantageous, as the refuse destructor would then be able to supply it. As regards the refuse destructor a large saving was expected, as the cost per ton for barging is high in Shoreditch. When proceeding to put the scheme in hand it was found to be difficult to acquire a site of suitable size, as the freeholders of most of the land in Shoreditch objected to dispose of their rights. The Vestry finally had to pay some £33,500 for $1\frac{1}{2}$ acres in the centre of the district. Additional property adjacent to the site was also purchased so as to prevent undue interference from residents on the ground of vibration, etc. This was a wise step, as the sites of the houses so acquired can be used for extensions when the present works become too small for the demand. Tenders were then advertised for, and the accepted offers amounted to a sum of £67,646, as against the engineer's original estimate of £65,000. This shows how carefully the engineers had prepared their plans. The contracts were awarded as follows: buildings, Messrs. Atherton and Dolman; dust destructor, with boilers, fans, lifting gear, and chimney shaft, Messrs. Manlove, Alliott, and Co., of Nottingham; dynamos, engines, motor-transformers, switchboards, and public lighting, the Electrical Construction Corporation, of Wolverhampton; mains and conduits, the British Insulated Wire Company and Messrs. W. T. Glover and Co. (the conduits used are of the Doulton type); steam, exhaust, and feed pipes, feed-pumps, and tanks, the Thames Ironworks Company; accumulators, Messrs. Pritchetts and Gold.

Buildings.

The buildings designed by the consulting engineers, and erected by Messrs. Atherton and Dolman, consist of a destructor-house and engine-house as well as suitable offices for the new department. The engine-house is 68ft. long and 46ft. broad, and is shown in Figs. 1 and 2. It is arranged with the high-tension continuous-current steam dynamos on one side, and the low-tension sets and station motor-transformers on the other side. A gallery of ample width is provided against one wall of the engine-house to accommodate the three switchboards. Adjoining the engine-room is the test-room, in which will be erected all the testing instruments, and which, in addition, will be used for the calibration of meters. The offices, which front on to the street at the end of the engine-room, contain suitable accommodation for the Electric Lighting Committee to hold their meetings, for the engineers, and for ordinary office purposes. In order to prevent, as far as possible, vibration from the running of the engines, the whole floor of the engine-house has been made a solid mass of concrete, about 10ft. in thickness, and the surface of this has been tiled over in a neat manner. The destructor-house is a building 80ft. by 80ft., with a roof of unusual shape and dimensions, specially designed by Messrs. Kincaid, Waller, and Manville. It forms a portion of the covering for the sides of the buildings in place of carrying the brick walls right up to the usual heights (see Fig. 3). There are also provided bathrooms, both for the engineers and the men, and accommodation for the men for taking their meals, etc.

The impression one receives from an inspection of the buildings is that, while they are most suitable for their purposes and are quite substantial, no money has been wasted on decoration. Thus the cost of building, which in some London stations has been excessive, in this case only amounts to some £8,000, which is a reasonable proportion of the total cost. It will also be noticed from the plan (Fig. 1) that there is ample space in the engine-room for additional plant. The buildings are of brick throughout, and their construction was supervised by Mr. Gardner, as clerk of the works.

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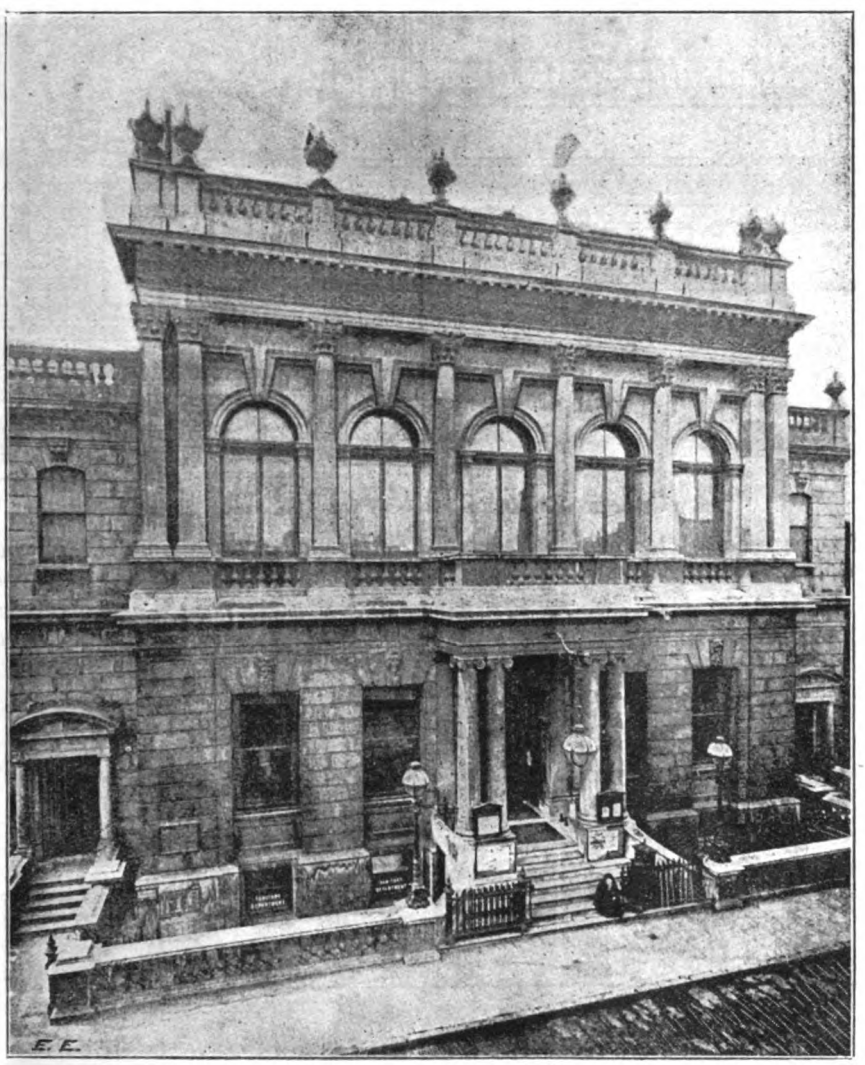
Refuse Destructors and Boilers.

The refuse destructors and the steam-raising plant are so interconnected in this installation that it is impossible to describe the one without the other. As mentioned above, this part of the work was executed by Messrs. Manlove, Alliot, and Co., who in 1893 reported to the Vestry as to what results they could guarantee in the way of heat for electric lighting purposes by the burning of 20,000 tons of dust per annum. This firm reported that with the aid of the thermal storage system of Mr. Druitt Halpin such refuse would produce sufficient heat for the electric lighting station proposed by Mr. Manville, and they pointed out that the value of the steam so produced would be £4,290 per annum, and that a saving of at least £1,500 would be effected by burning the dust instead of disposing of it by barging.

The destructor-house contains 12 cells for burning refuse, and six Babcock boilers, which are placed each between two destructor cells. The chimney is 150ft. high and 7ft. internal diameter at the top. It is lined with firebrick throughout. At the base a centrifugal dust-separating chamber has been constructed. The cap of the shaft is of cast iron put together in segments. The cells are worked under forced draught supplied from the fans placed in the adjoining shed. These fans are driven by motors on the fan axis, and are each capable of delivering 8,000 cubic feet of air per minute against a pressure in the ashpits equivalent to 3in. of water. Steam jets are also provided to increase the draught should occasion require. The illustration (Fig. 4) shows one face of the destructors and boilers, which are arranged back to back as seen in the general plan. The gases pass from the destructor cell directly to the space above the fire-bars of the boiler. The openings in the firebrick seating are near the front, so that the hottest part of the cell delivers direct into the boiler. Also, as the green refuse is higher up on the sloping grate, any noxious fumes distilled off by the temperature rising are drawn down over the hottest part of the fire and cremated. Wherever required, each boiler may be shut off entirely, by means of dampers, from each or both of its adjacent cells. It may also be fired at all times with coal or any other suitable fuel, or independently at times of heavy load, as the ordinary fire-bars are provided under the boiler. Again, the cells may be worked independently of the boilers, but in this latter contingency the gases pass out from the cells at the back and not at the front. Owing to this arrangement, the cells may be repaired independently of the boilers, and the boilers may be repaired independently of the cells; moreover, in the event of refuse not being collected or being deficient from any cause whatsoever, steam may still be raised by means of coal in the same manner as is adopted in any other electric lighting boiler-house.



THE TOWN HALL, SHOREDITCH.

The cells have each a grate area of 25 square feet, and the boilers have each 1,300 square feet of heating surface. The flues are arranged in duplicate to facilitate cleaning, as one flue can keep the whole station going.

The cells themselves are not charged with refuse by hand, but by means of Boulnois and Brodie's patent charging trucks. This arrangement is novel as arranged at Shoreditch, although the principle has been adopted in many other district stations. This arrangement and the gear for handling the refuse are worthy of special note. At one end of the destructor-house two electric lifts have been erected to elevate the refuse to the tipping platform (Fig. 5). The dust-carts discharge their loads into large hoppers, mounted on electric bogies, which are placed on the lifts. When the hopper is full, it is elevated to the level of the tipping platform. There two electrical connections are made to two trolleys running on overhead wires. On the circuit

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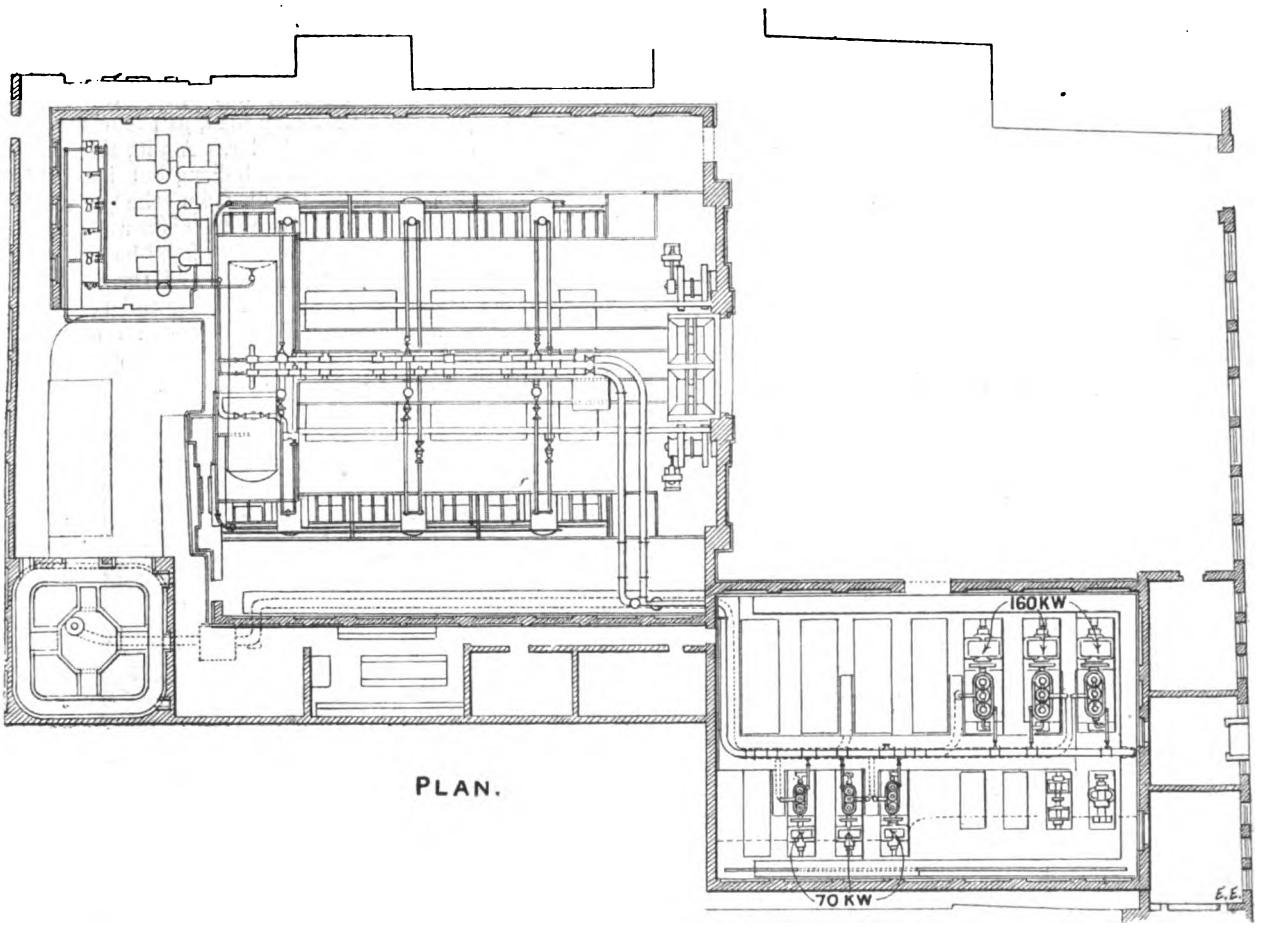
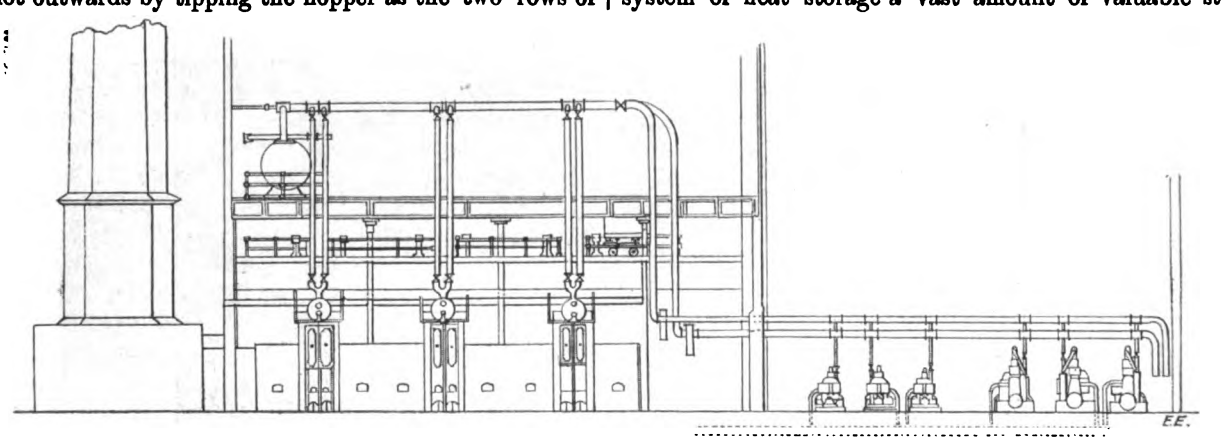
being closed the motor on the bogie moves the hopper along the rails, seen in Fig. 5, until it has reached the required position. If the refuse is required for immediate use, it is shot outwards by tipping the hopper as the two rows of openings on each side of the central bins discharge direct into the charging trucks. The central row of openings lead to the storage bins, where a certain amount of refuse can be kept till wanted. That this is a necessary provision will be understood when it is remembered that the dust-carts collect during the daytime only, while the destructor will cremate the refuse at a regular rate throughout the 24 hours. The two electric lifts are worked by one motor, which is geared to the hoisting drum by means of a worm and wheel running in oil.

The remaining feature of the destructor scheme is the use of Mr. Druitt Halpin's thermal storage system. At present one cylinder, 35ft. long and 8ft. diameter, has been installed, and is supported on the girders, shown in Fig. 5. The illustration (Fig. 6) of this cylinder as it was being hoisted into position is of general interest. Steam will be generated in the boiler at all hours, owing to the necessity of burning refuse continuously, and hence the working conditions are essentially different from those prevailing in the ordinary coal-fired boiler-house. On the other hand, light being required on a large scale only during some four to six hours out of the 24, it is obvious that without some system of heat storage a vast amount of valuable steam would be wasted. With the arrangements at Shoreditch, during the daytime, steam generated in the boilers will be passed into a thermal storage cylinder, where it will be mixed with a small quantity of cold water from the feed-



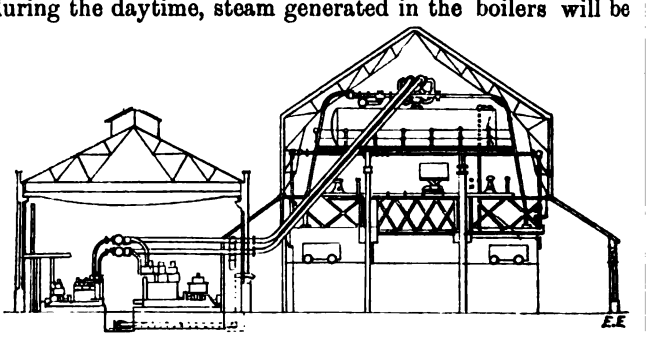
PLAN.

FIG. 1.—Plan of the Shoreditch Electricity Works and Refuse Destructor.



LONGITUDINAL ELEVATION.

FIG. 2.



TRANSVERSE ELEVATION.

FIG. 3.

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pumps, the proportions being such that when the evening approaches the cylinder will be full of water at the temperature and pressure of the steam required by the engines. The cylinder will then be shut off from the feed-

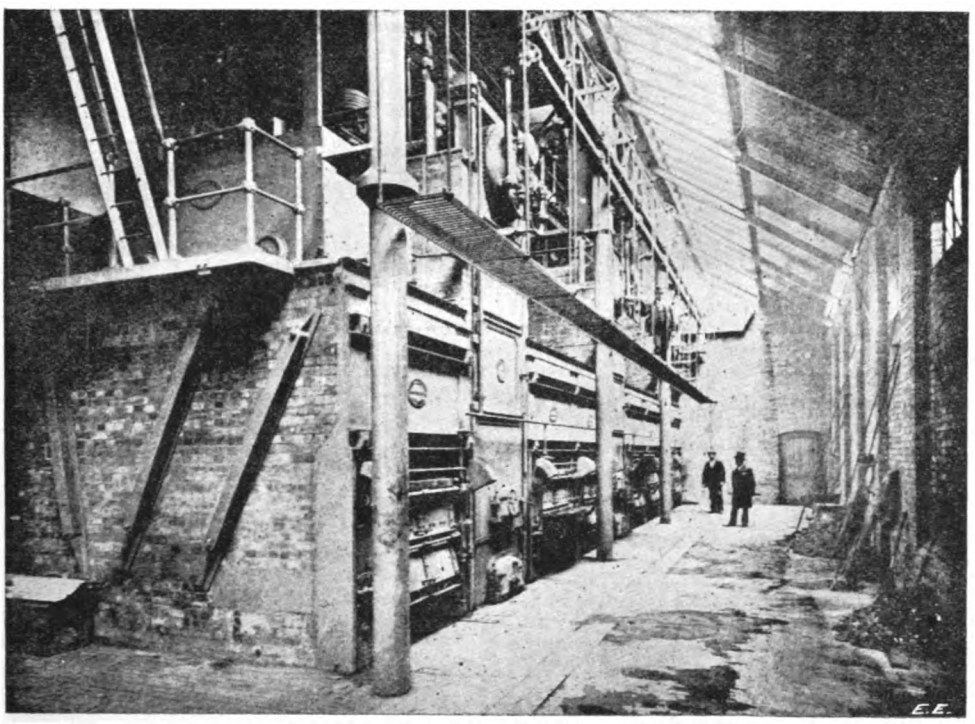

FIG. 4.—View of Front of the Boilers and Refuse Destructors at Shoreditch.

pumps and connected to the boilers, which in their turn are connected direct to the engines; hence, when the boilers require feed-water, they are supplied with it from the cylinder at such a temperature that the fuel that is then being burnt has merely to furnish to the water in the boilers the heat sufficient to overcome the latent heat of evaporation at the required pressure. The result of this arrangement is that the boilers are able to evaporate about one-third more steam than they would be able to evaporate were they fed direct. The importance of the thermal storage cylinder is further enhanced by the fact that it acts as a water purifier, as in it the deposit will be thrown down instead of in the boilers. When more storage cylinders have been added, steam will also be drawn from the thermal storage, but at present it will be used as a feed storage only. This important branch of the work includes all the equipment in the destructor-house, and has been superintended by Mr. H. B. Ransome on behalf of the contractors.

Steam and Exhaust Pipes.

The whole of the steam and exhaust pipes, as well as the feed-pumps and water-tanks, have been supplied and erected by the Thames Ironworks and Shipbuilding Company.

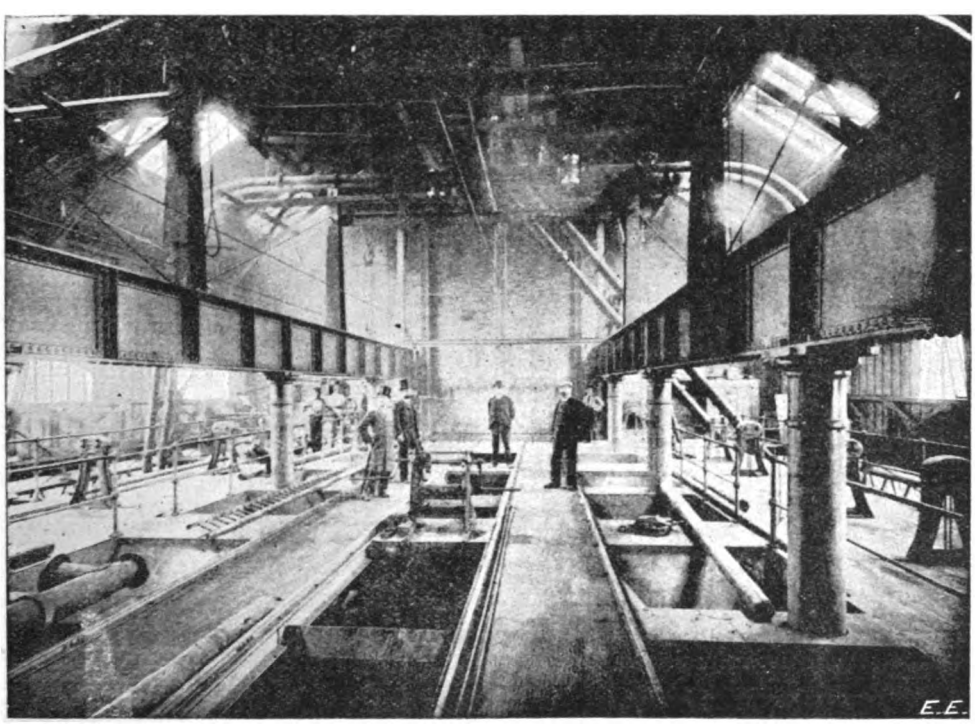

FIG. 5.—The Tipping Platform over the Refuse Destructors.

Every part of the steam-pipe system is arranged in duplicate, so that the risk of total breakdown, owing to one faulty pipe or joint, is avoided.

The main steam-pipes are 10in. in diameter, and are carried the whole length of the destructor-house near the roof, as seen in Fig. 5, which also shows the duplicate connections rising from the boilers to these main steam-pipes.

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The ranges are supported on iron columns with expansion rollers in the engine-room, and are placed down the centre between the high and low pressure plant. The pipes are drained when they leave the destructor-house, and again at the extreme ends of the pipes in the engine-house. Hopkinson's boiler fittings are used throughout. The connections to the engines are made by steel bends.

The exhaust-pipe runs along the bottom of the trench in the engine-room, and thence to the top of the chimney shaft. It is provided with tees and blank flanges for connecting up future engines, as well as the actual connections to the present engines. These connections are controlled by stop-valves of a sluice pattern, so that each engine may be shut off from the exhaust-pipe when not in use. At present it is proposed to use the exhaust steam to heat water for the baths being erected on the adjacent site, but connections are also provided so that a condenser or feed-water heater can be used in the engine-room if desired.

The boiler-feeding gear has also been provided in duplicate. The pumps are placed near the forced-draught apparatus. There are three pumps of the three-throw type, made by Messrs. Bailey and Co., each driven by a small donkey engine on the same bed-plate. The gearing between the pump and engine is of the skew-bevel type, and appears to work smoothly. Over the room containing this plant there has been erected a storage water-tank, which is 27ft. long, 18ft. wide by 6ft. deep. It is arranged in two separate sections, which may be used independently. Each pump drawing from this tank is capable of delivering 12,000lb. of water per hour against a boiler pressure of 200lb. Of course, it is intended, as described above, to feed as a rule the thermal storage tank, and then to let the boilers

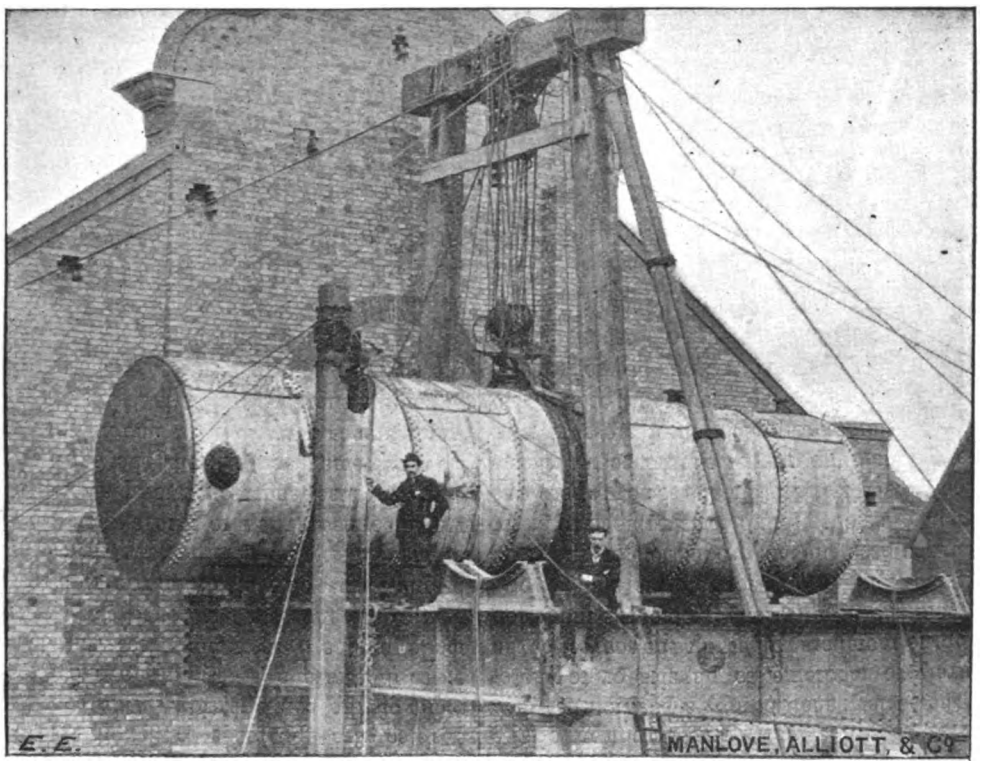

FIG. 6.—View of the Druitt-Halpin Thermal Storage Tank at Shoreditch.

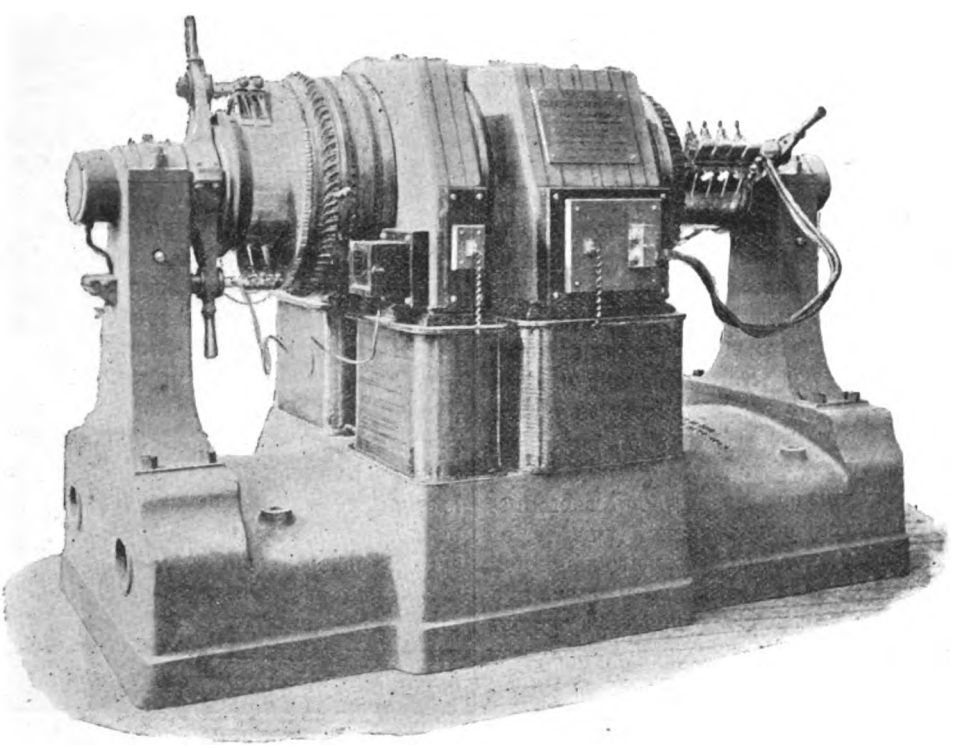

FIG. 7.—The Variable Ratio Continuous-Current Transformer.

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take their feed by gravity from this tank. The connections, however, allow of almost any combination of boiler feeding together with thermal storage feeding being adopted. The steam-pipes were tested to a high pressure before being passed, as they have to stand the normal pressure mentioned above.

Generating Plant.

The machinery for generating electricity and for transforming it at the sub-stations, together with the necessary switchboards and instruments, have been supplied by the Electric Construction Corporation, Limited, of Wolverhampton. There are two different systems of electrical generation and distribution used in the engine-house. One is the low tension, at an electrical pressure of from 150 to 165 volts, for direct supply to consumers in the immediate neighbourhood of the station by means of the simple two-wire network of conductors; and the other is the high-tension or "Oxford" system. For the former, three sets, or units, of plant are provided, each consisting of a Willans patent central-valve compound engine, G G G S size, running at 470 revolutions, indicating up to 115 h.p., and coupled direct to an Electric Construction Company's dynamo of 70-kilowatt capacity, at from 150 to 165 volts, the current being 425 amperes. These dynamos have bar conductor armatures of the latest type, with shunt-wound magnets, and are arranged with liberal proportions to secure a low temperature rise. The "Oxford" system generating plant, furnishing current for the outlying districts, works at the higher pressure of 1,000 to 1,100 volts. There are for this three sets of plant, each consisting of a Willans compound engine, I I I S size, indicating up to 260 h.p., and direct coupled to an E.C.C. dynamo of 165-kilowatt capacity. The current furnished by these machines, after passing the main switchboard, where all necessary measuring and controlling apparatus is provided, is supplied to rotary converters or transformers of the E.C.C. patent high-efficiency type situated in sub-stations. These machines, of which four have been supplied, convert the high-tension current into currents of lower pressure for distribution from house to house. Each transformer is controlled entirely from the generating station, being started and stopped automatically as the high-pressure current is turned on or off. It is connected to or disconnected from the low-tension network by means of a long-range switch actuated through the small pilot wires which run back to the station to indicate there the pressure at the feeding point. This switch and the pilot wires form the key to the successful working of the system, as by their use complete control is maintained over the whole of the distributing network and over all the sub-station transformers, which are cut in or out exactly as the load for the time being requires. By thus proportioning the running plant to the demand it is ensured that no part of the system is working uneconomically. Each transformer is further provided with an automatic switch, recently designed by the E.C.C., and used for the first time at Shoreditch, with a view to improve the self-regulating properties. This switch short-circuits the series starting coils immediately the machine is running at full speed; it is operated in the most simple manner by stray magnetism from the pole-pieces repelling an iron bar to which the necessary contacts are attached. The shaft bearings, lined with anti-friction metal, are furnished with oil force pumps and large oil reservoirs, so that lubrication is both automatic and liberal in quantity, the result being that the transformers, each of which is of 66-kilowatt capacity (equal to nearly 90 h.p., or to 2,200 lamps of 8 c.p. burning together), may be left for lengthened periods entirely without attention. It is on record that one transformer, started and stopped twice every day, ran with perfect success for a fortnight without having been once even inspected. However completely controlled and automatic in operation, the system is only seen at its best when aided by a secondary battery in one or more of the sub-stations, or, as in the case of Shoreditch, in the generating station itself. An electric accumulator, by taking up the supply during the time of very light load, enables the main steam plant to be shut down for sufficiently long periods to ensure thorough inspection and overhaul when necessary. To charge this battery, a small "volt-raising" or "booster" transformer has been put down, so that it is not necessary to detach any of the main generators for the purpose; the method, moreover, has the great advantage of enabling a good economic load to be maintained on the generators, irrespective of the lamp consumption, so long as they are under steam. Finally, as a connecting link between the high-tension and low-tension generators in the engine-house, another transformer is provided so that both high-tension and low-tension current are at all times available even though only the low-tension plant or the accumulator or only the high-tension generator were running. This transformer (Fig. 7) is of special interest, being of a new type which affords means for altering, through a considerable range, the ratio of transformation. It is known as a variable-ratio machine, and it is to be used either to produce low-tension while absorbing high-tension current, or to generate at high pressure while being supplied with current at low pressure. The reason of the special construction shown is as follows. With an ordinary motor-generator having a duplex-wound armature in one field the ratio of transformation is constant, and cannot be varied. Hence, any difference in pressure has to be made by adding resistance to one circuit or the other. The armature reactions of the two circuits balance each other, and hence no regulation of the lead of the machine for varying load is required. A variation of the strength of the field then only alters the speed of the machine. Now, in this new motor-generator the main armature is wound with both circuits as before. One winding, however, is continued across a smaller auxiliary core having a separate field. In this way, by altering the strength of this auxiliary field, E.M.F. can be added or subtracted from one of the circuits giving a variable transforming ratio. This method is much cheaper than having two separate machines coupled together, as has been done, and also the advantage of having the armature reaction balanced is practically retained. The size of the machine is 60 kilowatts, and it has the same high efficiency as the other fixed-ratio machines.

Switchboards.

All the switchboards used are fireproof, as should be the case in all central stations. The main switchboard is carried on an iron-framed platform high above the engine-floor level, over which it commands an uninterrupted view. It consists entirely of incombustible material, cast-iron frames being used throughout to support slate panel, on which the various instruments are mounted. The high-tension board is 22ft. 6in. long, and consists of three generator panels, six transformer panels, and four street arc-lighting panels. The low-tension board is 10ft. 6in. long, and is composed of three generator panels, one transformer panel, two battery panels (also controlling the booster transformer), and one circuit panel. The whole of the measuring instruments, with the exception of some Kelvin electrostatic voltmeters, and all the switch-gear, are of E.C.C. manufacture. The arc-light switchboard is arranged at present for joining upon three arc-lighting circuits to the main 'bus bars of the high-tension switchboard, as in the case of the high and low tension switchboards; this board is arranged for future extensions. A complete test-room equipment is also provided.

Public Lighting.

The public lighting at present consists of 57 standards supporting arc lamps, each post also being provided with two 32-c.p. incandescent lamps. There are also 36 incandescent lamps in by-streets. Owing to the economy effected in the consumption of current between midnight and dawn, the arc lamps are arranged to take more current than those generally used. Thus lamps, arcs taking 12½ amperes, are arranged in circuits of 19 in series, running off the high-tension 'bus bars at a difference of potential of 1,000 volts. Each lamp-post is fitted up with a cutting-in and cutting-out switch, and with one of Messrs. Glover and Co.'s (Edmund's) patent automatic switches (Fig. 8) for controlling the lighting of the incandescent lamps. These switches, which have been used successfully at Portsmouth for some time, are so arranged that during the time of running the arc lamps, should any one arc lamp or the whole circuit be accidentally extinguished, the incandescent lamps are automatically connected up to the low-tension network, whilst immediately the lamp in question or the

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series are relighted, the incandescent lamps are at once extinguished.

Mains.

The mains in Shoreditch have been supplied and laid by the British Insulated Wire Company and by Messrs. W. T. Glover and Co. They are all laid on the "drawn-in" system, and Doulton's earthenware conduits, as shown in

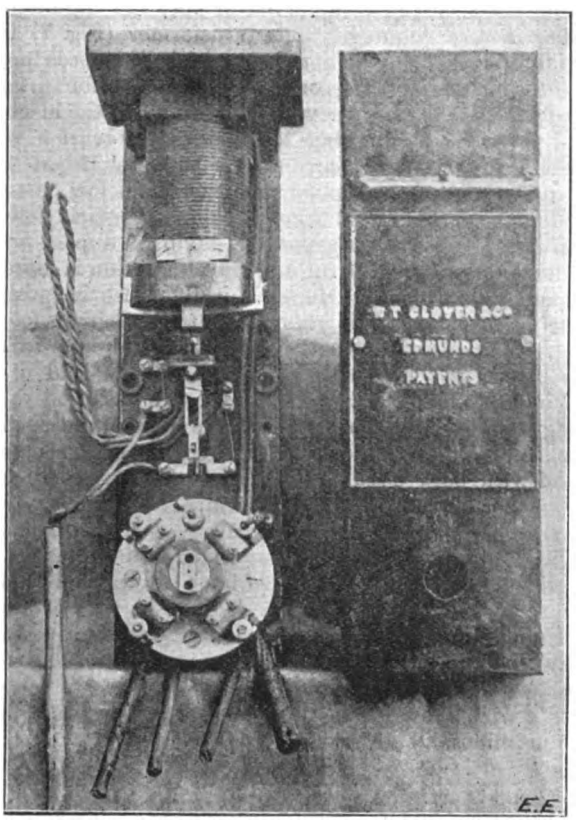

FIG. 8.—Elevation of the Edmunds Automatic Switch.

Fig. 9, are used. They were manufactured at Messrs. Doulton's Lambeth works, of their well-known hard-burnt glazed stoneware. Our illustration shows the three-way conduits, and two-way of the same type were also used, the size of the ducts in each case being 4in. by 4in. These types of Doulton conduit provide for making house connections at any point at a minimum cost, and without building special service boxes. In laying the conduits the ends of the lengths are brought together on a stoneware cradle, and the joint is rendered watertight with Portland cement, an operation which can be very rapidly and cheaply carried out. The distributing cables are drawn into one of the outside ducts—that nearest the houses. The conduits are manufactured by a patent method, which enables the top and side of this duct to be readily detached, giving access to the cables within. During manufacture a partial division of the substance is made, leaving sufficient material to preserve strength. The portion determined by the grooves may be at any time detached by means of a chisel. The part removed is replaced by a piece provided with a socket to receive the branch cables. The division between the conduit and the cover is of rebated cross-section, and facility is therefore afforded for making the longitudinal joint watertight. The other two ducts are occupied respectively by the feeders and arc-lighting circuits. The total quantity of conduit already laid exceeds 10 miles.

The three types of conductors used are as follows: high-tension concentric feeders, low-tension distributors, and high-tension arc-light conductors. These are drawn into separate ducts, while the pilot and telephone wires are drawn into the low-tension duct. The British Insulated Wire Company have provided and laid all the conduits above referred to, and all the drawing-in boxes, the concentric high-tension feeders, the twisted arc-light conductors, and a portion of the low-tension distribution network. The high-tension concentric feeders are of the type usually made by this company for alternating-current work, excepting that in this case the outer conductor is as well insulated from earth as is the inner conductor from the outer conductor, so that the whole of the high-tension feeder system is completely insulated from earth. In order to localise any possible breakdown between the two high-tension conductors in the concentric feeder, and, at the same time, to ensure the feeder being earthed if broken down, a copper tape has been wound around the dielectric covering the outer conductor before the lead sheathing was placed thereon. This copper conductor with the lead sheathing is well earthed at several points along the run of each feeder. The dielectric used is the British Insulated Wire Company's well-known paper insulation. The low-tension cables provided by this firm are single conductors insulated with paper and sheathed with lead. It was originally intended that the conductors, after being lead covered, should be finished off with braidings in the usual manner to protect the conductors from injury after drawing them into the earthenware ducts, but it was found that the surface of the earthenware ducts is so smooth that the cables can be drawn in, plain lead covered, without any braiding. This method was hence adopted for some of the remaining cable, as the braiding, when rotten, gives trouble if the cables have to be withdrawn. Messrs. Glover and Co. have supplied a large quantity of vulcanised rubber-covered insulated cables for the low-tension distribution network, about 20 miles of different sizes of the cables being drawn into the conduits. These cables are of the vulcanised rubber type this firm have supplied so largely for central-station work. Fig. 10 shows one of their junction-boxes used at Shoreditch. The low-tension distribution is at 150 volts on the two-wire system, at which pressure the consumers will be supplied. We understand that the gentlemen who have had charge of the laying of these mains have had no easy task. The district is honeycombed by water and gas mains *en route* for the City, and the path of

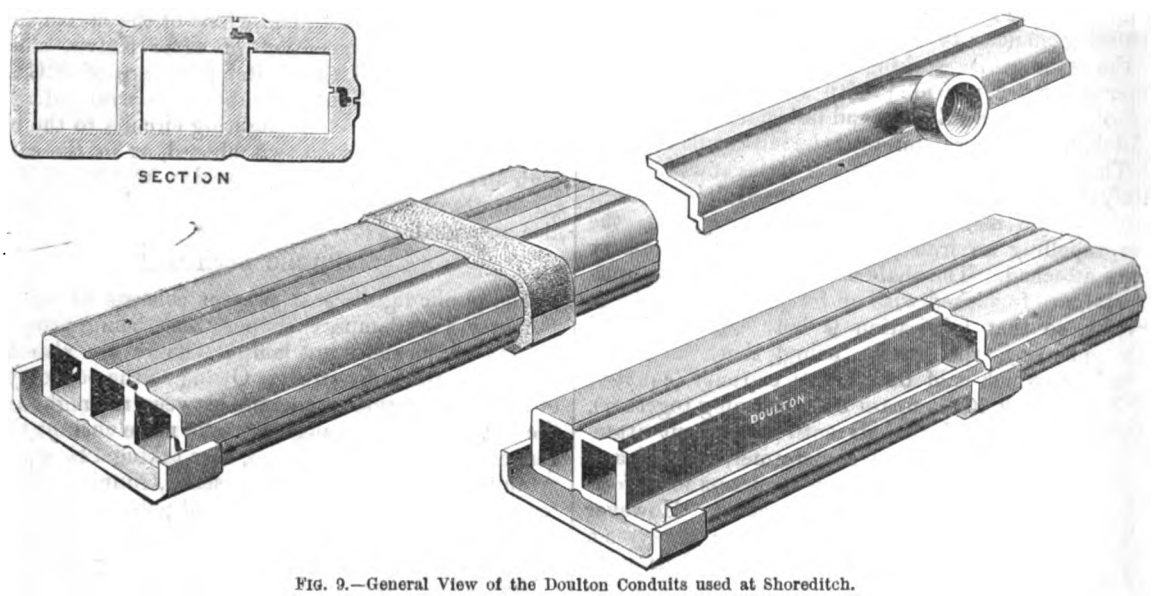

FIG. 9.—General View of the Doulton Conduits used at Shoreditch.

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the conduits is not a straight, if narrow, way by reason of these being added to the ordinary underground obstructions. The flexibility of the Doulton conduit was thus thoroughly proved, as well as the patience of those in charge of the job. In course of excavation the usual human bones were *not* found, but some ancient water-pipes of bored tree trunks and a venerable and holy well were discovered in Old-street and near Holywell-lane respectively. To avoid much cutting-up of the mains themselves, house and street-lamp service joints radiate from joint-boxes placed at intervals, which boxes are fed by a single joint on the low-tension mains. The brick street boxes are of varied sizes and shapes, to conform to the protuberant cellars of grasping landlords and the free-and-easy courses of the older established water, etc., mains. Jointers will appreciate some of the difficulties that their brethren laboured under in Shoreditch when they learn that a goodly number of joints had to be made in street boxes reeking with slime, poisoned by gas, and accessible only to specially-proportioned men trained as contortionists. The mains and conduit laying for the British Insulated Wire Company, Limited, was in charge of Mr. T. Harden, and Mr. J. Brooking superintended the work for W. T. Glover and Co.

Sub-Stations.

There are three sub-stations contemplated at present, of which the one at the junction at Curtain-road and Great Eastern-street is practically completed. This station is constructed under the street, but the other two will be in cottages bought by the Vestry for the purpose. Each of the motor-generators used in these sub-stations has an

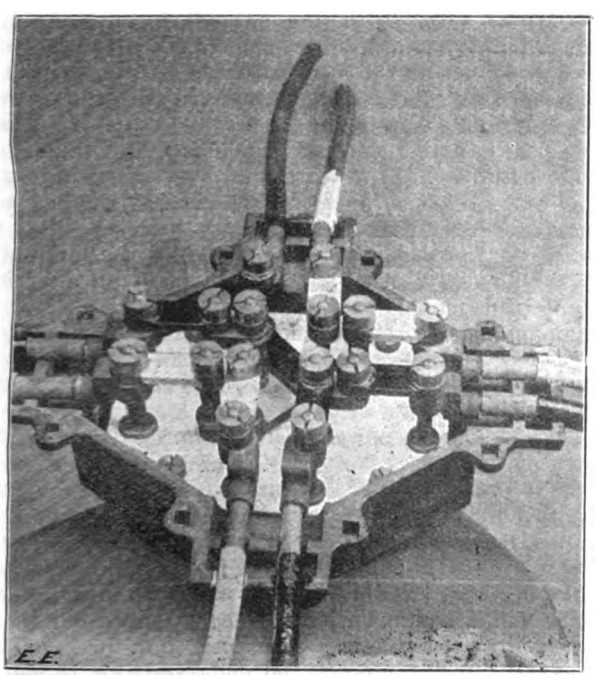

FIG. 10.—Glover's Joint-Box.

output on their secondary sides of 400 amperes at a maximum E.M.F. of 165 volts, receiving their primary current at an E.M.F. varying from 1,000 to 1,100. These machines consist of a single field magnet with a double wound armature, having a fixed transforming ratio between the primary and secondary windings of 1,000 to 150. The armatures run at a speed of about 450 revolutions per minute, and, as in the case of the generators, the high-tension windings of the armatures are of the Eickmeyer type. The battery of accumulators has been provided and erected by Messrs. Pritchetts and Gold. The battery is capable of discharging at a rate of 170 amperes for six hours at least, and of maintaining a minimum E.M.F. of 165 volts throughout the discharge. It is also to be capable of being discharged without injury to it at much higher rates, the maximum being 350 amperes.

The whole of the mechanical work has been put up under the supervision of the Vestry's chief electrical engineer, Mr. Charles Newton Russell, who has assisted Messrs. Kincaid, Waller, and Manville in that capacity, and the supervision of the laying of a considerable portion of the mains was carried out under Mr. R. F. Ferguson. The applications for a supply of current have been most numerous, the total number of lamps of 8 c.p. applied for before the station was set to work being 8,473. The system of charging adopted for current for lighting purposes is the Wright demand indicator system, 6d. per unit being charged for an average daily use for two hours of each lamp demanded through each half-year, and 4d. per unit for the electricity consumed beyond that average two hours' consumption. In addition, there are two rates of charging for current used for motive-power purposes—namely, 3d. per unit for current which may be demanded at all times of the day and night, and 2d. per unit for current that may be demanded during the hours of daylight.

Opening Ceremony.

The opening ceremony took place on Monday last at 2.30 p.m., and the "switching on" of the electric supply was effected by Lord Kelvin. A most representative gathering of eminent men were on the platform, erected in a marquee adjoining the station, and the tent was hardly able to contain the ratepayers invited to hear the speeches. They could not witness the switching on of the light, as for this purpose the ordinary switchboard was used. Then Lord Kelvin had to leave the platform in order to witness the shooting into the hoppers of a load of refuse and to turn on the electrical supply to the Shoreditch mains. The chair was taken by Mr. E. J. Wakeling, J.P., the chairman of the Vestry.

After the above ceremony had been performed, Lord KELVIN returned and gave his views on the installation generally. He characterised the system of burning the refuse, and using the steam so produced for electric lighting purposes, as a most excellent one. It was the first time the attempt to effect this had been made on such a large scale. The previous plan of having the Shoreditch refuse barged away and dropped into the sea was most unsatisfactory, as well as being more costly than the new method of cremating it. Shoreditch was, in his opinion, a pioneer vestry in this respect. But the present plant was only the small beginning of what would be a much greater thing. All their dust would soon be used in this way; and neighbouring vestries might come to Shoreditch and offer a considerable sum per ton if it would take their refuse and make light and power from it. Corporations were now waking up to the possible prospect of using electricity for the transmission of power; and it was almost certain that in Shoreditch, which was the centre of gravity of the cabinet-making industry, electric motors would be substituted for gas-engines, and much work would be done by energy obtained from dust and transmitted by electricity. He complimented the engineers on their carefully worked-out scheme, and on the way in which the work had been executed. Lord Kelvin then referred to the scale of charges in force at Shoreditch, and said that the electric light would be found to be cheaper than gas at 2s. 10d. per 1,000 cubic feet. He also commended the thermal storage system as used to supply feed-water to the boiler. He would finally advise all the people of Shoreditch to give the new illuminant and power a trial.

Mr. J. STUART, M.P., proposed a vote of thanks to Lord Kelvin for performing the opening ceremony, which Mr. J. LOWLES, M.P. seconded. Both gentlemen referred to the energy and foresight of the Shoreditch people in starting such a list of municipal works. The vote was carried by acclamation.

Mr. H. E. KERSHAW, the chairman of the Electric Lighting Committee, then made a statement as to the character and extent of the works now opened. He said the total cost was about £70,000, which sum the County Council had lent them at 2⅞ per cent. They had provided two systems by which the poor man would be supplied without having to incur the first cost of wiring. The first was by a prepayment meter, charging 1d. for six hours of an 8-c.p. lamp; the other system was that of the Free Wiring Syndicate.

Mr. W. H. PREECE then moved a vote of thanks to the engineers—Messrs. Kincaid, Waller, and Manville—for the skill with which they had designed the works, and for their careful superintendence of the works during construction. After a humorous speech about curling ladies' hair by electricity, etc., he prophesied that the price per unit will soon be reduced.

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Prof. GEORGE FORBES recounted some facts in the previous history of refuse destruction schemes, and then referred in glowing terms to the present work. He had pleasure in seconding the vote of thanks.

Mr. E. MANVILLE, in reply, said that Prof. Forbes had modestly refrained from stating that he himself had taken an active part in advocating the use of the heat from refuse destruction for generating electricity. He thanked those present for their kindly expressions of appreciation, and said that without the support of the Vestry their schemes could not have been carried out. Mr. Manville then detailed the excellent work done by the various contractors, to whom, he said, equal thanks were due.

Votes of thanks to the Shoreditch Lighting Committee, and to the chairman, were then proposed and passed.

This ceremony was followed by a dinner at the Shoreditch Town Hall, to which some 250 guests sat down. After the dinner, a full toast-list was gone through; but the crowded state of the galleries, which were opened to spectators, rendered most of the speeches inaudible. The chair was taken by Dr. W. J. Collins, the chairman of the London County Council.

MUNICIPAL ELECTRICAL ASSOCIATION.

SECOND ANNUAL CONVENTION, MANCHESTER, JUNE 30.

This convention was duly opened with commendable punctuality and without ceremony in the Mayor's parlour at the Manchester Town Hall on Wednesday last. The room was crowded with members and invited guests.

Wordingham, Charles Henry.—Born 1866. Educated at King's College School, London, from 1876 to 1882, from 1882 to 1885 at King's College, London, in the department of applied sciences; took up complete three years' course of engineering; obtained Clothworkers' Exhibition for science, eight prizes, and 22 certificates; on leaving was elected associate of the college (A.K.C.) and was presented with a special certificate of honour. On leaving college was articled to Dr. John Hopkinson, F.R.S., for two years; had charge of his laboratory and carried out a large amount of original research under his direction, also assisted him generally in his consulting work. On completion of articles with Dr. Hopkinson, went to United Telephone Company for rather more than a year; engaged chiefly in the erection of telephone exchanges. In 1889 joined the London Electric Supply Corporation as third engineer at their Grosvenor generating station. On the removal of the works to Deptford was appointed to take charge of the standardising department, the whole of the testing plant for which he designed. Subsequently had charge of the distributing stations in addition to the standardising department. In 1892 left the London Electric Supply Corporation to return to Dr. J. Hopkinson as his assistant, and was engaged in supervising on his behalf the carrying out of the contracts for the erection of the central stations at Manchester and Whitehaven. In December, 1893, proceeded temporarily to Manchester to organise the staff and working arrangements of the station, and in March, 1894, at the invitation of the Manchester Corporation, accepted the permanent position of chief engineer of the electric works, since which time he has managed the entire undertaking. In July, 1894, when Dr. Hopkinson's agreement with the Corporation terminated, he became consulting engineer in addition to his other duties; and additional plant to the extent of 3,000 h.p. has already been laid down under his direction, while that for another 5,000 h.p. is now being added. The area of supply also has been quadrupled. Was elected student in 1884 and associate member in 1892 of the Institution of Civil Engineers; student in 1894, associate in 1887, and member in 1894 of the Institution of Electrical Engineers, and is now a member of council of this Institution; member in 1894 of the Institution of Mechanical Engineers; member in 1894 of the Northern Society of Electrical Engineers, and has been for three years member of council of this society; is a member and was one of the founders of the Municipal Electrical Association, and is now president of this association; is a life Fellow of the Imperial Institute. He is the author of two papers presented to the Institution of Civil Engineers, one on "Telephonic Switching," the other on "Meters for Recording the Consumption of Electrical Energy." Both received Miller prizes, and were printed in full in the *Proceedings* of the institution, and the second has been republished in book form in America.

Upon taking the chair, the PRESIDENT stated that the Mayor was unavoidably absent, and that the programme being so lengthy he would detain them with no further remarks, but proceed at once with the business of the meeting.

Presidential Address.

BY C. H. WORDINGHAM, A.M.I.C.E., M.I.M.E. AND E.E.

To elect a man to the office of president is to confer on him the highest honour which is in the power of the members of a society, and I desire to express my very keen appreciation of this honour, which is the greater since this is but the second year of the existence of the association. Contrary to the custom in most societies, your president assumes office formally when his tenure of it is approaching an end, and when his responsibilities are about to cease. Instead of promises as to the future, it rests only with me to say that I have done my utmost during the past year to further the objects of the association in every way in my power, and I can only add that I hope to continue to do so in the future, whether as a member of council or as an ordinary member. Not the least of the responsibilities of a president is the preparation of a presidential address, and in the present instance there are special difficulties which do not usually arise. It is the custom on such occasions either to bring forward an account of some special investigation, or to give an historical review of progress during some long period. The former method is not suitable to an association of this kind, neither is the second available, for our association can hardly be said to have a past, though I trust and believe that it will have a useful and perhaps brilliant future. It may be thought by some that I should give a review of engineering progress, but such reviews have been given in other addresses by engineers infinitely more able than myself, and who have, moreover, a long vista of years in which to find incidents coming within their own personal experience, and to this I can hardly yet lay claim. I purpose, therefore, confining my remarks to the present, and endeavouring to indicate some of the directions in which I think the association may increase its sphere of usefulness.

First, as regards the association itself, we have every reason to be proud of the progress which has been made. Our roll of membership already reaches 139, of which number 51 are engineers, 41 are committees, and 47 are associates. The objects of the association appear now to be much better understood by the technical public than at first, and there seems every reason for congratulation that the association was formed, and that the lines of its constitution were those decided upon. As was pointed out by some of us at the beginning, there is really no room for another purely engineering society, but there is great need for an association which takes cognisance of the commercial and managerial aspects of electrical engineering as carried on by municipalities. The association is becoming recognised more and more each day as embodying the views of municipal authorities, and there can be no doubt that the meeting held in January last in connection with the question of fire insurance was productive of good results, and was very useful to all members. Evidence has been forthcoming that the association is already much appreciated by

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all classes of municipalities, not least by those smaller and more remote ones which find in it a means of keeping in touch with what is going on in the electrical world. One corporation, with the full approval of the contractor, has nominated the president of the association as arbitrator in the event of disputes arising under certain contracts, and it seems probable that arbitration will be one important function of the association in the future. As showing the standing we already have with bodies other than corporations, I may mention that recently the council was approached and consulted in an important matter by a committee of manufacturers, but it would not be proper to more particularly refer to this at the present time. The response to our applications to visit the works of manufacturers has been most gratifying, and shows the feeling of regard entertained towards our members, the number of invitations being more numerous than we could accept.

As will be seen from the programme, we have an immense amount of work to get through at this convention, yet there are several subjects not included which we have had strongly pressed on us by members, and which are of great general importance. There is no doubt that in order to deal with all the subjects we shall be obliged either to have one or more special meetings of the same character as that held in reference to fire insurance, or else to have two conventions a year. At the business meeting to be held on Saturday next there will be presented to the members the council's report on the constitution, and I need not therefore enter into the matter here; but it will not, perhaps, be out of place if I remind those members who were present at the meeting when the association was founded of the very strong manner in which I urged that committees should be admitted to membership. To this the meeting finally assented, and I feel convinced that to this step is due in large measure, if not entirely, the success which has been attained. Without the presence of the gentlemen representing committees the association could have carried but little weight in any matters requiring united action. At the meeting referred to it will be remembered that I also urged that representatives of committees should be eligible as members of our council. On this point, however, the meeting did not agree with me, but I foresaw that ultimately they must be admitted, for you cannot have two classes of members, and only one of them represented on the council. That this was strongly felt was evident at the last convention, and I trust that at the present one the members will adopt the report of the council on the subject. The desirability of admitting assistant engineers as members in certain cases has been repeatedly urged upon the council, and I have personally given the matter very anxious and careful consideration. It may well be that the principal assistant in a large station is quite as well qualified for membership as the chief of a small station, or even better. At the same time his responsibilities are not of the same nature. It is extremely difficult to differentiate between assistants, and to decide what qualifications it is necessary to require them to possess to render them eligible for full membership. I must not enter into this matter further here, but I am hopeful it will be found at the business meeting that a satisfactory solution of the problem has been arrived at. The various directions in which the association might be of use were so ably set forth by our former president, Mr. Arthur Wright, and the field described was so extensive, that I think it is unnecessary for me to add much to it. There are, however, one or two suggestions which I may make. If carried out, they would, I believe, be of great use to members, and they might be initiated at once.

All those in charge of a station must have felt the difficulty of laying their hands at short notice on suitable men for various kinds of work. I am not alluding now to heads of departments, but to workmen, and those minor assistants such as draughtsmen, inspectors, and others, of whom a plentiful supply exists, though not available for want of suitable organisation. I would suggest that the association might keep a register of the various classes, and enter therein the names of suitable men seeking employment, on certain conditions, the leading ones being: (1) that the candidate is proposed and recommended from personal knowledge by a member of the association, and is supported by two other members from trustworthy information; (2) that he produces at least two testimonials from former employers, such employers not being his proposers or supporters; (3) that he gives an account of his experience sufficiently detailed to enable an employer to form an estimate of the training he has received. If this suggestion were carried out, there would be compiled a list of men of good character and of suitable attainments, and any member of the association having a vacancy would be able to apply to the secretary, and would be practically certain of obtaining an efficient man. The convenience of this will be patent to everyone who has charge of a station, and I feel sure that such an organisation would be of immense practical service.

It frequently happens that, as stations extend their operations, the plant which was best suited to them in their early days becomes too small to be of any practical utility, and it becomes expedient to dispose of this plant and substitute larger generators in its place. The old plant has probably been maintained in a condition practically as good as when it was new. In some senses it is even better, inasmuch as it is well tried, and has attained, so to speak, a stable condition. Now this plant would be in all respects suitable for a station just starting, and might with great advantage be purchased instead of new if it could be known that it was available. If then the association could step in, as in the case of employers and employed, and bring together sellers and purchasers by means of a register of such plant, the interests of all would be served, and considerable advantage to members would ensue. It may be said that these two proposals would entail great work upon the secretary. This is undoubtedly true, and so long as our secretary is honorary he could hardly be expected to undertake it. If, however, other members of the association equally self-sacrificing and generous would come forward, the work might be subdivided and a different member be responsible for each of the two registers, thus relieving the secretary entirely of this portion of the work. I look forward to the association later on being in a position to make arrangements for the practical testing and stamping of electrical fittings and apparatus, for I feel convinced that only by some such means will the smaller towns be able to secure good work being done on their circuits. If a model set of general rules can be issued by the association with the approval of the Board of Trade, and if it can certify that certain apparatus is of satisfactory quality and efficient, the question of safe and cheap wiring will be greatly simplified.

The question of the status of municipal engineers is one greatly concerning members of this association, and it is a matter for satisfaction to observe that municipal authorities are at length beginning to recognise the importance of the duties discharged by their electrical engineers. At the beginning of the enterprise the salaries offered and paid were such as could not possibly secure, at any rate for any length of time, the services of competent engineers. Such engineers as did accept the positions in all probability did so solely with a view to securing experience, and a corporation is apt to find that salaries paid in experience instead of cash are extremely high. It should be manifest to any person who will consider the subject that the wise and economical expenditure of large sums of money on so highly technical a subject as electric supply, a subject which requires long years of close application and expensive study, cannot be secured by the employment of men at a salary less than that of an ordinary clerk, or even of a common workman. A few towns, however, which it is unnecessary to particularise, have to their credit set the example of the payment of salaries more nearly adequate to the services required, and in time there can be little doubt that all towns will have to follow suit—some learning wisdom by bitter experience, others copying the example set them. In the case of small towns, it appears to me that it will be impossible for the amounts necessary to secure proper men to be paid, and in my opinion a suitable solution of this difficulty would be the combination of several such towns to secure the services of an engineer to direct and manage their undertakings, each authority having in addition a resident assistant engineer.

(Continued on page 17.)

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THE SHOREDITCH SCHEME.

We have had during the past few years many schemes before us for combining refuse destruction and electric lighting plants. In several such schemes that have been completed we have reported the opening speeches, in which great savings from the combination have been expected. We regret to say that in most cases these predictions as to the regular supply of steam available have never been fulfilled in the slightest degree. This fact, however, does not detract from the value of the two separate plants, as the refuse destructors in question have been able to fulfil their primary object of destroying refuse, and to do this work at a price below that of the older methods of disposal. All the refuse is, as a rule, destroyed in a sanitary manner, without causing any nuisance to the neighbourhood. In the same way, the electrical undertakings have paid even without the help promised in the way of free steam from the refuse destructors. As the two separate items in the older combined schemes have been financially successful, the ratepayers interested do not inquire into the working, and the statements above referred to as to the advantages derived are supposed by many to have been realised. The fault as a rule has been with the refuse destructors, which were constructed in defiance of all accepted rules governing the design of steam-raising plant. Thus the destructor cells were usually bunched together and connected by a long flue to the shaft. The boiler was then placed somewhere in this flue and carefully provided with by-passes to prevent a too large quantity of water being evaporated. Natural draught was used, and in most cases the temperature in the furnace was low. Hence, by the time the gases from the different furnaces had mixed together and reached the boiler, their temperature was too low to do much steam raising. In the Shoreditch plant, opened last Monday by Lord Kelvin, the problem of steam raising from ashbin refuse has been attacked by Messrs. Kincaid, Waller, and Manville from a scientific standpoint. The various defects referred to above have been removed one by one. Thus the boilers, which are of the water-tube type, are each sandwiched between two destructor cells, so that the destructor furnaces and the boiler furnaces are side by side. Hence a very short path for the gases is provided, as they pass directly from the front of the destructor firebars, through the firebrick partition, on to the tubes of the boilers. The boiler firebars are retained so that the coal can be burnt on them in times of heavy load, when the heat from the burning refuse will not be sufficient to cope with the demand. The next improvement is the use of forced draught, by which an increased temperature is obtained in the destructor furnaces. In some of the old types the refuse simply smoulders away, giving off noxious fumes, but at Shoreditch on Monday we noticed that all the furnaces were delivering incandesced gases to the boilers. This, from a sanitary point of view, is what should occur, as the high temperature destroys all the malarial fumes; and, again, the lowering of the temperature of these gases in heating the surface of

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the boiler gives off useful work. The furnaces are fed from the top on to sloping firebars, so that the refuse is allowed to heat up somewhat slowly as it descends to the part of the bars where it is kindled and burned. Any gases given off in this period are drawn over the burning refuse and consumed. Leaving now the destructor part, we must pay our tribute to the excellent design of the electrical system, which is in every way suitable for taking advantage of the regular supply of steam promised. The high-tension direct-current system allows of the use of accumulators, which can be charged up at periods of light load. It also provides for the use of direct-current motors, which, in Shoreditch, are likely to be much in demand. As regards the results expected from this combined scheme, we consider that the engineers—Messrs. Kincaid, Waller, and Manville—and the contractors—Messrs. Manlove and Alliott—have taken every precaution to ensure success. Still, courage, both on the part of the Vestry and the engineers, is wanted to bring out new schemes of this kind. It is, therefore, gratifying to know that if for some unforeseen reason the results obtained should be below those expected, there is still for the Vestry a very wide margin of advantage from the combination. The station was certainly being run by steam raised from refuse on Monday last; and we await with interest the figures to be obtained from the regular working of the plant.

MUNICIPAL ELECTRICAL ASSOCIATION.

Presidential Address.

(Continued from page 15.)

Such a course would be far preferable to that now obtaining in some towns, where the electrical engineer is placed under the control of the manager of some other deparment of the corporation's work; for however excellent such an official may be in his own department of engineering, it cannot be expected that his knowledge of electrical work should be more than superficial, and the effect of the arrangement will almost certainly be to mar the success of the undertaking. Efficient operation must of necessity depend on the electrical engineer, and few men work well or heartily unless they have full confidence in those over them, and are allowed responsibility for their actions, together with the credit or discredit ensuing from them.

While insisting upon the importance of the duties discharged by municipal electrical engineers, I feel that there is another side to the question. I have met some of these gentlemen, who seem to take an altogether exaggerated view of the importance of their office, appearing to think that all other departments of the corporation are insignificant compared to their own, and that the officials connected with them are hopelessly unenlightened and behind the times. Much can be done electrically, but it is not probable that the entire machinery of a municipality will be wholly worked in this manner for some time to come. I must not, however, be understood by these remarks to wish in any sense to belittle our responsibility. On the contrary, I believe that the future of electrical engineering as a profession depends largely upon municipal engineers. Their numbers, and the importance of their undertakings, are increasing daily. In my opinion, the class of consulting engineers will in the future be largely recruited from their ranks, and on the consulting engineer depends, after all, the inception and success or failure of most electrical enterprise. I myself cannot view without the deepest concern and apprehension the present tendency of many electrical engineers. The old traditions handed down by the civil engineers, who have made the reputation of Great Britain as the foremost engineering country in the world, are openly scoffed at, and a large section of men appear to see nothing degrading in canvassing and advertising, and in joining in a competition more worthy of an enterprising cheap-jack than a member of an honourable profession. I have often been told that everyone advertises, and that the only difference is in the form of the advertisement. This I deny. It is true that if good work is done by a man it will be known, but as good wine needs no bush to proclaim its merits, so his work will be known by its results, and it appears to me that few can honestly maintain that this is advertising in the same sense as canvassing and newspaper paragraphs are. It behoves municipal engineers to set a high standard of professional probity, uprightness, and independence, and, if you will, etiquette. If they will only live up to the traditions of the founders of the engineering profession, they can and will save electrical engineering from becoming a mere trade, with the sordid appendages too often connected with commerce.

While speaking of their duties, I would wish to point out a pitfall which awaits engineers no less than ordinary mortals, and that is the danger of being led away by a fashion, a fashion often brought about by what, to use a modern word, is known as "booming." A type of plant, a dielectric, a system of working supposed to be new, is introduced. It operates successfully in one or two cases. Immediately there is a chorus of praise. Every other method, and every other type of plant, is condemned. The fashion is set, and everyone must rush to make alterations, or he is supposed to be behind the times, without intelligence, and ignorant. On what evidence is the change made? Often on none at all worthy of the name; a few leading articles in the technical papers, a considerable amount of gossip, and a few positive assertions from interested parties. Let every engineer make his own direct enquiries. Let him try the new thing on a limited scale, and get his own experience of it. Let him use his own reason, and care nothing for what he hears unless it be proved, and then let him weigh well the advantages and disadvantages, and consider whether, after all, the old methods are not as good as the new, or better, and then let him make up his mind to act quite irrespectively of what other people may think. I venture to prophesy that in the long run he will find that he has done better not only for the undertaking with which he is connected, but for himself and his own reputation, than if he had been in the fashion. It may not perhaps be amiss if I venture to give a word of advice to assistant engineers. It would be well if they would bear in mind that all cannot be first, and that in large stations there must of necessity be good secondary berths. In some of the more important towns the magnitude of the electrical undertaking is at present as nothing compared with what it will almost certainly be in the future, and those who obtain a footing now and work steadily and contentedly for a few years will probably find themselves in a far better position at the end of that time than those who, tempted by a small immediate advance of salary, abandon their chance in the large concern and take a position in a town where the electrical development can never be very great, with the result that they stagnate and become shelved. It is a fatal mistake for a man to be constantly shifting from station to station. A certain amount of variety of experience is, of course, necessary, but it is those who are associated with the development of an undertaking, and who evince an interest in its affairs and concern for its well-being, who will ultimately succeed.

A matter which very closely affects committees, and more especially their chief engineers, is the question of the provision and supply of an adequate and competent staff. At the present time, when so many new stations are springing up, this difficulty is aggravated, for new berths are being created week by week, and a supply of engineers-in-charge must be had, and is naturally drawn from assistants at stations, even though these assistants may have had no experience whatever of the managerial portion of the work required; and let it be understood it is as important for an engineer-in-charge to be a good manager as a good engineer.

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Neither one class of knowledge nor the other can be dispensed with; both must be combined in one man if the undertaking is to be a commercial success. No doubt the present state of things is temporary. There must arrive a time before many years are over when practically all towns of any importance will have established their electric supply stations, but meanwhile the problem confronts us, how are we to retain our assistants, and, if they secure good positions, as it must surely be the desire of us all that they should, how are we to replace them?

(To be concluded.)

Mr. ARNOT (Glasgow) moved a vote of thanks to the president for his address. Whether they would all be able to follow his advice or not depended upon the circumstances of their several spheres.

Mr. J. H. RIDER seconded the vote, and it was formally carried.

The first paper taken was:

The Generation of Steam.

BY JOHN F. C. SNELL, A.M.I.C.E.

Snell, John F. C, A.M.I.C.E, A.M.I.Mech.E., F.G.S., M.I.E.E. Son of late Commander Snell, R.E., born at Saltash, Cornwall, and educated at the Plymouth Grammar School, and afterwards attended King's College Originally intended for cadetship, R.N., but rejected through defective sight. Articled to Woodhouse and Rawson 1883-1889, when he was transferred to Messrs. Crompton and Co., by whom he was engaged at the Kensington Court central station, one of his duties being to change over from two to three wire system; from thence transferred to Notting Hill central station as one of two engineers for Messrs. Crompton and Co., resident during the carrying out of that works. About this time he designed a single insulator system of bare copper mains, tried by Mr. Crompton at Notting Hill, and subsequently laid at Stockholm and (with further improvements in insulators by Mr. H. W. Miller) at Hull. After 18 months at Notting Hill, sent to Stockholm to lay mains for lighting of city. At end of 1891 was offered post of electrical inspector at Crystal Palace during exhibition of 1891. In April of that year was offered (at suggestion of Mr. Crompton) and accepted post of resident engineer for General Webber, C.B., R.E., at South Kensington, where he was engaged upon designs for large electric light and hydraulic station, besides superintending part erection of heavy steelwork. Six months later became chief assistant to General Webber in his consulting practice, and engaged upon several schemes, tramway tests, and surveys. In October, 1893, was offered by Prof. Henry Robinson and accepted position of chief assistant engineer at the Stanhope-street station, St. Pancras, and at latter end of 1894 became resident engineer for Prof. Robinson during the equipment of the King's-road station, sub-stations, and mains (five-wire system), upon completion of which he was unanimously appointed by the Vestry as resident engineer in charge of that station. In August of last year was appointed borough electrical engineer at Sunderland, which position he now holds.

Few matters can be of more importance to a central-station engineer than the means by which steam is raised in his station. The selection of the type of boiler, the proper treatment of the feed-water, the method of firing, the general economy of the steam-raising appliances, and the up-keep of the plant, are all factors which engage the serious attention of the designer. The object of this paper is to bring before you the types of boilers in use and details in connection with them so that they may be discussed to our mutual advantage. In Table 1 figures of the four types with which we have to deal have been tabulated—viz.: (1) Lancashire; (2) water-tube; (3) dry-back marine or "Economic"; (4) marine—from which will be obtained the evaporation, floor space, and approximate cost per 1,000lb. evaporated, and other data. It will be an advantage to take the types seriatim.

Lancashire.—A Lancashire boiler takes 69 square feet of floor space, and costs erected £76 without, and £99 with, an economiser per 1,000lb. maximum evaporation. The average pressure is from 120lb. to 150lb.; but there are many in use working at 200lb. pressure. A Lancashire boiler cannot be considered complete without an economiser in series with it; for the temperature of the exit gases not infrequently exceeds 600deg., whereas after leaving the economiser, the temperature is reduced to about 300deg. The advantages may be claimed to be: large steam space, with dry steam, accessibility for inspection and cleaning, and small cost of repairs. The disadvantages are: the length of time required to get a cold boiler under steam, waste of water while warming up, which usually obtains, and (though only very occasionally) collapse of flues when improperly cleaned, or when fed from the hot-well of a surface condenser. The loss of water during warming up can be got over by the use of a hydro-kineter in lieu of the barbarous method of running water out of the blow-off. The boiler is very generally favoured; and certainly, in the author's opinion, is hard to beat. It is economical, both in evaporative duty and in cleaning; in the latter item, probably the cheapest of all boilers. After having had charge of six of this type, the author has found that a 30ft. by 7ft. 6in. costs about £9 per annum for flue cleaning and inside cleaning. This figure does not include re-grinding of any valves, or repairs to fittings; but solely the cost of the boiler cleaning. At the same time it can be forced to burn over 30lb. of coal per square foot of grate area if needed, though, of course, with a decrease in the evaporation per pound of coal. It also can be economically worked by either hand-firing or mechanical stoking. In line I. of the table, the evaporation was 12·46 from and at 212deg. F. with mechanical stokers, and in line II. 11·76 hand-fired, at rather a quicker rate of combustion. A well-known authority, Hutton, on "Steam-Boiler Construction," gives the average life of a Lancashire boiler at 33 years.

Water-Tube.—This has for its chief advantage small floor space, the space required being 34·4 square feet, and the approximate cost £96, erected, per 1,000lb. evaporation. It is a quick steam raiser, and greater safety at high pressure is also claimed. The disadvantages usually advanced are small steam space, wetness of steam, frequent repairs to firebrick lining, and costliness in cleaning. The author has had to deal with over a dozen of these, and certainly believes in the advantages enumerated, and does not think that steam will be necessarily wet, if steam receivers are added to the drum; also if the firebrick lining be tied into the brickwork here and there, the bulging is much reduced and the lining does not fall in. The cleaning is certainly a costly business comparatively; but presumably this type would only be adopted where the water is either naturally soft, or is treated before entering the boiler, thereby allowing the boiler to steam for longer periods. It is of the greatest importance that steam should be able to be raised quickly in a stand-by boiler, and a water-tube is certainly the quickest steaming boiler, and probably the safest in such a case. There is probably more fuel required to keep this boiler up to pressure when standing by than is required by a Lancashire. It is more difficult to keep an even steam line, and a fireman needs to be specially used to this type. It is economical in evaporation, and the temperature of the exit gases is often as low as 250deg. F. when not fired too hard, which means a high efficiency. The cost of cleaning a boiler evaporating, say, 5,000lb. per hour maximum, with a fairly soft feed, may be taken at £24. 12s. per annum, including cleaning of flues, scraping tubes, repairs to firebrick lining, and occasional replacement of a tube. Hutton gives the average life as being 15 years only, but it is presumed this only applies to the tubes; and the drum and headers should be as long lived as any Lancashire or other type of boiler.

"*Economic.*"—This boiler has been adopted in many stations, especially in London, from the comparatively small floor space combined with small headroom required; it requires 34·4 square feet floor space, and costs about £94 per 1,000lb. evaporated. It is also a quick steam raiser, and to some extent combines the advantages of both Lancashire and marine boilers. The treatment of the feed-water is as necessary in this case as in a water-tube, unless naturally soft; as for that, this is equally important whatever the type of boiler be. The addition of a hydro-kineter to warm up the water under the flue tubes should be made, though this boiler is better situated than a marine in this respect; the author would expect to find that the greater number of British thermal units are utilised with this boiler on account of the prolonged contact of the gases with the boiler, and therefore the boiler is highly efficient. It must be more

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	Type of boiler.	1 Floor space.	2 Grate area.	3 Heat surface.	4 Pounds of coal per square foot grate.	5 Evaporation per pound of coal.	6 Evaporation from and at 212deg. F.	7 Total evaporation per hour.	8 Temperature feed.	9 Chimney draught.	10 Temperature flue gases exit.	11 Steam-press. gauge.	12 Kind of coal.	13 Calorific value.	14 Approximate cost per 1,000lb. evaporated.	15 Depreciation per annum.	16 Floor space per 1,000lb. max. evaporation.	17 Fuel per hour, stand-by.
1	Lancashire Vicars stoker 96-tube economiser	11·3′ by 32·5′	21	936	16·8	10 7	12·46	3 760	202°	0·6″	473°	120	—	—	£99	5%	90 (with economiser)	24lb.
2	Lancashire Without economiser Hand-fired	11·5′ by 35′	22·5	1,000	23·6	10·08	11·76	5,363	42·4°	0 75″	435°	125	Best Welsh	—	£76	3%	69	—
3	Babcock and Wilcox	25	25	—	13 44	10·73	11·52	2 606	156°	—	—	—	Scotch coal	—	—	—	—	—
4	,, ,,	—	15 5	983	20·9	9·02	10 82	3,915	66°	·347	519°	155	—	—	£96	7%	—	—
5	,, ,,	23′ by 7′ 9″	30	1,619	15·6	9·74	11 9	5,160	48°	·301	285°	173·5	Nixon's navigation	14,400	—	—	34·4	35
6	Marine Single-ended Two furnaces	12·5′ by 11′	42	1,480	22·4	9·15	10·63	8,616	106°	·086	452°	165	—	14,830	£100	6%	16·0	—
7	Economic	14·5″ by 11·5″	30	1,006	17	—	9 5	4,845	204°	—	—	155	Small Welsh	—	£94	6%	34·4	—

costly to clean than either Lancashire or marine boiler adapted for land service. The author is indebted to Mr. Llewellyn Foster, A.M.I.C.E., the resident engineer of the Davies-street station, Westminster Company, for the following information as to upkeep and cost of cleaning. The cleaning costs about £20 per boiler per annum when worked hard and with fairly hard feed-water, and the upkeep about 2-5d. per unit generated.

Marine.—This type has been adopted in some provincial stations. It requires only about 25 square feet of floor space, and costs about £100 per 1,000lb. evaporated, when not forced. Personally the author does not consider it to be so efficient as the last named on account of the setting and arrangement of the flues; on the other hand, it requires no brickwork, is easily inspected on the exterior, and is very neat in appearance. The addition of the hydro-kineter, as in the last named, also applies, and is even more necessary. The cost of cleaning may be taken at about £18 per annum. The average life of the boiler may be taken at 18 years.

The locomotive boiler is not dealt with, because, although an excellent boiler on the railroad, it does not find much favour, in large sizes, for station work, and requires so much room to withdraw the tubes. To summarise the results of the table, the water-tube boiler takes up the least floor space per 1,000lb. evaporated (except the marine), and costs most for cleaning, and is said to have the shortest life. The Lancashire type requires the greatest floor space, and costs least for cleaning; and is known to have a very long life. Either type is now built for the extra high-pressures, though the water-tube would probably cause the least destruction in the event of an explosion. The water-tube is the quickest steamer; and the Lancashire probably the slowest, but certainly gives driest steam. Either type can be fired with any variety of coal—from bituminous to anthracite. If a softened feed-water be used, as it ought to be, there is, therefore, very little, it would seem, to choose between the two. In a station quick steam is a necessity, though we also want dry steam (this may be got in the future by the addition of superheaters to either type), and the author's opinion is that the cheapest and most useful battery of boilers will be found in the discreet combination of both types, as inaugurated by Mr. Gay at Islington. Both of the marine type are also excellent, though, personally, for station practice, the author would prefer the dry-back type, for the above-mentioned reason—viz., that the gases remain so much longer in contact with the boiler—and it therefore should be more efficient and economical. Both require very little floor space. With all boilers great care should be observed in keeping the safety, stop, and blow-off valves and scum cocks, tight; and it is surprising how much can be saved by attention to these points, both in water and fuel. At Sunderland, the Lancashire boilers are laid off every five or six weeks, and the combined dead-weight and low-water valve, the spring safety valve, feed checks, blow-off valve, and scum cock, are taken off and thoroughly set up at least every other time; and the author believes it pays to do this. The smallest escape through a blow-off valve or scum-cock, or a small escape of steam through the stop-valve, when standing; or again, an escape from a float low-water valve (and this type of valve is much given to this), means considerable increase, perhaps, to one's coal and water bill.

Another point which is frequently not attended to, is the inspection of the boiler during construction. The author thinks it advisable that the station engineer should do this, and test his own sample strips, or be present at the tests. The boiler-makers would themselves also probably appreciate and prefer this. Again, the author has known several cases in which a simple hydraulic test has been made without any gauging of flues or flat surfaces; that is only a half-test, and of course gives no indication of any deformation or set which may have resulted under the stress. An evaporative trial of each boiler should be insisted upon, or of at least one of several similar boilers installed, and is, of course, generally done. Another saving may be effected by the shutting off of boilers as quickly as possible on a decreasing load. The "stand-by" losses cannot differ very largely in either type of boiler, the Lancashire, though having a large volume of water to raise in temperature after 12 hours' standing, say, from 323·8deg. F. (the temperature of steam at 80lb.) to 352·5deg. F., the temperature at 125lb., after each lay-by, yet does not lose so much by radiation or absorption by brickwork as a water-tube. The amount of coal required per hour to keep the boiler No. 1, in the table, up to pressure, when no steam was withdrawn, was 24lb. This is from a report by Prof. Kennedy and Mr. Bryan Donkin, which has been extracted from *Engineering*. The amount required to keep a water-tube boiler up to pressure under the same condition is about 35lb. per hour.

Feed-Pumps.—It is well known that the usual donkey pumps are wasteful. The average ratio of steam required to drive the pumps to the feed-water pumped is some 3 per cent. This is a serious item, and the following figures may go some way to accelerate the adoption of electrically-driven pumps for feeding station boilers. One hundred pounds of steam evaporated in a boiler may be accounted for thus: 90lb. used in the engines, and 10lb. condensed in the pipes, etc. An engine working on a variable load, such as usually obtains, requires some 31lb. to 32lb. of steam per electrical horse-power per hour. Assume the boiler pressure to be 125lb.; then the pump has to deliver 100lb. against an equivalent load of $(125 \times 2{\cdot}3)$, say 288ft., which means an expenditure of 28,800 foot-pounds; or, assuming the combined efficiency of an electrical motor pump to be only 0·6, and the steam dynamo 0·85, 1,298 watts, therefore $\frac{1,298}{129,684} = \frac{X}{100}$, or the per-centage of power required to feed the boiler by an electric pump is just 1 per cent., as against 3 per cent. when a donkey pump is used. In direct-current stations, with accumulators, it would be a great advantage to be able to fill up boilers, say, on Sundays, without having to turn on steam, even if the feed-pump pipes are taken directly from the boilers, instead of from the range. Of course it would be a distinct disadvantage, or even an impossibility in an alternating-current station, unless designed on the Bolton or Croydon systems, with accumulators. But accumulators seem to be gaining ground in both types of station; and therefore the electrically-driven pump could be almost generally adopted. Motor pumps are more costly initially; but this would seem to be the only objection. The treatment of feed-water requires more attention than is frequently given to it. The author knows of certain stations where very hard water is used, and is pumped cold into the boilers. A boiler fluid is certainly periodically pumped in; but it will be agreed that the boiler is not the right place in which to precipitate the salts, and cold feed in these days should be out of the question. First, as to treating the water. The author has had two different water softeners in his charge; and in both cases the water (in one case 17½deg. and in the other 20½deg.) has been reduced to some 4deg. or 5deg. of hardness, and at a small cost, and with the further advantage that the plant takes up but little floor space. When it is remembered that 1-16in. scale means an increased consumption of coal of some 9 per cent., it will

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be seen how necessary this treatment is. At Sunderland, there is an evaporative condenser, and as the water is some 20½deg., and contains a large proportion of the less easily reduced sulphates, the installation of it was the more necessary. The hot-well water is pumped through an oil extractor, and the make-up feed-water is obtained from the town main, undergoing treatment by the softener before use. This should be the best method for treating feed-water, both for economy and scale reduction. Treatment of the water in the boiler is not at all satisfactory; partly because in some cases a heavy scum results which may cause overheating, or at any rate priming; and, secondly, because the heating surface of the boiler must be reduced from the lodgement of the precipitate at the bottom of the boiler, where there is already a deficiency of heat in drum boiler; and it also means additional and more frequent cleaning. A complete water-softening plant only costs about £0·18 per kilowatt installed. Heating the feed-water is again important, because every 10deg. rise in temperature results in a saving of 1 per cent. in fuel. In stations exhausting to atmosphere, of course the latent heat of the steam is partially given up through the medium of heaters to raise the feed-water to a temperature of about 210deg. F.; or in the case of Lancashire boiler, or similar type, an economiser is placed in the flue between the boilers and chimney in which temperatures of anything up to 350deg. may be obtained. A further advantage is obtained—viz., that the before-mentioned sulphates of lime or magnesia are rendered insoluble long before this temperature is reached, and are precipitated before entering the boiler.

Fuel.—Locality has a very great deal to do with the class of fuel adopted. In London engineers are no doubt right, and have barely an alternative, in adopting Welsh coal, from its smokeless nature. But some of us have to burn duff or smudge, or, at any rate, bituminous coal; and then arises the question of hand-firing *versus* mechanical stokers—the better results with very small coal, such as slack or duff coal, are probably obtained with mechanical stokers; the firing must be little and often, or damping and caking results: and in hand-firing this means a large admission of cold air at each charge, which must affect the evaporation. The excellent figures by Mr. Ellington, in his papers before the Institutions of Civil Engineers and Mechanical Engineers, on "Hydraulic Power," taken from boilers fed by mechanical stokers, fed by coal conveyors, go to show the efficiency of this method of firing, and in cases, too, where there is a variable load much the same as in an electricity station. To a boiler in which Welsh coal has been burnt, and which hand-fired had evaporated 7lb. per pound of coal, a mechanical stoker was fixed, and a bituminous slack used as fuel, when the evaporation of 8·98lb. water per pound of coal was obtained. The temperature of the feed was the same in both cases, and also the rate of firing. It is surprising that forced draught is not more frequently adopted. Mr. Patchell has fixed an apparatus at the Maiden-lane station, and his excellent results were read before the Institution of Mechanical Engineers. The closed ashpit system with fans, such Fothergill's and others, give, of course, a far higher rate of combustion than with natural draught; and so with the steam-jet system as fixed at Islington and other stations. The production of a larger indicated horse-power from the same boiler, which results from the adoption of forced draught, and the enormously increased evaporation when required, cannot fail to commend it. This system, combined with a quick-feeding mechanical stoker, should obviate any fear of smoke nuisance; the emission of black smoke being the disadvantage of forced draught when the fire is hand fed. Mr. Crompton has tried petroleum refuse, or astatki, at Kensington, and owing to the high calorific value of the fuel (as in all fuels containing a large proportion of hydrogen), and the comparatively small cost of the requisite fittings, it may prove a valuable adjunct to boiler equipments, to be used at least in an emergency.

Steam-Pipes.—Although perhaps foreign to the strict title of the paper, yet from the important item in the water and coal bill which is represented by the condensation losses in steam-pipes, the author has ventured to include a few remarks about them. They are now completely duplicated in probably every station, and the present tendency is to adopt wrought iron or mild steel, straight lengths, and solid-drawn copper bends. In these latter steel flanges seem preferable, owing to their greater resistance to "cupping." The valves should preferably be of a sluice type, thereby giving a full bore to the pipe when open. By-passes with cocks should be fitted to any valves larger than 5in. bore, and are useful in keeping joints tight, by gradually warming up the laid-off pipes when required, and driving out any water that may accumulate therein, and in the prevention of water hammer. The author also considers it imperative, not only to thoroughly cover the pipes with non-conducting material, but also the flanges and stop-valves. The condensation in a 6in. steam-pipe uncovered is 1·41lb. per lineal foot per hour, and with a 2in. covering 0·123lb. at a temperature of 349·8deg. F., or a pressure of about 120lb., or less than one-tenth of the quantity given above. As the flanges form effective gills, they radiate a great deal when left uncovered. An objection is that the flanges are not open to examination, and that leaky joints spoil the covering; leaky joints can be, and ought to be, averted; and now there are several means of covering the flanges with easily removable composition, in sections and otherwise. The drainage of steam-pipes is not always so well arranged as might be. From personal experience the author thinks in cases where there is a full bore throughout the whole range (by the adoption of sluice type valves) occasional drain pockets, with gauge glasses fitted, working on efficient steam traps (having a by-pass direct to atmosphere for emergencies), the most effective system. There are steam traps and steam traps. Of four varieties with which the author has had to do, only one has been found to be reliable, and of value. No doubt members will have had their own experiences. There are some traps which will not only work well but will deliver the condensation water against a head of some feet. This is often of great help in saving water by delivering direct to a feed-tank, the drain traps being presumably at the lowest level, and the feed-tank with a slight head on the feed-pumps, the condensation water thus being used again.

Conclusion.—The author has not touched upon superheating, it having been thoroughly discussed at various meetings of the Institutions of Civil Engineers and Mechanical Engineers during the last 12 months. That this is certainly a source of economy in a station there can be no doubt, Edinburgh, for example, having given excellent results, and perhaps the vice-president, Mr. Newington, will give us his opinion on this matter. There is nothing, probably, in this paper of which all are not thoroughly cognisant, but the author hopes that in having had the honour of bringing it before you a favourable opportunity may have arrived when this important question, which affects a figure of from 25 to 30 per cent. of our works' costs, may be discussed, and some of us obtain benefit by the experience of others in the various matters touched upon.

This was immediately succeeded by the following paper on the same subject by Mr. J. J. Steinitz, borough electrical engineer of West Ham:

The Generation of Steam.

BY J. J. STEINITZ, BOROUGH ELECTRICAL ENGINEER, WEST HAM.

Steinitz, J. J.—Commenced his professional career at Messrs. R. Napier and Sons, of Glasgow, and was afterwards with Messrs. Woodhouse and Rawson, subsequently joining the staff of the Peninsular and Oriental Steam Navigation Company, going several voyages in their vessels. After some years in private installation and experimental work, he joined the Brush Company, and was resident engineer for that company at Huddersfield, Lancaster, and Leicester. On completion of the Leicester station he was engaged by the Corporation as chief of the electricity staff. From Leicester he received the appointment of borough electrical engineer to West Ham, with instructions to design and carry out the central station at West Ham. This work has been carried into operation, and the station is now running.

The question of the generation of steam must be of considerable interest to all connected with this association. A paper on such a subject must give rise to a discussion, and though the author is afraid he can present very little new or interesting matter to the meeting, he has no doubt, when the discussion is finished, good reasons will be advanced for generating steam entirely on one's own account or combining with some other corporation department—such as refuse destruction or sewage pumping—for using this type of boiler or that type, or for

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various combinations. Further, the questions of mechanical stoking, important when we think of trade disputes and the difficulty of getting good stokers, of water cleaners, of forced draught and of economisers, feed heaters and superheaters, are all of paramount importance and are well worthy of the attention of the borough electrical engineers of this country.

The efficiency and economy of the generation of steam are dependent on: (1) the type of boiler; (2) the fuel; (3) the water; (4) the stoking arrangements; (5) adjuncts to the boiler, such as economisers, feed heaters, superheaters, and forced draught. The types most commonly in use in electric lighting stations in this country are Lancashire boilers, tubular boilers of the Babcock and Wilcox type, and marine-type boilers. All these are so well known that a description is unnecessary, but one or two of their characteristics are interesting.

In a correspondence the author had recently with a well-known firm, he was somewhat surprised to find them advise him not to have cross tubes fitted in the flues of Lancashire boilers. Even if the circulation is not increased much—and one naturally thinks it is—it seems that the flue by the insertion of these tubes is considerably strengthened. The author cannot come across any evaporation tests of two Lancashire boilers, one fitted with cross tubes and one without, except when the boiler with tubes was new and the one without old. Naturally the new boiler with the tubes came out the better. The circulation of water in this type may not be so good as in the multitubular boiler, but there is no reason why a circulator should not be fitted, and the circulation, and consequently the efficiency, increased. Such a fitting is used at the present time for cleaning purposes. Whether or not it is a success as a cleaner I do not know, but from experiments witnessed the circulation was certainly improved. Good circulation is the salvation of a boiler. It is governed to some extent by the working pressure, consequently the water-tube type has had the advantage. With bad circulation there is a loss of economy due to an increased temperature of the heating surfaces, which leads to the rapid deterioration of the boiler.

The question of the pressure at which a Lancashire boiler may be worked is of importance, and it is noteworthy that quite recently one large firm, builders of this type, advised the use of tubular boilers for all pressures over 120lb. As regards the life of this boiler so much depends on the nature of the feed-water used and the care taken in cleaning, etc., that any stated time might be misleading. With good water and ordinary care the average life of this type is about 20 years, without any reduction in the working pressure being called for or necessary. With tubular boilers of the Babcock and Wilcox type the pressure can be raised considerably above that usually raised in Lancashire boilers. As to the life it can hardly be given, as a few tubes will at any time make it practically as good as new. The repairs and maintenance of this boiler will in most cases be considerably in excess of the amount spent on a Lancashire boiler. Cleaning is a longer job, and the chances of trouble or an accident from a defective joint are considerably increased as between the 70 or 80 joints on a Babcock and Wilcox, and the one or two joints on a Lancashire boiler. The circulation is very good, and the evaporation per pound of fuel consumed very high; in fact, I think the highest ever obtained, except by the Thorneycroft boiler as used on some of the torpedo boats built by that firm. The boiler takes up little room for the work it does, though it must be remembered that a distance for drawing the tubes should be debited to the account of the space allowed for it. Many conflicting statements have been made in favour of and against the Babcock and Wilcox boiler for intermittent use. The majority of boilers in an electric light station are thus used, so this point is of considerable interest to us. That there is more loss in cooling down in a Babcock and Wilcox than from a Lancashire boiler the author thinks is true, owing to the large radiating surface of brickwork enclosing the former. This, however, may be more than compensated for by the ease with which steam is raised in the former.

The marine boiler has proved an unqualified success wherever it has been adopted. The average life would be rather less than the Lancashire boiler, owing to the difficulty in cleaning it. Many are the efforts made by engineers to stop either pitting or scale forming on the tubes and plates. One arrangement struck the author as being rather neat—at least, in theory. It was described by Mr. Dolby at the Institution of Civil Engineers some years ago. A small alternating machine was driven by a strap from the propeller shaft. From one terminal a wire was carried through the shell of the boiler, but insulated from it, and was fastened to two rods at a point above the water-line. The rods were bolted to two plates about the centre of the height of the water. The plates were kept in position by clamps insulated from the shell of the boiler. The other terminal of the machine was connected to earth. The effect of the current was to electrolyse a small part of the water. The hydrogen would follow the course of the current and be deposited on the shell of the boiler and the flue tubes. When the current changed, oxygen would be produced. The two would combine and produce a thin film of chemically pure water, which would hinder the deposit upon the shell and tubes. Another plan the author has seen adopted at sea, is to give the inside of the boiler a good coating of coal-tar. He has known this tried on boilers on land with the result that instead of cleaning the boilers every three weeks, every eight weeks was quite sufficient. Many engineers hold that it is as important that the products of combustion in their course to the shaft should be brought into contact with all the heating surface, as that there should be the good circulation of water. Should this be so, no boiler he is acquainted with fulfils the conditions better than one of the ordinary marine type.

Fuel.—The theoretical value of various fuels can be found in many pocket-books; these the author does not intend to touch on. All he can say is, that one must be guided by the locality in which the steam has to be generated and that controls the cost, the by-laws of the town with reference to smoke nuisance, and the stoking arrangements employed. If in the centre of a town the by-laws will probably make it a necessity to use mechanical stokers and cheap coal, or the best Welsh coal and ordinary hand-firing—and perhaps if the town is far from any coalfields, nothing better or more economical than the latter is to be had.

Feed-Water.—In all cases and whatever boiler may be in use it is undoubtedly necessary to have good water. In many districts the water has to be treated, and it most certainly pays the user of steam to have this treatment effected outside the boiler. Boiler compositions may be good; they may also do more damage to the boilers than good to the water, but whatever is done to the water, the author's point is that it should be done outside the boiler. He does not intend to touch on the many water cleaners, softeners, etc., in the market, but there are some which will be found to do all that is necessary with very little initial outlay, small maintenance, and practically no trouble. If surface condensers are used a certain amount of oil will get into the water, and if not dealt with carefully will most probably play havoc with the boiler. This will be the result with all boilers, though probably an accident would be more likely to happen with a boiler of the tubular type. A coke filter used intelligently will be found to be all that is required. The author understands from Mr. Proctor, of Bristol, that he has adopted an ordinary cream separator to deal with his condensed water.

Stoking Arrangements.—We now come to one of the most interesting considerations in connection with the generation of steam. The main question at first is hand-firing *v.* mechanical stoking, but after one has made up one's mind to the advantages of the latter system, which, with the exception of a few special cases is inevitable, one is met with the question of coking *v.* sprinkling stokers. As all electricity works are growing concerns we need hardly go into the question of whether mechanical stokers are advantageous where only one or two boilers are in use, as all our works must have, ere long, large batteries of boilers. The advantages accruing from the use of mechanical stokers are: immunity from creating a smoke nuisance. This is not of vital importance to us all at present, but the time must come shortly when the public will have recognised that the creation of smoke is not a necessity, and will insist on the nuisance being abated. By that time mechanical stokers will probably be adopted as an easy and economical way out of the difficulty. That a smoke nuisance may be avoided by very careful hand-firing and the use of the best coal, is admitted, but it is almost impossible to get three shifts of careful stokers and almost as difficult to get an engineer to continue buying the best coal if he can struggle through (with perhaps an occasional summons) on an inferior quality; while with mechanical stokers the commonest slack can be used with advantage, with no prospect of trouble, and there will be a large reduction in the coal bill. The reason for the economy of fuel is partly due to the fire being always clear. Again, not only do you get better results from your boilers, but the economiser is more efficient, and the flue gases do not carry so much smoke with them, so that greatest heat is obtained in the furnace. That economy in fuel does really exist is best brought to your notice by quoting the following tests:

HAND-FIRING *v.* MECHANICAL STOKING.

Duration of trial	10 hours	10 hours.
Description of fuel used...	Small slack	Small slack.
Price of fuel used.....	About 6s. per ton.	About 6s. per ton.
Fuel consumed per hour...	492·8lb.	588lb.
Water evaporated per hour	415 gallons	624 gallons.
Temperature of feed-water	70deg. F.....	70deg. F.
Steam pressure.....	50lb.	50lb.
Water evaporating per pound of fuel from and at 212deg. F.....	9·87lb.	12·43lb.
Cost of evaporating 500 gallons	1/4·2	1/0·9.

With a mechanical stoker and conveyor properly arranged, one man can attend to the firing of five boilers and with furnaces each; with hand-firing it is also impossible to get more than four furnaces attended to by the very best of stokers. The saving therefore in stoking five boilers mechanically would be

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three men's wages against seven men's, a saving of £6 per week. Against this there is the cost of working the mechanical stoker, 3s. per week; the interest and sinking fund on the outlay, 17s. 10d. per week; and the repairs and maintenance of the stokers, 13s. 5d. per week, or a saving of £4. 5s. 9d. per week, independently of any saving by the use of cheaper fuel. The difference between Vicars, which is a good example of the coking stoker, and the Bennis, which is a good example of the sprinkling stoker, lies in the fact that the former machine pushes the coal on at the front end of the firegrate, and gradually carries the fuel to the back end; there is, therefore, a great mass of incandescent fuel at the front, the fire gradually tapering down to nothing at the back end; in the latter the fire is kept level, as it ought to be in hand-firing, and the coke thrown on in small quantities, each time in a different place, thus approximating as nearly as possible to perfect hand-firing. With the former machine the boilers cannot be forced rapidly; with the latter machine the amount of coal burned can be adjusted from 15lb. to 50lb. per square foot of grate per hour, thus giving the necessary margin to meet sudden demands of steam. From this point of view alone borough electrical engineers must look with favour on a good sprinkling stoker. Further, the following tests—there are many others of a similar nature—may assist one in making up one's mind as to the advisability of adopting a coking or a sprinkling stoker:

	Coking stoker (Vicars.)	Sprinkling stoker (Bennis.)
Duration of trial	120 hours.	120 hours.
Description of fuel used ...	Small slack.	Small slack.
Price of fuel used	About 4s. per ton at pit.	About 4s. per ton at pit.
Fuel consumed per hour ...	700lb.	885lb.
Temperature in flue (av.)...	680deg. F.	831deg. F.
Temperature of feed-water	161deg. F.	161deg. F.
Steam pressure	80lb.	80lb.
Water evaporated per hour	4,372lb.	6,916lb.
Water evaporated per pound of fuel from and at 212deg. F.	6·72lb.	8·48lb.

It is interesting in connection with these tests to notice that at the Leeds electricity works, where the record, according to *Lightning*, is held for the lowest cost of coal per unit sold, sprinkling stokers are used.

Economisers.—Probably of all the adjuncts to a boiler none is more used or better known than the economiser; the author thinks he is right in saying that there is hardly an electric lighting station in the kingdom where an economiser has not been installed. The economiser, consisting as it does of a bundle of tubes placed in the flue leading from the boiler to the chimney, is simplicity itself. Fitted, as they generally are, with mechanical cleaners, the maintenance is very small, the repairs are, or ought to be, few—in fact, except for its very apparent advantages, it might be installed, set to work, and then be completely forgotten. The only point to be taken into consideration before installing an economiser is the question of the temperature of the flue gases. Should the temperature of the gases leaving the boiler be not more than 400deg. F. (but, as a rule, they are nearer 600deg. F.) an economiser would be practically useless. The economy due to the use of a good economiser may be put down at from 10 to 15 per cent. of the fuel burned according to the temperature of the gases escaping from the furnaces. About the only precaution to take is not to pump cold water through the economiser, otherwise there is a risk of excessive external corrosion. This is a trifling point, though, and easily got over by running the exhaust of one of the auxiliary engines into the feed-water tank. Where no arrangements for condensing are made, an economical way of heating the feed-water is by passing it through some form of exhaust feed heater. Considerable economy is experienced, the feed-water being raised to about 200deg. F. when a fair load is on the engines. A heater has also the advantage of acting as a purifier.

Superheating.—While superheaters may be classed as adjuncts to the boiler, the economies (with an exception in the case of the MacPhail superheater) are noticed in the engine. The advantage to the boiler is that its duty is lightened. The paper on this subject by Mr. Patchell, together with the discussion on it, read before the Institution of Mechanical Engineers, is probably fresh in the memory of all. From it we may gather the advantages of superheating are very real, and that the superheater has come, and come to stay. The few difficulties in the way of their general adoption are being rapidly overcome. Knowing as we do that a small degree of superheat only slightly in excess of that in saturated steam produces a disproportionately large beneficial effect, there ought to be some good reason for superheaters not being more generally adopted. In 1870, when superheating was practically dropped, the reasons were apparent. At that time they had no suitable lubricant, and large superheaters, placed as they generally were in the uptake of the flue, were liable to become overheated and become a source of danger. Both these difficulties have been got over now, and the author is inclined to agree with the writer who attributed the non-adoption of superheaters to the fact that "the design of engines had been so cut, that any step in the direction of the almost unknown was useless and unprofitable."

Forced Draught.—In studying the economical generation of steam the effect of forced draught must not be neglected. In most cases one hears of enormous savings in boilers under forced draught against those without, but one never hears of any debit for inducing this draught. Steam, say, at 120lb. pressure (the author is now talking of forced draughts induced by steam jets), wastes away at a wonderful rate through the very small orifices in use. No doubt some member will be able to give some information on this point. In dealing with the smoke question, forced draught will undoubtedly be worth very careful consideration, and, in suitable places where coal and coke dust can be obtained at a nominal price, be simply invaluable. In fact, the use of this fuel is impossible without a forced draught. To station engineers with the present unsatisfactory load curves the question of the adoption of the forced draught is particularly interesting. Very large demands for steam are made for a very short period of the 24 hours. It will therefore be generally found desirable to keep the number of boilers down and force them for the short period referred to, even if at that time one does not get the full duty from the fuel burned. One of the best means of adopting forced draught is to have a fan forcing air into the stokehold and leaving the only passage out through the furnaces. This plan has been adopted in many boats, and there is no reason why some modification might not be adopted in our boiler-houses on land.

The author would like to raise the question of the advisability of joining with some other corporation department for the generation of steam; combinations of dust destructors and electric lighting plants have been, and are being, erected—with what measure of success he is hardly prepared to say. At Oldham, the combination seems to work well, and Mr. Newington, the borough electrical engineer, informs the author that they are at the present time saving about five tons of fuel per week. At Leicester, too, destructors of six cells each are at work. The steam available in one case is used to generate electricity for lighting the destructor buildings, while the other supplies the engine of a small factory. At West Ham the author has joined with the borough engineer, who is erecting a large sewage pumping station, in having a joint boiler-house. As he will always have to be prepared to put his storm-water pumps into action, and will consequently have boilers for that purpose under steam, it may fairly be expected that the electricity department will have very little to pay for the generation of steam during the greater part of each day throughout each year. It may be of interest to you to know the temporary arrangements we are now making for generating steam before the boiler-house and shaft are complete. We have laid down two boilers (out of nine) farthest away from the shaft. These two boilers are fixed permanently. Where the main flue is to be continued a damper is put in. At the end of the flue a small engine and fan and wrought-iron shaft are erected. If this arrangement is to be used for some time, we shall heat the air in tubes at the back end of the boiler, and then pass it through the fire, through the fan to the iron shaft. We shall thus get a good draught, no smoke, and the total cost of the temporary arrangement will be only some £400. The building of the main flue and shaft can be continued, and when all is complete the damper can be withdrawn and the engine and fan and the iron shaft removed. In connection with this, the following test made by Messrs. Allen, Son, and Co., of Bedford, to whom the author is indebted for showing him a similar plant at their works, is of interest.

Test.

Babcock and Wilcox's boilers. Induced draught, with arrangement for heating air supplied to furnaces by means of waste gases.

Duration of Experiment.—Fire lit at 3·15 p.m., Wednesday, November 25, 1896. Fires drawn at 2 p.m., Saturday, November 28, 1896. Actual number of working hours, 32¾.

Coal Used.—Waynes's Merthyr.

All the coal used included in the following results—viz., the coal used in getting up steam and banking fires on Wednesday, Thursday, and Friday nights—is included with that actually used for steam purposes.

Feed-Water.—Feed-water heated from 49deg. F. to an average temperature during experiment of 137·2deg. F. by exhaust steam from fan engine. Kennedy's water-meter used.

Mean pressure of steam during experiment, 176·3lb. above atmos.

Water evaporated per pound of coal at 176·3 above atmosphere	= 9·64lb.
Water evaporated per pound of coal from and at 212deg. F.	= 10·91lb.
Percentage of ash.....	12·5 per cent.
Water evaporated per pound of combustible matter at 176·3lb. above atmosphere.....	= 11lb.
Average temperature of escaping gases in fan chamber	= 378deg. F.
Average temperature of atmosphere in stokehole...	= 57·9deg. F.
Average temperature of air supplied to furnaces...	= 157deg. F.

The ashpit doors were kept closed except while removing ashes.

Average vacuum above firebars as measured in fan chamber	= 1·95in. water

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In conclusion, the author feels an apology is necessary for not presenting data on the various points raised. As an excuse, he may remind members that at present he is an engineer without a station and with no boilers to experiment on. At some future date he may be able to bring forward information which may be of interest to the association, as to the best and most economical method of generating steam, and which will set at rest, if no other, at least his own many doubts, that have grown as he prepared this paper.

DISCUSSION.

The Chairman, in opening the discussion, asked the speakers to keep strictly to the points raised in the papers. However interesting other matter might be, if they strayed away from the strict matter of the papers they would want a convention lasting 365 days.

Mr. R. E. B. Crompton said there were the strongest proofs that no boiler would stand forcing so well as the water-tube boiler. He need only point out the experiments on board the "Powerful" and the "Terrible." Again, in one of the London stations some time ago there was a difficulty with the steam-pipe, which involved cutting off all the boilers but one. That boiler, a water-tube one, met the emergency by evaporating 20,000lb. instead of 9 000lb., and there was no interruption or wet steam. In designing a station he felt very great confidence when he had water-tube boilers instead of the type of boilers that were generally used for mill work. He knew of a great number of Lancashire boilers, and whenever these were working in the same station side by side with the water-tube boiler, in no instance did they give better results. He doubted the large saving made out by Mr. Steinitz for mechanical stokers. Three shifts were exceptional. Two shifts in winter and one in summer would be more nearly the general case. He would not recommend coking stokers, but was glad to hear the others gave such excellent results. As to the superheater, much depended on where it was placed. Much of the superheat might get wasted before it reached the steam-chest.

Mr. A. H. Gibbings (Bradford) said an absolute conclusion was impossible; it would all depend upon the circumstances of the station, the fuel and water available, and the possibility of condensing. One point to be noticed was the difference between forced draught and induced draught. In the latter the power was got right through, instead of a force diminishing from the nozzle inwards through the combustion chamber. In counting efficiencies of various contrivances the savings of each must not be simply added together, but their mutual effect considered.

Mr. J. S Raworth admired the courage, not to say the impudence, of the authors in attacking the Lancashire boiler in Manchester. The steam-boiler had been gradually evolved. He could remember the wagon boiler. Then, as pressures got higher, they had the egg-ended boiler, externally fired. The egg-ended boiler was so bad that nobody could put up with it. Then they put the fire inside and the water outside it. That was half the Lancashire boiler; the other half was the Green's economiser. All good results from the Lancashire boiler were got with that. When he went in for electricity they were using about 80lb. pressure. Something more was required When he first saw the Babcock boiler in a shop window he thought it would meet the case, and it did. The higher pressures, however, had a reflex action on the Lancashire boiler-makers, and now they supplied, as a matter of course, boilers for what four or five years ago they considered an excessive pressure. The Babcock boiler was accused of giving wet steam. That was an easy accusation to make, because, though untrue, it was usually impossible of disproof, because the condensation water could not be separated from what was supposed to come from the boiler. Boilers were usually specified most carefully, even down to the size of the rivets. If every possible dimension and material was specified, strictly specified, the result that came out was the act of God, and not of the boilermaker, and it was useless to tie him up further with a test.

Mr. W. Arnot (Glasgow) said in Glasgow their water was almost too good, and they could use very small tubes. He believed much depended on this, and an efficiency gained by using one type in one place might be quite impossible in another. Mr. Steinitz made no mention of the cost of repairs to the brickwork, only of the tubes of the water-tube boiler. In Glasgow they had five pure marine boilers. These might be poor steam raisers, but he thought that when steam was once got up they were better for economy than Babcock boilers

Mr Norbury (Messrs. Galloway's) quite appreciated the courage shown in attacking the Lancashire boiler. Tests varied so much according to circumstances that it was impossible to take any one as a datum. His firm had investigated water-tube boilers in America and the Continent with a view to high pressures, and had finally bought the patents of the Steinmüller boiler as the best. After building it and trying it in every way at great expense, they had finally practically given it up. There was no doubt that water-tube boilers did give nearly-saturated steam. It must be so with small steam space. Fewer were made now for Lancashire than 10 years ago.

Mr. Raworth said the merit of the Galloway, as apart from the Lancashire boiler, was due to its being, in a sense, a water-tube boiler.

Mr. Kelle (Messrs. Babcock and Wilcox) said his boilers had been spoken of so highly by the others that there was little left for him to say. He thought that it was a feather in his cap that having selected the Steinmüller as the best of water-boilers after the Babcock, Galloways had practically given up the competition. The tendency at present was to larger boiler units. This brought about economies in fittings as well as economies in men. Babcock boilers had been put into stations that had begun with Lancashire boilers. As to life, there was no reason why, with proper renewals of parts, the water-tube boiler should not live as long as anybody in the room. The life of the marine boiler was, he believed, about 15 years.

Mr. Gregory (Messrs. Musgrave) said the test results all depended on the coal used. With Burnley coal they had got 9lb. with a Lancashire boiler, and in some cases even better results.

Mr. Wilmshurst (Halifax) said, though Mr. Steinitz's calculation of the economy of fuel from mechanical stokers might not be maintained, there were the undoubted advantages of immunity from smoking and saving of wages. Another great advantage was seldom noticed, as it did not affect the works' cost, and that was that there being no opening of the furnace doors, the unequal expansion was avoided and the life of the boiler prolonged. Only last week he had seen at Halifax a superheater in a cotton mill—it was a 1,000-h.p. boiler. This had been running for three months, and the owner assured him that not only was there an economy of 15 per cent., but that the consumption of oil in the cylinder was cut down 50 per cent. This was, of course, in contradiction to all their previous views.

Mr. Dolby (Westminster) said it was important to know what was the best method of cleaning the tubes.

Mr. Tremlett Carter said the selection of the type of boiler must largely depend upon the class of coal available. It would be a mistake to use a Lancashire boiler with coke breeze, or a Babcock boiler with bituminous and smoky. The same thing applied to mechanical stokers—*i.e.*, which type to use.

Mr. Crossland (Vulcan Boiler Insurance Company) thought, in contradiction to Mr. Snell, that the inspection of the boiler when in process of manufacture should be done by a boiler inspector, and not by the electrical engineer. It was very difficult, when all things were taken into consideration, to show any economy from mechanical stokers. Nothing had been said about the chimney, upon which so much depended. Forced draught was very valuable where the chimney became too small owing to extensions. Mr. Patchell, who occupied a very confined station in Maiden-lane, was using it with good effect. The loss from condensation from uncovered pipes was most serious, and had been shockingly neglected. It would most seriously affect any economy to be derived from superheat. From a number of experiments he could say that tubulous boilers did supply dry steam.

Mr. R. Hammond said there was no doubt that in most cases the greatest economy that was to be effected was before they got their steam into the engine, and not in the electrical part of their work. At Leeds they had been making practical tests for two or three years. Their coal bill last year was 0·3d. per unit delivered to the customer. Their plant was Lancashire boilers, but they did not press them, but had one or two extra. They had sprinkler mechanical stokers, worked condensing, of course, with jet condensers, and pumped the water into the boilers. They had no steam-ring as they had at first. They had grown out of it, and decided instead to put in something which would not get out of repair. Thay had consequently very little surface to produce condensation. Mr. Hammond further referred to the Hotel Cecil plant. [This has only recently been fully described in our columns.]

Mr. Kershaw (Shoreditch) gave a brief description of the new plant as an example of combining work. [The plant is specially dealt with in this week's issue.]

Mr. Sayers (Glasgow) said there was great question on the Clyde as to the comparative merits of pressure in the ashpit or suction in the uptake in forced draught. Much information on the subject would be obtained from a paper by Mr. Paul, of Dumbarton, read before the Engineers and Shipbuilders of Scotland.

Mr. Andrews (Hastings) said, in using forced draught, they lost a large number of tubes, but when they distributed the additional load over several boilers it ceased. He had found that one man could stoke six furnaces (three boilers).

Mr. Geipel said Prof. Unwin had remarked that there was very little difference between one boiler and another. The whole question was settled by the furnace arrangements. Increasing the steam temperature by superheat would mean increasing the radiation loss. It was easy to lose 500 tons of coal per annum in radiation.

Mr. Tittensor (Dundee) had had a lot of trouble with surface condensers, and did not find a coke filter, unless of unworkable size, meet the oil difficuity.

The **Chairman** said that if he understood that at Leeds they were working with nothing equivalent to a duplication of the steam-pipe, in spite of the large economy, he could not think it other than unjustifiable. An accident was certain to come sooner or later.

Mr. Snell replied very briefly. He never said that the steam from Babcock boilers really was wet, but only that it was said so of them. As he distinctly did not run down Lancashire boilers, he did not see where the impudence Mr. Raworth spoke of came in. As a matter of fact, he thought highly of Lancashire boilers, had used them, and intended to do so again. As to the marine boiler being unfitted for the surroundings of a station, Prof. Kennedy, who was supposed to be an authority, did not think so, and Mr. Jeckell's station was like the stokehold of a ship. No one now would let his flue gas go away at 600deg. He would certainly put in an economiser and use more of the B.T.U.'s. He did not suggest that the electrical engineer should specify the detailed dimensions of the boiler. The boilermaker knew about that better. The main dimensions and the evapora

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tive power should be specified. The electrical engineer might get his tests made by a boiler inspector if he liked. He regretted that the question of electrical feed-pumps had not been touched upon. The saving was not to be despised though he knew of the difficulties.

Mr. Steinitz would merely mention that he had laid down nine Lancashire boilers at West Ham. Forced draught was used with a small chimney with advantage at Bedford. With regard to Mr. Tittensor's experience, much depended on the quantity of oil used. Other remarks he would defer.

Municipal Aids to Wiring.

BY ALFRED H. GIBBINGS, BOROUGH ELECTRICAL ENGINEER, BRADFORD.

Gibbings, Alfred Horswill.—Born in 1866. Apprenticed to Messrs. Joseph Baker and Sons, mechanical engineers. Between the years 1883 and 1889 Mr. Gibbings was a student at Finsbury Technical College, at first under Profs. Ayrton and Perry, and afterwards under Prof. Silvanus Thompson. Having completed his apprenticeship he went to the Edison and Swan United Electric Light Company, and subsequently with the India Rubber Company, at Silvertown. Leaving there he became draughtsman to Messrs. E. R. and F. Turner, of Ipswich, and in the following year was appointed electrician with the P. and O. Steam Navigation Company, under whose auspices he visited India and Australia. In 1889, Mr. Gibbings superintended the erection and subsequent working for 12 months of the Liverpool Silver and Copper Company's electro-deposition plant, depositing 50 tons of auriferous and argentiferous copper per week. The following year he fitted up the ss. "Ophir," one of the Orient line of steamships, with 800 lights, and four compound engines and dynamos. The next two years saw him superintending the laying of the mains in the north division of the city of London, for the City of London Company, and from 1892 to 1893 he held the post of electrical engineer to the Hove Commissioners. In 1893 Mr. Gibbings received the appointment of borough electrical engineer of Hull, where he remained for over two years. In November, 1895, he left Hull on accepting the post of electrical engineer to the Corporation of Bradford, where he still remains. Some excellent results have been achieved by him since he accepted this responsible post, and in the future there is little doubt he will be extensively heard of. Mr. Gibbings is the author of several papers, which he has read before various scientific and technical societies and institutions; also many contributions to the electrical and engineering journals have come from his pen during the past four or five years.

The subject of this paper is at the present time engaging the attention of many municipal electrical engineers, and the reason is obvious. The object in view, of course, is to encourage by all possible means the use of electric current, or, in other words, to secure additional consumers. Extended business would add to the profits of the business if already paying its way, and would enable many a small though enterprising town to turn an unprofitable into a profitable concern.

Several inducements for increasing the demand for electricity and for popularising its many applications are already in the field. Among the more noticeable of such enterprises may be mentioned the following: (1) laying the service free of cost; (2) abolition of meter rents; (3) reduced prices for motive power; (4) penny-in-the-slot meters; (5) maximum demand indicators; (6) free supply of incandescent lamps; (7) hiring out of fittings, motors, heating apparatus, arc lamps, etc.; (8) free wiring.

Upon most of the above the author has already made several communications to the electrical technical Press of this country, and a general review of the question was given by him under a pseudonym in *Electricity* for January 1, 1897. In that article the subject of free wiring was considered from its two most important aspects—viz., (1) the position of the private householder; and (2) the direct or immediate effect on the supply undertaking and the cost per unit. These two points, however, we may say, have undoubtedly already received a fair amount of attention and consideration from a broad, general point of view, and the same may be said of the other items enumerated above. There is another point of view which it is the author's intention to bring before you, and which in his opinion is, after all, of more real moment to all municipal electrical undertakings in this country. It is the question of obtaining extended powers and resources to take up, develop, and work these enterprising methods. At the present time, however remunerative such methods as free wiring and hiring out of motors, etc., may be seen or proved to be, and however much a municipal corporation might desire to adopt them, it is not able to get the necessary permission to borrow the capital for the purpose. Municipal corporations are therefore placed at a great disadvantage in this respect compared with public and private companies, and even with municipally-owned gas undertakings, which are not so circumscribed with restrictions.

Of the eight items enumerated as inducements to a more extended use of electricity on the part of the public, the last two alone are those upon which municipal corporations have no power to borrow money. The consequence is that it has been considered worth while to form a public company for the exploitation of this particular business, and there can be no question but that the scope of their operations will be very wide. Through the medium of an independent company, therefore, electric supply undertakings will still be able to offer free wiring and the hiring system to the public. The author, however, is of opinion that it would be most desirable for many reasons that municipal corporations should have the control of all such matters entirely in their own hands. Some of these reasons may be found in the many advantages which municipally-owned undertakings bring to the citizen through the operation of each department in one interest. They include the facilities for borrowing the necessary capital at low rates of interest, the collection of accounts by one department, purchase and guaranteed supply of articles of good quality and value, competent workmanship, and others which are equally familiar and apparent to you. All these things must operate in the direction of a true economy in initial expense of wiring and fittings, and hence the actual charges made to the public must be much less than would be the case where these collateral enterprises are in the hands of private trading concerns. There is no need, however, to dilate further upon the advisability of having such matters as free wiring and the hiring out of motors, arc lamps, etc., under the control of the corporations owning electric works. There is, I am aware, considerable objection taken by some corporations against too extended municipalisation on the ground that it interferes with private trade, but the power or option of doing certain work, or of carrying on certain schemes, should not necessarily imply a monopoly. Private enterprise need not be interfered with, but there is no valid reason why the corporation should not be its competitor. If, as would probably be the case, the corporations took up the schemes referred to in a proper commercial spirit, then the consumer would be the gainer, and the profits accruing, instead of feeding the pockets of private capitalists, would be applied to the reduction of the borough rates.

Having thus briefly introduced the subject, the author would suggest that the association should take such steps as are necessary towards ascertaining the opinions of the various corporations upon the question, with the ultimate view of approaching the Local Government Board for powers to borrow money for these purposes.

Discussion.

The **Chairman** said the question of prepayment meters might stand over, as they had a paper on that subject to come.

Mr. Nesbitt said that municipal wiring must be cash wiring. His political opinions told him a municipality should do everything and anything, but his business instincts that there were many things municipalities had better leave alone, and wiring was one of them. The possibility of hiring motors would hardly be an inducement for people to come on.

Alderman Higginbotham (Manchester) said the subject hardly touched them at present there, as their difficulty was to supply consumers as fast as they came on, but he was of opinion that a municipality ought not to deal with wiring or contractor's work. Large things, in which there could be no general competition like tramway work and gas, water, or electricity supply, were different.

Councillor Pearson (Bristol) also had more people coming on than they knew what to do with, but was adverse to the proposal. The wiring contractors were the best unpaid canvassers for the electric light that the Corporation could have, and in Bristol they left no one untouched who could be supplied from the mains. At Bristol they had hired out some motors without asking anybody's leave. The Local Government Board would probably raise no objection to proceeding in a small way.

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Mr. R. C. Quin said they had decided to adopt free wiring in Blackpool in connection with a certain syndicate. They had also adopted the demand indicator. They had a shifting population, and small consumers could not pay the cost of wiring another man's house when they might speedily leave. He did not see why there should be a reduction for motive power. The reduction should be on the basis of a rebate on the profit made upon the consumption.

Alderman Calvert (Huddersfield) was in substantial agreement with Councillor Pearson. It was important to get landlords in building new houses to wire them.

Mr. Barnard (Hull) said at Lancaster, where the Corporation did both gas and electricity, municipal wiring was tried. The result was very bad, and it was found advisable to get contractors in.

Alderman Miles (Bolton) did not advocate free wiring, but something must be done to induce the tradesman who had spent a good deal of money on a gas installation to change to electric light. He did not think that immediate payment need be required. Payment by instalments gave excellent results. He was convinced that they should abolish meter rents, as the gas companies had done. There was a great deal of jerry work in connection with wiring, and he thought municipal wiring would deal with that, because municipalities, whatever they did, did not do jerry work.

Mr. Richards (Bedford) described the system of allowing customers to exchange old lamps for new free every quarter as a rebate on prompt payment. It was introduced in Bedford because consumers bought bad lamps, and ascribed the bad results to the faults of electric lighting.

Mr. Talbot (Nottingham) agreed as to abolishing meter rents, as these were always a subject of complaint, but was opposed to free wiring.

Mr. Kershaw (Shoreditch) said they had at starting effected two agreements, one with the Free Wiring Syndicate, and another with the penny-in-the slot people. The people most likely to take up these were their best customers. They were mostly small shopkeepers, who kept their light on for a long time. For other classes they had also the maximum indicator. The reduced charge for motive power should be really a reduction for a day load—for instance, it did not matter to them if a man wanted the current to light his basement. Their charge would be 2d. for this, or 3d. for motive power if taken at any time.

Mr. Ruthven Murray (Worcester) said they had hired out motors at a charge of 15 per cent. His committee had reduced meter rents one-half as a compromise. They had the maximum demand indicator, 6d. for the first hour and 2½d. afterwards. It was no good not to make the difference high enough to seem an obvious inducement. He did not see why a corporation taking up free wiring should harm the contractors, as the people who wanted it without it would not be wired at all, and therefore would not give the contractors any work. In reply to a suggestion of Mr. Mordey, Mr. Murray added that at Worcester they had 80 h.p. of motors varying from 30 h.p. to $\frac{1}{6}$ h.p. These last were used by barbers. They used three different types, and all were eminently satisfactory. They were single-phase motors of a periodicity of 100.

Mr. Gibbings's reply was deferred to the next morning.

At the invitation of the Chairman (Alderman Higginbotham) and the Electricity Committe, the members adjourned to another room to lunch. An admirable lunch was served, and after the long morning session was highly appreciated.

A few toasts appropriately wound up the morning's work. The first was, of course, "The Queen," which was duly honoured.

Alderman PEARSON, of Bristol, proposed "The Lord Mayor of Manchester," suggesting that such toast came appropriately from one who represented an ancient city, with a mayoral roll extending over six centuries. However, the ancient cities were not at all envious of the progress made by the younger cities of the North, and appreciated the energy which had within modern times raised these cities to such power and wealth.

The Mayor of MANCHESTER suitably replied.

Alderman HOPKINSON then proposed the toast of the moment, "The Association of Municipal Electrical Engineers." He told us that the members of the association were comparatively young men, representing a new industry, and referred to his own life-long labours in pure and applied science, stating that so long back as 1842 he was experimenting in electrical matters, and thought he then knew all there was to know of the subject. In the service of man, electricity was then utilised for lightning conductors and for something connected with vineyards. The exact application we did not catch, and, writing from memory, will not venture to state. He pointed out that his interest in electricity was hereditary, as he had three sons in the business, and he might claim their president as somewhat of a grandson.

The PRESIDENT thanked Alderman Hopkinson for the kind words he had spoken of the association and of himself personally, and said the association was greatly favoured in its young days in being allowed to use so noble a hall for its meeting, and being so nobly entertained as they had been by Alderman Higginbotham and the Electricity Committee.

Mr. RAWORTH then proposed the toast of the health of Alderman Higginbotham and the Electrical Committee of Manchester. He stated that both he and Alderman Higginbotham were greatly indebted during the early years of their career to Alderman Hopkinson. He claimed to be the first to introduce the electric light to Manchester at a time when its development was greatly different to what it was now, when men had it in order to obtain a blaze of light for advertising purposes. It was not then looked on with the same favour as now, when, under the fostering care of the chairman and Electricity Committee, it had made so great strides and obtained so enviable a position in Manchester.

Alderman HIGGINBOTHAM replied, stating that only since March last had the Electricity Committee been a separate committee; before that time it had been a sub-committee of the Gas Committee. He mentioned that twice previously they had held premier position of British stations as regarded cost, and according to the accounts—not yet published, however—he thought they would be able again to claim that position.

Mr. CROMPTON proposed the health of Mr. J. Swan, whom he regarded as the man whose investigations and inventions had made the present position of electrical light undertakings possible.

Mr. SWAN replied, calling up a reminiscence of a meeting at the Board of Trade, with Mr. Chamberlain in the chair, as far back as during 1882, when the first Bill was in preparation—which Bill was, he contended too stringent, and had kept back progress.

The members then walked to the Dickenson-street generating station. Our readers know that the scheme for Manchester was originally prepared by Dr. J. Hopkinson, and a first installation made of about 3,000 h.p. Mr. Wordingham, the resident engineer, took over the consulting work in July, 1894, and is answerable for the extensions since that date—the capacity now reaching some 6,200 h.p., and this is being extended to 10,600 h.p. At the present time, the equivalent of 147,068 lamps of 8 c.p. are connected, taking 4,707 kilowatts if all consuming devices were working at once. The net profit on the working of 1896-7 is £16,812. 8s. 1d., the total expenditure to March, 1897, is £309,291, and a further sum of £130,000 is now being applied for.

DIAMOND JUBILEE PARTY.

On Thursday last, July 1, a novel and most successful party was given by Mr. James Paxman, J.P., the head of the well-known firm of Davey, Paxman, and Co., engineers, Colchester, at his residence, Stisted Hall, Braintree. Invitations had been issued to a large number of guests, of whom some 400 accepted, to an evening garden party for 8.30, and very soon after the appointed time the neighbouring roads were literally alive with vehicles bringing the invited from every quarter. A special train from Liverpool-street, which reached Braintree at 7.55, conveyed a large contingent from town, whilst every Colchester conveyance must have been engaged.

The carriages entered the park by the south lodge and departed by the north lodge. The drives were amply illuminated by arc lights, one of which, placed in the magnificent oak tree (one of the finest in Essex) near the south lodge, produced a specially pleasing effect. The marquees were also similarly illuminated, the lighting power being supplied by the engines which are on ordinary occasions used for lighting the house. After driving through the park to the western entrance of the house the company proceeded through the entrance and inner halls to the drawing-room, where they were received by the host and his daughter, Mrs. C. Everitt, in the large reception-room of the Hall. From thence they made their way either to the fine marquee set apart for dancing through a long covered walk which led from the house, or dispersed in different directions through the beautiful and beautifully-decorated grounds.

It would be impossible to exaggerate the charms of this *al fresco* party, which combined the best features of a season ball in town and a country house *fête*. The gardens so thoughtfully planned out and carefully planted by former generations, and so tenderly dealt with by Mr. Paxman, lent themselves to the clever manipulation of myriad lights so skilfully disposed of by Messrs. Griffing and Son, of Colchester. A series of charming walks amid beautiful flowering shrubs,

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many still in bloom, beneath trees of commanding size and infinite variety, some of them a source of bewilderment even to those who know about trees, tempted the enterprising explorer to find new beauties a little further from the house; the winding north walk, with its charming views of the park, where pheasants and rabbits by the hundred seemed literally to swarm; the beautiful grass walk on the south side, commanding distant views of the lake; the sloping lawns, which on all sides surround the old fishponds; the stately avenues of limes, elms, and yews; the American garden (so called because every tree and shrub in it is indigenous to that hemisphere), the labyrinthine walks amid the thick shrubbries, all these partially revealed by the fading lights of the gloaming, or rendered fairy-like by endless variety of lights and lanterns, beguiled most of the guests from the more prosaic charms of the marquee, where as in the light of the day the votaries of Terpsichore discharged the solemn rites of the dance. Not to the eye only were appeals made; the magnificent band of the York and Lancaster Regiment, by kind permission of Colonel Whitaker and the officers, under the able conduct of Mr. Wood (bandmaster), at short intervals discoursed sweet music; and in their turn might be heard the familiar strains of the Standard Ironworks band, in which Mr. Paxman has naturally taken so great an interest, and which reflects such credit upon the able leadership of the bandmaster (Mr. Gees).

Soon after 10 o'clock, the supper tent, amply and well supplied by Messrs. Wright and Son, of Colchester, was thrown open to those whom the necessity of a very early dinner and the fresh air of Stisted combined to make refreshment a matter of considerable importance, and for two hours or more a continuous stream of "the hungry" might have been observed setting in that direction. Nor were the creature comforts of those who brought the guests to Stisted forgotten; provision had been made in the stables, ordinarily adapted for 24 horses, for all comers, perhaps 120 or more, and those who drove them had, we believe, no reason to regret their share in the matter. About 1.30, the premonitory symptoms of a break-up began to be observable. Guests were heard asking how long does it take to get to Braintree, whence a special train for London was to start at 2.30, and by 4 a.m. the grounds, so full of life and sound, had resumed their normal quiet. A large house party remained to discuss the brilliant *fête* and seek such rest as time permitted. Where the genial host disposed of his many guests is a mystery, but if some of the young ones found unusual resting places, the game was for once most emphatically worth the candle.

PHYSICAL SOCIETY.—June 25.

Mr. SHELFORD BIDWELL (president) in the chair.

A paper by **Mr. Sutherland** on **"A New Theory of the Earth's Magnetism,"** was taken as read.

Dr. Kuenen described some **"Experiments on Critical Phenomena,"** made in continuation of a research on the condensation and critical phenomena of mixtures of ethane and nitrous oxide, the results of which were published last year. The author now investigates mixtures of ethane and acetylene, and mixtures of ethane and carbonic acid, and finds for them similar properties to those of the mixture of ethane and nitrous oxide. The first part of the paper refers to the preparation of ethane. Impurities are often present, and affect the vapour pressure and critical constants. Ethane from ethyl iodide is not very pure. In the former paper, above referred to, instances are mentioned of mixtures having critical temperatures below those of the component substances. The only instance of critical temperatures above those of the components, seem to be those relating to mixtures of carbonic acid and acetylene. According to an experiment of Dewar's, however, a mixture of $\frac{1}{2}CO_2$ and $\frac{1}{2}C_2H_2$ has a critical temperature of 41deg. C., those for carbonic acid and acetylene being 31deg. and 37deg. respectively. The present investigation contradicts this result. Dewar may not have taken sufficient precaution in avoiding errors of retardation. Mixtures of carbonic acid and acetylene have critical temperatures between those of the component pure gases. An instance of a critical temperature above those of the components, for this mixture, has not yet been proved. Theory indicates that this phenomenon probably occurs for mixtures having a minimum vapour pressure at low temperature. Critical temperatures below those of components, seem to occur for mixtures having a maximum vapour pressure; as for nitrous oxide and ethane.

Dr. S. P. Thompson asked whether diagrams characteristic of cyanogen had been obtained. Its remarkable polymerism suggested an interesting case for critical phenomena.

Dr. Kuenen thought such a substance might be worth investigation.

A paper by **Dr. Barton** on **"The Attenuation of Electric Waves in Wires,"** was taken as read.

Mr. G. F. C. Searle read a paper on **"The Steady Motion of an Electrified Ellipsoid."** The first part of the investigation is printed in the *Phil. Trans.* Roy. Soc. It contains the principles required in the solution of problems with respect to moving electrical charges. The second part, now presented to the Physical Society, deals with the motion of a charged ellipsoid; the treatment is entirely mathematical. When any system of electric charges moves with uniform velocity through the ether, the electromagnetic field, referred to axes moving forward with the charges, can be completely defined by means of a quantity of which the electric force and the magnetic force are simple functions. Another vector concerned in the problem is the mechanical force experienced by a unit charge moving with the rest of the system. A distribution of electricity on the surface of a charged body, such as to give zero distribution at all points inside the surface, is an equilibrium distribution. Since the mechanical force vanishes inside the surface, it is shown that on the outside of the surface the mechanical force is perpendicular to the surface, and the above-mentioned function is constant over the surface, and the distribution on an ellipsoid is the same for motion as for rest. When a charged sphere is at rest, it produces the same effect as a point-charge at its centre. If the sphere is in motion, it produces the same effect as an uniformly-charged line whose length bears to the diameter of the sphere the same ratio as the velocity of the sphere bears to the velocity of light. When the sphere moves with the velocity of light, the line becomes the diameter of the sphere; the same is true for an ellipsoid. At the velocity of light the charge on any surface is in equilibrium whatever the distribution. The force between two charges moving with the speed of light is zero. The lines of electric force for a charged sphere in motion are not radial; they form a series of hyperbolas. The author proceeds to calculate the total energy possessed by an ellipsoid when in motion along its axis of figure. Expressions are given (1) for the energy of a Heaviside ellipsoid, (2) for a sphere, and (3) for a very slender ellipsoid. In all cases the energy becomes infinite when the charges move at the velocity of light. It would seem impossible to make a charged body move at a greater speed than that of light.

Prof. Perry said the paper would help to solve many problems connected with the effect of the rotation of the earth upon electrical surface charges. An expression might be found for the mechanical and magnetic forces due to the motion of a charge at any point of the earth's surface. At the equator a point moves at different velocity at mid-day to its midnight velocity; it may now be possible to determine the magnetic and mechanical effects due to electrical charges at equatorial points.

Mr. Blakesley asked whether, in calculating the mutual action of two charged particles proceeding at the velocity of light, it was assumed that the lines of motion were parallel.

Mr. Searle said he had always considered parallel lines of motion; he could not say whether the force would be zero in any other case. The results arrived at in the paper could be applied to problems connected with distributions of terrestrial charges.

The **President** proposed votes of thanks to the authors, and the meeting then adjourned until November.

SUNDERLAND ACCOUNTS.

We give herewith the details of the revenue and expenditure of the Sunderland electricity works for the year ending March 31, 1897. It will be noticed that the financial results do not appear at first sight to be so good as last year. This is due to what, in the long run, is a sound policy—*i.e.*, the price per unit has been reduced to encourage the demand. Also the alternate-current plant has been put to work this year, and has caused what we hope is but a temporary increase in the cost per unit. The coal used at the steam trials has been charged to the general costs of coal, and besides this the motor-generator supplying the outlying district has had to be kept running for practically no return. When a good load has been obtained, this will cease to be the case. We understand that the high cost of repairs is due to the accumulators, which had rather bad treatment before Mr. Snell took over the management of the works. We are sure that, under his energetic management, a balance on the right side will be earned during the current year.

ANALYSIS OF ACCOUNTS FOR YEAR ENDED MARCH 31.

	1896-7.	1895-6.
Year of working	Second.	First.
Capital expended March 31	£39,341	£29,233
Revenue from electricity supply	2,497	2,040
Revenue from meter rents and other sources	217	84
Total revenue	2,714	2,124
Total costs	1,993	1,448
Gross profit before setting aside instalments for interest, depreciation, and sinking fund	721	676
Per cent. of costs to revenue	73·4%	68%
Per cent. of gross profit to capital (outlay during year being averaged)	1·83%	2·82%
Interest on loans, less credits	£872	£829
Amount set aside for depreciation, sinking fund, etc.	796	548
Per cent. of ditto to capital (averaged)	4 8%	2·29%
Financial result after covering all charges and providing for sinking fund and interest, deficit	£947	£701
Capacity of dynamos, kilowatts	446	196

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Maximum load reached, kilowatts	220	124
Capital outlay per kilowatt	£88	£148
Number of lamps connected (in 8 c.p.)	12,672	7,724
Number of units sold	146,440	95,446
B.T.U. sold per lamp (connections throughout year being averaged)	14·3	21
Revenue per lamp (ditto)	4s. 10d.	9s.
Statutory price	8d.	8d.
Price charged, private	5d. and 6d.	and dis
Price charged, power and heat	2½d. ,, 3d.	,,
Average price obtained	4·09d.	5·11d.

ANALYSIS OF COSTS.

Generation and distribution.	1896-7. £	Per unit. d.	1895-6. £	Per unit. d.	Increase + Decrease −
Coal and other fuel	304	0·49	166	0 42	·07 +
Oil, waste, engine-room stores	128	0·21	39	0·10	·11 +
Wages, workmen	600	0·98	339	9 85	·13 +
Repairs and maintenance of buildings, plant, machinery, instruments, tools, mains, etc.	190	0·31	44	0 11	·20 +
Works costs	—	1·99	—	1 48	·51 +
Rents, rates, and taxes	287	0 47	225	0·46	·01 +
Management, salaries, stationery, printing, insurance, & general establishment charges	482	0·79	675	17 0	·91 −
Total costs		3·25		3·64	·39 −

FINANCIAL RESULT FOR 1896-7.

Gross profit on year's working		£721
Less interest on loans	£872	
Sinking fund	796	
		1,668
Deficit for year		£947

BELFAST ELECTRICITY WORKS.

The accounts of the Belfast Corporation electricity works for the year ending December 31, 1896, have just come to hand. We give herewith the revenue account, balance-sheet, and statement of electricity generated, sold, etc.:

REVENUE ACCOUNT.

	£ s. d.	£ s. d.
Gas	830 13 1	
Oil, waste, water, and engine-room stores	121 6 6	
Salaries and wages	542 17 8	
Repairs and maintenance	219 1 5	
		1,713 18 8
Repairs and renewals of mains	104 11 7	
Repairs at consumers' premises	1 18 8	
Repairs at distributing station	4 12 2	
		111 2 5
Rents	127 0 0	
Rates and taxes	103 15 0	
		230 15 0
Salaries—engineer's department	279 3 4	
Stationery and printing	41 10 6	
General establishment charges	115 12 11	
		436 6 9
Insurance		12 1 0
		2,504 3 10
Amount carried to net revenue account		1,553 6 0
		£4,057 9 10

Cr.	£ s. d.
Sale of current	4,346 16 4
Less discount, £405. 14s. 4d.; less bad debts, £13. 3s. 8d.	418 18 0
	£3,927 18 4
Meter rents, £122. 17s. 4d.; less bad debts, 12s. 10d.	122 4 6
Testing fees	7 7 0
	£4,057 9 10

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£ s. d.
Capital account—amount received	25,299 14 0
Sundry creditors	1,735 5 2
Interest	1,579 14 8
Sinking fund	127 4 4
Treasurer	7,975 5 6
Net revenue account—balance at credit thereof	219 19 7
	£36,937 3 3

Cr. Assets.	£ s. d.
Capital account—amount expended	35,187 6 8
Stores on hand—oils, waste, etc.	11 3 2
Sundry debtors for current supplied to Dec. 31, 1896	1,699 4 5
Sundry debtors for meter rents to Dec. 31, 1896	39 9 0
	£36,937 3 3

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Units generated		166,219
Quantity sold—		
Private consumers by meter at 4d.	1,604	149,721
Private consumers by meter at 7d.	148,117	
Quantity used on works		6,123
Total quantity accounted for		162,397
Quantity lost in battery		6,553
Quantity not accounted for		3,822
Total maximum supply demanded in watts		240,000

LEGAL INTELLIGENCE.

CLAIM FOR JUBILEE LAMPS.

In the Southwark County Court, on Monday, his Honour Judge Addison had before him the case of Tucker *v.* Phillip, in which the plaintiff sought to recover payment in respect of a quantity of electrical fittings supplied to the order of the defendant for the purpose of the Jubilee procession.

Plaintiff's Representative said the goods in question were supplied to the defendant six months ago, and were used by him in connection with the Jubilee festivities.

The defendant did not appear, and his **Honour** gave judgment for the plaintiff for the amount claimed, with costs, to be paid in a week.

MARRIED WOMEN'S LIABILITIES.

In the Westminster County Court, on Tuesday, the case of Frazer *v.* Ellis was before his Honour Judge Lumley Smith, Q.C.

It was an action by the plaintiff to recover payment in respect of electrical work done to the order of the defendant, a lady residing at Marlborough-mansions, Victoria-street, Westminster.

The **Defendant** did not deny that the work had been done, but said she had been improperly sued as a single woman, whilst, as a matter of fact, she was married in Bombay 13 years ago.

On behalf of the **Plaintiff** it was said that the defendant represented herself as a single woman, and it was not until this action was brought that she put forward the present defence.

His **Honour** gave judgment for the plaintiff for the amount of the claim, payable £1 a month.

COMPANIES' MEETINGS AND REPORTS.

SOUTH STAFFORDSHIRE TRAMWAYS COMPANY.

An extraordinary general meeting was held on Monday, at Cannon-street Hotel, to consider the terms of an agreement for the settlement of the claims of the Electric Construction Corporation against this Company.

Mr. W. Somers Schuster presided, and, in moving that the agreement be confirmed, alluded to the financial position of the Company at the time the present Board came into office, and remarked that, in addition to the difficulty of accrued interest in arrear, they had to deal with various legal and other questions for which they were themselves in no way responsible. Had the Company gone into liquidation, there could be little doubt but that the ordinary and preference shareholders would have been wiped out entirely. He could assure them that the terms of the agreement were the best for the Company that the directors could secure. The motion was duly seconded and agreed to, after which a resolution was passed authorising the Board to pay the costs and charges properly incurred by the Shareholders' Protection Committee incidental to the legal proceedings, to which the committee were parties, in connection with the steps taken to procure the removal of former directors of the Company, and generally with reference to its affairs.

The seventh annual general meeting was afterwards held.

Mr. Schuster again presided, and moved the adoption of the report, which showed that the total receipts for the year amounted to £32,725, an increase on the previous year of £3,058. The total expenditure for the 12 months was £1,734 more than in the corresponding period. Owing to the many difficulties the directors had had to contend with, they considered that the profit of £3,387 on revenue account, as compared with £2,063 in 1895, might be regarded as satisfactory.

Mr. S. R. Blundstone seconded the motion, and the report was adopted.

ELECTRIC AND GENERAL INVESTMENT COMPANY, LIMITED.

Directors: George Herring, chairman; J. B. Braithwaite, jun.; Emile Garcke; B. H. Van Tromp.

Report of directors to be submitted to the eighth ordinary general meeting of the shareholders to be held at Winchester House, Old Broad-street, E.C., on Friday, July 2, at 3 p.m.:

The profit and loss account shows a gross profit on the transactions of the year of £15,052. 8s. 4d., and after deducting all

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standing charges, the interim dividend already paid on the ordinary shares, and a further provision for contingencies of £5,026. 1s. 1d., there remains a net balance of £7,000 available for distribution. The directors now recommend that this sum be applied to the payment of a further dividend at the rate of 40 per cent. per annum for the past six months on the ordinary shares, making with the interim dividend a distribution of 25 per cent. for the year upon the capital paid up thereon. In accordance with the provisions of the Company's articles of association, the holders of the founders' shares are entitled to a distribution of £30 per share. The trustees for the founders' shares reserve fund propose to distribute to the holders of such shares a sum of £20 per share out of the proceeds of investments sold and dividends received in respect of the fund, making a total distribution of £50 on each founder's share. The reserve fund of £10,483. 7s. 1d. has been invested and the securities placed in the names of trustees on behalf of the ordinary shareholders. The directors retiring this year are Mr. J. B. Braithwaite, jun., and Mr. Emile Garcke, who, being duly eligible, offer themselves for re-election. The auditor, Mr. G. T. Rait, also retires, but offers himself for re-election. It is proposed to make the dividends payable on July 3, 1897.

Dr. BALANCE-SHEET, MAY 31, 1897.

	£	s.	d.
Capital subscribed—20,000 ordinary shares	100,000	0	0
100 founders' shares	500	0	0
Capital called up—£1 per share on 20,000 ordinary	20,000	0	0
£5 per share on 100 founders'	500	0	0
	20,500	0	0
Reserve fund, invested on behalf of holders of ordinary shares	10,483	7	1
Provision for contingencies £10,222 16 0			
Amount added May 31, 1897 5,026 1 1			
	15,248	17	1
Sundry creditors	52,424	13	5
Unclaimed dividends	5	1	8
Balance of profit and loss account	7,000	0	0
	£105,661	19	3

Note.—There is a liability amounting to £850 in respect of calls that may become due on securities held by the Company.

Cr.

	£	s.	d.
Investments at cost	73,847	0	8
Sundry debtors	18,732	14	3
Cash in hand and at bankers	13,082	4	4
	£105,661	19	3

PROFIT AND LOSS ACCOUNT, MAY 31, 1897.

Dr.

	£	s.	d.
General charges, including directors' fees, and additional remuneration as per articles of association, general expenses, legal charges, advertising, printing, and auditor's fee, etc.	2,026	7	3
Amount carried to "provision for contingencies fund"	5,026	1	1
Interim dividend paid Jan. 1, 1897, at the rate of 10 per cent. per annum for the six months	1,000	0	0
Net profit available for division	7,000	0	0
	£15,052	8	4

Cr.

	£	s.	d.
Interest, dividends, commissions, and sundry profits	15,052	8	4
	£15,052	8	4

ELECTRICAL POWER STORAGE COMPANY, LIMITED.

Directors: John Irving Courtenay, Esq., chairman and managing director; Sir Daniel Cooper, Bart., G.C.M.G.; Frederick Green, Esq.; Sir James Pender, Bart., M.P. Manager: Frank King, M.I.E.E. Secretary: J. W. Barnard.

Report of the directors, to be presented to the shareholders at the eighth ordinary general meeting, to be held on Thursday, July 8, at the offices of the Company, 4, Great Winchester-street, E.C., at 12.30 p.m.:

The net profit for the year is £4,141. 5s. 5d., which, with a balance of £343. 19s. 7d. from last year, amounts to £4,485. 5s., out of which the directors recommend the payment of a dividend of 5 per cent. on the ordinary share capital, which will absorb £4,243. 4s. 10d., leaving £242. 0s. 2d. to be carried forward. Provision has been made for the maintenance of buildings, plant, tools, etc., at a cost of £2,048. 15s. 2d. The arrangements for the manufacture of the new Faure-King cell are being rapidly pressed forward, and large orders are being obtained for this new class of goods. The Company will shortly be in a position to manufacture and supply storage batteries to any specification embodying known types. The increased demand for storage batteries of the Company's manufacture has necessitated additional accommodation, and premises adjacent to the Company's Millwall works, having an area of about 16,000 square feet, having accordingly been acquired on favourable terms. For the purpose of providing the necessary capital, which the increase of the Company's business and the equipment of the new premises renders necessary, an issue of debentures to the amount of £30,000, bearing interest at the rate of 5 per cent., has been authorised. The retiring director is Mr. Frederick Green, who offers himself for re-election. The auditors, Messrs. James Meston and Co., chartered accountants, also offer themselves for re-election.

BALANCE-SHEET, MAY 31, 1897.

Liabilities.

	£	s.	d.
Share capital authorised—			
20,100 shares of £5 each, of which 100 are founders' shares	100,500	0	0
Shares issued 66 founders' shares of £5 each, fully paid (exclusive of four shares forfeited)	330	0	0
15,120 ordinary shares of £5 each, fully paid	75,600	0	0
3,137 ditto of £5 each, £3 called (exclusive of 400 shares forfeited)	9,411	0	0
18,323	85,341	0	0
Deduct calls in arrear	121	15	6
	85,219	4	6
Debenture issued authorised £30,000			
Debentures issued—106 debentures of £100 each, £10,600; deduct amount unpaid, £100	10,500	0	0
Sundry creditors	11,483	16	4
Bills payable	3,500	0	0
Reserve fund	12,000	0	0
Profit and loss account—balance at credit May 30, 1896, after paying dividend at 5 per cent., £343. 19s. 7d.; add profit for year 1896-97, £4,141. 5s. 5d.	4,485	5	0
	£127,188	5	10

Assets.

	£	s.	d.
Patents, goodwill, etc., as per last balance-sheet	85,760	0	0
Added this year	10	0	0
	85,770	0	0
Plant, tools, furniture, fixtures, etc. (including £526. 11s. 9d. for plant, etc., added this year), £3,163. 1s. 5d.; less depreciation written off this year, £263. 12s. 11d.	2,899	8	6
Stock on hand at cost or under	16,326	1	8
Sundry debtors (less reserve for discounts and doubtful debts)	14,506	2	5
Bills receivable	398	10	0
Investments — debentures and shares in other undertakings	2,800	0	0
Cash at bankers, £4,451. 8s. 9d.; in hand, £36. 14s. 6d.	4,488	3	3
	£127,188	5	10

THOMAS PARKER, LIMITED.

The following is the report of the directors of this Company for the year ending April 30, 1897:

After writing off various depreciations, the balance standing to the credit of profit and loss account is £5,227. 2s. 9d. Out of this the directors propose to pay a dividend at the rate of 7 per cent. per annum, less income tax, amounting to £4,059. 8s. 7d., and to carry forward to next year the balance of £1,167. 14s. 2d. During the past year the works have been kept full of orders, and to meet the growing requirements of the trade, the fitting shop has been increased by an area of 15,000 square feet. A large addition of tools has been made, and messrooms have been added to increase the comfort of the workpeople. The directors propose to call up the balance of uncalled capital before the end of the year, and shareholders will be invited to pay up the amounts for which they are liable at an earlier date if they choose. The director who retires by rotation is Mr. C. T. Mander, who is eligible for and offers himself for re-election. The auditors, Messrs. Allen Edwards and Smith, also retire, but are eligible for and offer themselves for re-election.

BALANCE-SHEET.

Liabilities.

	£	s.	d.
Nominal capital—7,500 ordinary shares of £10 each.	75,000	0	0
Subscribed capital—viz., 1,750 ordinary £10 shares, fully paid	17,500	0	0
5,750 ordinary £10 shares, £8 paid	46,000	0	0
	63,500	0	0
Mortgage debentures	15,000	0	0
Sundry creditors (less reserve for discounts)	12,066	14	11
Amount due to bankers	3,287	17	10
Profit and loss account	5,227	2	9
	£99,081	15	6

Assets.

	£	s.	d.
Sundry debtors (less reserve for discounts, etc.)	19,866	15	0
Freehold land and buildings, plant and machinery, loose tools, patterns, patents, goodwill, office furniture, etc. (less depreciation)	65,868	15	7
Preliminary expenses, as per last account, £762. 4s.; less amount written off, £762. 4s.	0	0	0
Stocks on hand and work in progress, as certified by the managing director	13,346	4	11
	£99,081	15	6

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CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Paris.—The French Telegraphic Authorities will receive tenders at Paris, Rue de Grenelled, 103, on July 13 for 755 kilometres of paper-insulated cable.

Madrid.—The Spanish Government Post and Telegraph Departmental Authorities will receive tenders at Madrid on July 12 for 20,000 battery zincs for telegraph work.

Paris.—Tenders will be received at the Undersecretariat of Posts and Telegraphs (Rue de Grenelle, 103) on July 13 for the supply of material for Calland batteries. Application for permission to tender must be made at once (July 3).

Herve (Belgium)—Offers will be received up to October 1 by the Municipal Authorities of Hervé, in the Province of Liège, for an installation of town lighting. No information is given as to the system (electrical or otherwise) which would be preferred.

Madrid.—Tenders will be received by the Spanish Government for the supply of 14 tons of sulphate of copper for the Spanish telegraphs. Delivery at Bilbao or Huelva. Tenders, on stamped paper, and with a security of 10 per cent., and particulars on application to the Direccion-General de Cerros y Telegrafos, Madrid.

London, N.—The Metropolitan Asylums Board are prepared to receive tenders for the supply and running of mains in the grounds and for the wiring of the nurses' quarters now in course of erection at the North-Western Fever Hospital, Haverstock Hill. Sealed tenders are to be delivered at the chief office of the Board not later than 11 o'clock on July 8. For further particulars see advertisement.

Glasgow.—The Corporation invite tenders for the supply of (1) copper rods, (2) small cast-iron covers, (3) gunmetal terminals, (4) brass grip-boxes, and (5) stoneware insulators. Forms of tender and specification will be obtained, and samples of articles required seen, at the office of the Electrical Engineer, 75, Waterloo-street. Tenders to be lodged with Mr. J. D. Marwick, town clerk, Glasgow, by July 5.

London, S.E.—The St. Mary's (Newington) Vestry require tenders for the supply and fixing of clocks (electrical or otherwise) at the new baths and washhouses, Manor-place, Walworth. A schedule of the clocks required, with a description of the size of each dial, may be obtained from Mr. L. J. Dunham, vestry clerk, Vestry Hall, Walworth, S.E., to whom tenders are to be delivered, marked "Tender for Clocks," by July 5.

Huddersfield.—The Electric Lighting Committee of the Huddersfield Corporation have for disposal a 100-h.p. compound vertical Brush engine and a 50-unit Mordey alternator (2,000 volts 25 amperes). Sealed tenders, endorsed "Tender for Purchase of Plant," must be delivered free of charge, addressed in the handwriting of the tenderer or his agent, to the Town Clerk, Town Hall, Huddersfield, not later than July 14.

Jassy (Roumania).—Tenders will be received on September 6 18 at 4 p.m., in the hall of the Communal Council of the Mairie of the Commune of Jassy, for the concession for a term of 40 years of the contract for gas or electric lighting, or gas and electric lighting, of the public thoroughfares and communal buildings. Every applicant, before being entitled to tender, will be required to deposit a provisional security of 70,000fr. in cash or Roumanian public bonds. All tenders must be sealed and lodged at the Mairie by the day and hour named. Conditions of tender and specification respecting this concession will be forwarded on application to Mr. C. Gall, secretary.

South Shields.—The Corporation are inviting tenders for the supply and erection of the following plant: (Section A) boiler and boiler mountings; (B) pumps and accessories. Firms tendering are at liberty to tender for any of the sections, but not for part of a section, and no tender for any plant which is not in strict accordance with the specification will be considered. Copies of specification, including conditions of tender and form of contract, can be obtained at the Borough Electrical Engineer's Office, West Holborn, South Shields, on payment of £1. 1s., which sum will be returned on receipt of a bona fide tender. Tenders, sealed and marked "Tender for Electric Lighting, to be delivered to Mr. J. Moore Hayton, town clerk, South Shields, by noon on July 9.

Jassy (Roumania).—Tenders will be received on and after September 6-18 at 3 p.m., in the hall of the Communal Council of the Mairie of the Commune of Jassy, for the concession for a term of 40 years of a line of tramways to serve the Commune of Jassy, the said concession to include the construction, maintenance, and working of the line. Every applicant, before being entitled to tender, will be required to deposit a provisional security of 50,000fr. in cash or Roumanian public bonds. All tenders must be sealed and lodged at the Mairie until the day and hour above named. Conditions of tender and specification respecting this concession will be forwarded on application. Tenders will be subject to articles 68-79 of the Public Accounts Act. Mr. C. Gall, secretary.

St. Helens (Lancs.).—The Electric Lighting Committee of the Corporation are prepared to receive tenders for the supply and erection of the following plant for the extension of the municipal electricity works: (Section A) boiler-house plant—Lancashire boiler and fittings, forced-draught apparatus, feed pump, economiser, etc.; (B) engine-house plant—steam alternator and exciter, etc., steam exhaust, feed, blow-off, and sundry pipes, valves, etc.; (C) switchboard and instruments; (D) underground work—culverts and cables; (E) transformer sub-stations. Tenderers are at liberty to tender for any section or sections, or for the whole of the sections, but not for part of a section. The plans of plant and specification, with terms and conditions of tender and contract, may be obtained at the office of Mr. Robert Hammond, M.I.E.E., consulting engineer to the Corporation, Ormond House, Great Trinity-lane, London, E.C., on payment of £2 2s. for each copy, which sum will be refunded on the return of the specification, fiilled up with a bona fide tender. Tenders (sealed, and marked "Tender for Electric Lighting") must be addressed to Mr. W. J. Jeeves, town clerk, Town Hall, St. Helens, and delivered by July 20.

Lincoln.—The Corporation require tenders for the supply, delivery, and erection, according to specifications, of the following plant: (Section A) two dry-back marine-type boilers; (B) high-speed engines, continuous-current dynamos, steam and other pipes, pumps, motors, and travelling crane; (C) a fuel economiser; (D) storage batteries; (E) a main switchboard and instruments; (F) armoured concentric and triple-concentric cables, and pilot wire cables. Specifications, general conditions of contract, and plans for all or any of above sections may be obtained at the office of Mr. C. S Vesey Brown, city electrical engineer, Corporation Offices, Silver-street, Lincoln, on payment of a deposit of £1. 1s. for each section; the deposit will be refunded on the return of the specification, etc., with a bona fide tender. If a tender is accepted, such acceptance will be subject to the sanction of the Local Government Board being obtained to the borrowing by the Corporation of the moneys required for the carrying out of the works comprised in the above contracts. Sealed tenders, addressed to the Electric Lighting Committee of the Lincoln Corporation, endorsed with the words "Tender for Section A, B, C, D, E, or F (as the case may be) Electricity Works," must be delivered to the office of Mr. H. K. Hebb, deputy town clerk, St. Peter's Churchyard, Silver-street, Lincoln, by noon on July 14.

RESULTS OF TENDERS.

Blston.—The District Council have accepted the tender of the Universal Electric Light Company for an electric light plant for the town.

Spandau.—The tenders for the supply of incandescent lamps to the Spandau arsenal were as follows: For 800 16-c.p. 100-volt lamps for Edison sockets and for 100 50-c.p. 110-volt lamps to take the new Helios socket, Gebr. Pintsche, 50pfg. and 80pfg.; Bäyerische Gluhlampen-Fabrik, 48pfg. and 95pfg.; Allg. Elektricitäts-Gesell., 50pfg. and 1 mark 12pfg. each.

BUSINESS NOTES.

Western and Brazilian Telegraph Company, Limited.—For the past week the receipts were £2,070.

Personal.—Mr. C. Walmsley has been appointed secretary to the British Electric Traction Company, Limited.

Battersea.—The Vestry have declined to transfer their electric lighting order to the South London Electric Supply Corporation, Limited.

Metropolitan Electric Supply Company.—The transfer registers of the new ordinary shares will be closed from July 1 to 15, both days inclusive, for payment of the 4 per cent. interest.

Madeira Electric Lighting Company.—The coupons for debenture interest due 30th inst. will be paid on and after that date by the Halifax Joint-Stock Bank, Princess-street, Halifax.

Electrocution.—Robert Powley, an Englishman, who was recently sentenced to death for wife murder, was executed by electricity at Auburn Prison, New York State, on Tuesday.

Electric Traction in the Transvaal.—The Transvaal Volksraad has thrown out the new electric tram contract for the Rand, a majority of the members holding it to be against existing vested interests.

Motorcar Transports.—During the forthcoming French Army manœuvres motorcars will be used for the first time, with the view of ascertaining their value as transport for both men and stores in the time of war.

Hobart Electric Tramway Company.—The Commercial Bank of Scotland, 62, Lombard-street, E.C., will pay the half-yearly interest coupons on the first and second mortgage debentures due yesterday (Thursday).

Western and Brazilian Telegraph Company.—The receipts for the week ending June 25, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, amount to £2,070.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended June 27 amounted to £1,716, as compared with £1,219 in the corresponding week of the previous year, being an increase of £497.

Tunbridge Wells.—The pastor of the Bible Mission Hall is endeavouring to raise money for the adoption of the electric light in the large hall, which at present is rendered almost unbearable by the heat of the gas.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended June 25 were £4,027. 13s. 6d., compared with £2,333. 19s. 4d. for the corresponding period of last year, being an increase of £1,693. 14s. 2d.

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New Electric Lighting Companies.—Messrs Edmundsons, Limited, have this week registered three companies for electric lighting in Peterborough, Ryde, and Weymouth respectively. A nominal capital of £10,000 each is asked for.

Charing Cross and Strand Company.—The coupons of the 5 per cent. debentures of the Charing Cross and Strand Electricity Supply Corporation, Limited, numbered 1 to 700, due on July 1, will be paid at the Union Bank of London, Charing Cross branch.

City of London Electric Lighting Company, Limited.—The Board have declared an interim dividend on the preference shares of this Company at the rate of 6 per cent. per annum for the half-year ending June 30, 1897, payable on and after July 19 next.

Nantwich.—At the Urban District Council meeting a letter from the Edmondson Electric Lighting Corporation, giving particulars with reference to their conditions in regard to supplying the electric light, was referred to the Lighting Committee to consider and report.

City and South London Railway.—The returns for the week ended June 27 were £1,337 compared with £891 for the corresponding period of last year, being an increase of £446. The total receipts for the half-year 1897 were £26,645, compared with £24,069 last year, being an increase of £2,576.

Penarth Electric Lighting Company, Limited.—This Company has been registered, with a capital of £2,000 in £1 shares, to carry on the business of electricians, engineers, suppliers of electricity, and the general business of an electric lighting company. Registered office: Vienna-chambers, Cardiff.

Ipswich.—Messrs. R. D. and J. B. Fraser are about to put up on a bracket in front of their premises in Princes-street an electric time ball. This apparatus will be connected by telegraph with Greenwich Observatory, and precisely at one o'clock each day, Greenwich mean time, a heavy ball will drop.

Willenhall.—At the monthly meeting of the Urban District Council it was stated that the Electric Pioneer Company had served a statutory notice upon the Council of their intention to supply the electric light to private consumers in Willenhall. The notice is to be considered by the General Purposes Committee of the Council.

Cable Rates.—The Eastern Extension, Australasia, and China Telegraph Company, Limited, notifies that the cable rate between Great Britain and Queensland will be reduced on July 1 from 9s. 5d. to 5s. 1d. per word. Substantial reductions will also be made on the same date in China and Japan tariffs, as already announced.

Electrical Pioneer Syndicate, Limited.—This Company has been registered, with a capital of £10,000 in £50 shares, to carry on the business of electricians, mechanical engineers, and manufacturers of and dealers in machines, lamps, lanterns, safety lamps, etc. Registered office: Bank-chambers, Waterloo-street, Birmingham.

Bromley.—At the Rural District Council meeting the Clerk said that, so far as he was concerned, the license from the Board of Trade to the Chislehurst Electric Lighting Company was settled. He suggested that it should go to the Parish Council. Mr. Willis thought they did not want to see it, but, as a matter of form, the clerk's recommendation was adopted.

West African Rubber Concessions Syndicate, Limited.—This Company has been registered, with a capital of £4,000 in £1 shares, to obtain options over and to acquire any interests and concessions as to the collection and planting of indiarubber in West Africa and elsewhere. Registered without articles of association. Registered office: 65, New Broad-street, E.C.

The Metric System Bill.—In the House of Commons, on Tuesday, Mr Daly asked the President of the Board of Trade whether he could say if the Weights and Measures (Metric System) Bill applied to Ireland, and, if so, would it be compulsory on traders to buy and sell by the metric system if passed into law. Mr. Ritchie replied that the Bill did apply to Ireland, but was entirely voluntary.

Exeter.—At the City Council meeting the Electric Lighting Committee presented a report from the surveyor on the scheme for lighting the main street from Exe Bridge to St. Anne's Chapel and Queen-street with the electric light. The number of lamps required was 33, and the estimated cost of the installation work was £1,650. On the motion of Mr. Domville, seconded by Mr. Wreford, the report was adopted.

South California.—The cable electric railway to a peak of the Sierra Madre Mountains overlooking Los Angeles, about 6,000ft. above the sea, has not proved financially successful. The line issued bonds to the amount of £100,000, of which few, if any, were taken by British capitalists, and it is now in the hands of a receiver. Owing to an informality in the issue of the bonds, it is possible that the bondholders will not get anything.

Hampstead.—The Electric Lighting Committee reported at the Vestry meeting that they had appointed Mr. Hall as chairman of the committee until the next annual election of vestrymen, and that they had resolved not to appoint a vice-chairman of the committee. They recommended that the engineer be authorised to obtain fuse-boxes, meters, and house-service boxes, as detailed in a list submitted to the committee, at a cost of £91. 6s. The report was adopted.

London Lighting Extensions.—The London County Council have sanctioned extensions, of which notice has been given by the St. Pancras Vestry, the County of London and Brush Provincial Electric Lighting Company, the London Electric Supply Corporation, the Notting Hill, the City of London, and the House-to-House Companies. The Kensington Vestry have also given permission to the Notting Hill Company and the House-to-House Company for extensions.

Anderson Electrical Traction Syndicate, Limited.—This Company has been registered, with a capital of £5,000 in £1 shares, to acquire and develop the patents and patent rights of C. Anderson for improvements in apparatus for working electric tramways by means of an underground cable contained in a closed conduit, and to enter into a certain agreement. The directors are Sir H. Mitchell, Kt., G. F. Crowe, W. C. Dawson, C. Anderson, J. Gould, and W. M. Harris.

Taunton.—At the Somerset County Council meeting Mr. Goodford presented a supplemental report which recommended that the Taunton light railway scheme be opposed on the grounds, among others, that the main roads were in some places too narrow for the purpose; and, secondly, because no sufficient guarantee was inserted in the draft order for maintaining the surface of the roads in repair, or of restoring it in the event of the abandonment of the scheme. The supplemental report was agreed to.

Rowley Regis.—At the Urban District Council meeting, the Chairman intimated that a prospectus had been received from a man named Barnett, who proposed to provide electrical power over a considerable area of that district—from Wolverhampton to Walsall, and from Walsall to Smethwick, and from Smethwick to Stourbridge. The scheme, if carried out, could be used for working all kinds of machines, and would no doubt be a great boon to the locality. The Council decided to take no action in the matter.

Bath.—Mr Tulloch has held a Local Government Board enquiry as to the application of the Urban Sanitary Authority to borrow the sums of £6,880 and £3,750 for purposes of electric lighting, and £5,000 for wood pavement works. It was explained that the sum of £6,880 included extensions of mains, consent to which the Board withheld on the occasion of a former enquiry, and £1,000 expenses in opposing the old company's application and costs of the purchase. The £3,750 was for a new roof to the works, extension of the boiler-house, etc.

Hull.—At a meeting of the Electric Lighting Committee, the Electrical Engineer reported that as there seemed little probability of the new extension of the electric light undertaking being ready for the commencement of the winter load, he would suggest that some temporary provision should be made to supply the increased demand. He recommended that temporary machinery equal to 300 h.p. should be put up for three months, for which a site would have to be provided. The report was ordered to be entered on the minutes, and the engineer authorised to advertise for tenders for the hire of the plant.

High-Conductivity Copper.—The Usines Mouchel Company, of Boisthorel and Paris, inform us that they have appointed Messrs. Charles Jennings and Co., of 90, Cannon-street, London, E.C., sole agents for the United Kingdom for the sale of their manufactures. The company's works at Boisthorel, Aube, and Tillières have been established for over a century, and at present manufacture annually upwards of 4,000 tons of copper, brass, and alloys of copper. The productions embrace all sections of rods and wires, sheets, etc., in all the usual dimensions, as well as high-conductivity copper for electrical purposes.

Norway.—An electric installation of considerable importance has recently been completed at Röros, Norway. There are two large alternate-current dynamos, with a tension of 5,000 volts. The dynamos are directly coupled with the turbines, each of 300 h.p. The current is conveyed from the machinery-house to three copper mines, some five to seven miles distant, and is there transformed to 150 volts. The electricity is used both for lighting purposes and for working a considerable amount of machinery. A separate dynamo supplies the requisite electricity for the electric railways. The height of the fall is about 50ft.

Organisation of Women in the Electrical Trades.—A meeting of women employed in the electrical trades in Wolverhampton has been held for the purpose of considering the advisability of forming a trades union. Mr. W. Day presided. Miss Marian Barry, organiser of the Women's Trade Union League, London, delivered an address. She said she had heard that in Wolverhampton women in several trades were unfairly used to compete with male workers, and in some of the electrical establishments in the district women were doing work for less than half a male worker's earnings. It was decided unanimously to form a union of electrical women workers in the town.

Hanover.—The directors of the Hanover tramway system have published an important report, in which they narrate their experiences with accumulators as the source of the power for their cars. In Hanover both overhead wires and accumulators have been used for a considerable time, so that the managers are in a position to institute a reliable comparison. Taking everything into account, they pronounce in favour of the storage cell. The cost of maintenance, they say, has been determined with the utmost exactitude possible for the year 1896, and the managers reach the conclusion that the additional cost of accumulators does not exceed one groschen, or 1d., per mile. Consequently, it has been decided that the entire system shall, as soon as the requisite arrangements can be made, be driven by secondary batteries.

Islington.—Mr. Price moved at the Vestry meeting that it be referred to the Electric Lighting Committee to consider and report to the Vestry (1) what particular area in the parish should be included in the next extension of the electric lighting system; (2) when it would be desirable to proceed with such extension; and (3) the estimate of the probable cost of such extension. The motion was carried. A report will be received at to-night's meeting of the Vestry from the Electric Lighting Committee

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stating that it has had under consideration the question of the salary of Mr. C. H. Yeaman, the assistant engineer, and being of opinion that his present remuneration is inadequate having regard to the services he renders, it recommends that his salary be increased from £160 to £200 per annum from July 1, 1897.

Leeds.—In Boar-lane and Briggate the present gas lamps are to be removed, and the light supplied by 40 arc lamps. These are to be placed on the top of the centre poles and side brackets, to be used in connection with the overhead electrical tramway system. The current is to be obtained from the Corporation's tramway electrical generating station at Crown Point. Each light will have an illuminating power of about 1,500 candles. These lamps are expected to be ready for use about the end of September. During the last fortnight the experiment has been tried of lighting Park-row, from the Cathedral to the end of Bond-street, with incandescent lights. In the opinion of Mr. Vickers, the chairman of the Lamp Committee, the trial has proved exceedingly satisfactory, and it is probable at an early date the committee will take into consideration the advisability of introducing this form of illumination in several of the main thoroughfares.

Subways under Streets.—At the London County Council meeting the Highways Committee recommended: "(*a*) That the Council do seek power in the next session of Parliament for the construction of subways in such of the streets in the county of London as it may consider suitable for the purpose, provision being made that companies and others having pipes and mains in such streets shall remove their pipes, etc., into the subways, and shall pay rent, according to a scale to be determined by agreement, or in default of agreement by arbitration of the Board of Trade, in respect of the user of the subways, the remainder of the expenses of construction and maintenance being defrayed by the local authority in whose district each such subway may be situated, or by the Council, or by both. (*b*) That it be referred to the Parliamentary Committee to take the necessary measures to give effect to the above resolution." This was taken back.

Woodward Electrical Storage Battery Company, Limited.—This Company has been registered, with a capital of £60,000 in £1 shares, to carry on the business of storage battery manufacturers, manufacturing electricians, engineers, and contractors for supplying lighting appliances, electric tramcars, omnibuses, motorcars, and other vehicles worked by electric power; and also the business of an electric light and supply company in all its branches, and in particular to construct, lay down, establish, fix, and carry out all necessary cables, wires, accumulators, lamps and works, and to generate, accumulate, distribute, use, and supply electricity and similar forces, and to construct and maintain telegraphs, telephones, etc.; to manufacture and deal in steam, gas, thermo, hydrocarbon, petroleum and other engines, dynamo machinery, electric balloon signals, miners' electric safety lamps, thermopiles, lamps, transformers, meters, instrument fittings, etc.

United River Plate Telephone Company.—The report of the directors for the year ended March 31 last states that the gross receipts in sterling for the year in the River Plate were £60,325, as against £48,744 for the year before, and the working expenses in the River Plate £30,204, as against £24,967, leaving a profit, after the deduction of debenture interest and all London charges, less transfer fees and interest on investments, of £20,552, as against £14,504, to which should be added £4,524 brought forward from the previous year, making an available balance of £25,076. Out of this sum the directors propose to transfer £3,000 to depreciation fund, and they recommend that a dividend of 5 per cent., free of income tax, as against 4 per cent. last year, be paid upon the ordinary share capital of the Company, and that the balance of £7,576 be carried forward. The capital outlay was £4,647, as compared with £2,682 last year. The increase in the business of the Company has fully met the anticipations of the directors, and further steady improvement is confidently expected.

Tynemouth.—At the meeting of the Town Council, Alderman Armstrong proposed the confirmation of the Trade and Commerce Committee's report, which recommended that the service of Mr. E. M. Lacey, electrical engineer, be retained. He said the time had now come for taking the supply of electric energy into consideration, with a view, in the first place, of securing to the ratepayers of the borough the exclusive right to provide for themselves, and for their own benefit in the future, the electric light for illuminating purposes, and securing that right by complying with the conditions and terms under which they held their parliamentary powers, before the Board of Trade was moved to revoke them; and, in the next place, to ascertain whether it was practical, and, if so, whether it was desirable, that they as a community should set themselves to work to provide electric power for the purpose of lighting, for the working of the trams, and for other purposes. They had these two things in view in proposing the appointment of an electrical expert in order that they might get a report on the whole subject. Alderman Collins seconded the motion, which, after some discussion, was agreed to.

Stoke-on-Trent.—At the Town Council meeting the Town Clerk reported the receipt of a letter from the Board of Trade, enclosing copy of an application by the North Staffordshire Tramways Company for the use of steam for a further period of 12 months. It was recommended that the request be granted. Mr. A. J. Bradshaw said there were complaints in the town about the action of the tramway company in refusing to allow decorations to be erected on or attached to the new poles which formed part of the proposed electrical equipment of the tramways. The Chairman said the Council had no power in this matter. He thought the Council made a mistake when they gave permission to the company to erect the poles. More unsightly things he never saw. The recommendation to sanction the use of steam power on the tramways for another 12 months was confirmed. A letter had been received from Messrs. Crompton and Co., Limited, electric light engineers, saying that they proposed applying for a provisional order for an electric lighting supply for the town of Stoke, and asking whether the Council would favourably receive that action. The town clerk had replied that the Corporation would oppose any such application, and his action was approved.

Iron and Steel Institute.—In accordance with previous announcements, the autumn meeting of the Iron and Steel Institute will be held at Cardiff on Tuesday, Wednesday, Thursday, and Friday, August 3, 4, 5, and 6 next. The following papers have been offered for reading: "On Passive Iron," by J. S. de Bennevil'e (Philadelphia); "On the Diffusion of Sulphides through Steel," by E. D. Campbell (Ann Arbor, Michigan); "On the Manufacture of Tin-plates," by George B. Hammond (Penarth); "On a Spectroscopic Analysis of Iron Ores," by Prof. W. N. Hartley, F.R.S., and Hugh Ramage, Assoc.R.C.Sc.I., F.I.C. (Royal College of Science, Dublin); "On Improvements in Shipping Appliances in the Bristol Channel," by Sir W. T. Lewis, Bart., member of council; "On the Iron Industry of Hungary," by D. A. Louis, F.I.C. (London); "On a Thermo-Chemical Study of the Refining of Iron," by Prof. Honoré Ponthière (Louvain); "On Carbon and Iron," by E. H. Saniter (Wigan); "On Some Mechanical Appliances at Penarth Docks," by T. Hurry Riches, M.I.C.E. (Cardiff); "On the Application of Travelling Belts to the Shipment of Coal," by Thomas Wrightson, M.I.C.E. (Thornaby-on-Tees). The outline pragramme has been issued, and the detailed programme will be issued at the meeting.

Inspection of Telegraph Messengers.—There was a large gathering on Monday evening on the Guards' Ground, in Hyde Park, on the occasion of the annual inspection of the London telegraph messengers. In all 1,075 messengers were drawn up, the Central Telegraph Office sending 96, in addition to 67 indoor boys, the Wandsworth and Norwood districts 68, the Eastern district 101, the East Central district 93, Paddington 91, the South-East district 102, the South-West district 105, the North-West district 91, the Western district 67, the West Central district 93, and the Northern district 101. Amongst those present to see the parade were the Duke of Norfolk (Postmaster-General), Mr. A. Morley (late Postmaster-General), and a large gathering of the officials from St. Martin's-le Grand. Lord Methuen, carried out the inspection, and was attended by Colonel M'Kinnon, A.A.G., and Captain Vandeleur, D.S.O., A.D.C. The boys, who were under the command of Lieut.-Colonel J. P. Macgregor, wore their ordinary Post Office uniform, with the addition of waterproof capes rolled over the shoulders. They bore Martini-Henry carbines. The bands of the various districts were massed. The boys were drawn up in 12 companies of 30 file. On his arrival on the parade ground Lord Methuen, who was received with a general salute, proceeded to inspect the line. There was a march past, and then the battalion performed several evolutions of physical drill to music, afterwards advancing in review order to the saluting point, when the boys were briefly addressed by Lord Methuen. He expressed his pleasure at what he had seen, and congratulated the battalion on its smart appearance and on the way it had carried out its drill.

Newington.—The Electric Lighting Committee, in a report brought up by the clerk, reported at the Vestry meeting that the provisional order for the supply of electric light in Newington has been included in the Electric Light Provisional Order No. 11 Bill. The second reading took place in the House of Lords on the 1st ult., and the Bill is now for commitment. The committee observed from the daily papers that a deficit had arisen in the electric light undertaking at St Pancras and Islington during the past year, and, knowing that the Vestry would feel anxious to be advised of the circumstances that had brought about this result, they had caused enquiries to be made, and now submitted a criticism of the accounts which had been sent to them by experts fully competent to form a correct opinion. The report concluded by stating that in a parish like Newington, where the greatest care would be taken not to incur any unnecessary capital charge on the generating station, the committee feel assured that the financial aspect of the Vestry's undertakings are even still more promising than shown by Mr. Manville's report, upon which the Vestry decided to apply for an order. Mr. Edwards moved the adoption of the report, and Mr. Cory seconded the motion. Mr. Robins moved that the matter be deferred until the next meeting, in order that the report might be printed and circulated among the members. On a division the amendment was carried. Mr. Hester was granted leave to withdraw the following notice of motion: "That, as the returns of the Vestry elections show that the majority of the electors in the compulsory area are opposed to the electric lighting scheme, this Vestry does not deem it advisable, in the face of such opposition, to run counter to the expressed views of the electorate, and therefore declines to proceed with the electric lighting scheme." He said he wished to withdraw because of the extraordinary report read by the clerk.

Leicester.—The Gas and Electric Lighting Committee report that they have had brought under their notice by the engineer, Mr. Alfred Colson, M.I.C.E., the productive capacity of the electric light central station at the Aylestone-road works, and the probable demand for current next winter. In 1893 the erection of generating plant was authorised capable of producing 675 kilowatts. The demand for electricity since the opening of the station in December, 1894, has been of so satisfactory a character that even last winter the load reached 90 per cent. of the capacity of the station, and the demand next winter will doubtless far exceed the present

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capacity to supply. In anticipation of an early increase of the generating plant being required, the committee and engineer have fully investigated the latest development of alternators, both English and Continental, and with a view of making their investigation as thorough and complete as possible, a deputation visited in the early part of the year a number of Continental central stations and electrical engineering works. As a result of their investigation, the committee have decided to adopt what is known as the inductor type of alternator. The engineer recommends the erection at as early a date as possible of four 350-kilowatt inductor alternators in substitution of the present three 200-kilowatt and one 75-kilowatt alternators. In three cases the present engines will be ample for this size machine, but a fourth engine corresponding to these will be needed, as also additional boiler power, etc. The engineer also recommends the laying of two additional high-tension feeders into the town from the central station, as well as an extension of both high and low tension distributing cables with the necessary sub-stations and transformers. The engineer's estimate of the cost of the work is £30,193, and the committee recommend that the works be carried out, and that application be made to the Local Government Board for their sanction to a loan of £33,719, which amount is made up by the sum required for the works now recommended and expenditure which has been already incurred beyond the amount previously sanctioned by the Local Government Board—namely, overspent for sub-stations and transformers, £1,253; and for mains and services, £2,273.

PROVISIONAL PATENTS, 1897.

JUNE 21.

14963. Improvements in trolleys for electrically-propelled cars. Egmont Hoegerstaedt, 89, Chancery-lane, London. (Complete specification.)

15011. Improvements in brush-holders for dynamo-electric machines. James Henry Yearsley, Norfolk House, Victoria-embankment, London. (Complete specification.)

15013. Negative electrode for zinc accumulators. Sydney Pitt, 24, Southampton-buildings, Chancery-lane, London. (Léger Bomel and Société Bisson, Bergès et Cie., France.) (Complete specification.)

JUNE 23.

15047. Improvements in and relating to electric accumulators or storage batteries. Arthur Heinemann and Wilhelm Schäfer, 11, Southampton-buildings, Chancery-lane, London.

15080. Improvements in or relating to electric batteries. Alfred Julius Boult, 111, Hatton-garden, London. (Joseph Trillet, France.)

15090. Improvements in electric accumulators. Henry Charles Carter, 115, Cannon-street, London.

15099. Improvements in or relating to apparatus for controlling and governing electric motors. Reginald Belfield, 322, High Holborn, London. (Harry P. Davis, United States.)

JUNE 24.

15159. Improvements in arc lamps. Paul Duflos, 18, Buckingham-street, Strand, London.

15168. A method of measuring electrical power and appliances for that purpose. Michael Birt Field, 28, Southampton-buildings, Chancery-lane, London.

JUNE 25.

15222. Improvements in and relating to electric accumulators. Lothaire Fiedler, 32, London-street, Tottenham Court-road, London.

15237. Improvements in electrical switch apparatus for the points and crossings of electrical railways or tramways with underground conductors. Siemens Bros. and Co., Limited, 28, Southampton-buildings, Chancery-lane, London. (Siemens and Halske, Germany.)

15238. An improved manufacture of electrical resistances. Josef Franz Bachmann, Adolf Vogt, Joseph Kirchner, Albert König, Carl Camille Weiner, and Alexander Jörg, 28, Southampton-buildings, Chancery-lane, London.

15239. Improved carbon clamp for electrical purposes. Josef Franz Bachmann, Adolf Vogt, Josef Kirchner, Albert König, Carl Camile Weiner, and Alexander Jörg, 28, Southampton-buildings, Chacery-lane, London.

JUNE 26.

12942a. Improvements in electrical igniting apparatus for explosion engines and for other purposes. Charles M. Johnson, 77, Chancery-lane, London. (Date claimed under Patents Rule 19, May 25, 1897.)

15276. Improvements in dynamo-electric machines. William Harding Scott, Gothic Works, Thorpe Hamlet, Norwich.

15298. Improvements in electric arc lamps. Louis Bardon, 47, Lincoln's-inn-fields, London.

15323. Improvements in electrical accumulators. Albrecht Heil, 55, Chancery-lane, London.

15328. Improvements in apparatus for operating two or more electric-current switches simultaneously or periodically. Owen David Lucas, 37, Essex-street, Strand, London.

15329. A new or improved electrical reproducing typewriter. Louis Delmer, 70, Chancery-lane, London. (Complete specification.)

15370. Improvements in apparatus for recording the duration of telephonic conversations. Robert Weber, 45, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1896.

9047. Method of and apparatus for heating by electricity. Farrall.

11894. Means for opening and closing doors by electricity. Cambie.

12330. Electrical switches. Wilkinson.

12581. Method of supplying electricity to electrically-propelled tramcars and other vehicles and apparatus therefor. Pringle and Money-Kent.

12859. Electric transformers. Miller.

13646. Electric accumulators or storage batteries and the manufacture of plates or electrodes therefor. Smith and Wallis.

14331. Electric tramways or railways. Adamson.

14393. Anodes for electrolytic purposes. Jensen. (Störmer.)

14642. Electric bells, gong, and the like. Byng and Bell.

17161. Manufacture of an active material for the plates or electrodes of electric accumulators. Hammacher.

17338. Device for automatically throwing into circuit reserve electric lamps, motors, or resistances in case of breakdown and for protective purposes. Jokl, Christian, and Kemp.

30164. Electric accumulators. De Contades.

1897.

7223. Electric sound-producing devices. Thompson. (Trudeau.)

8809. Telegraphic transmitting and receiving apparatus. Mewburn. (Hoffman.)

9707. Alternating-current motors. Bláthy and Kandó.

9708. Method of and means for preventing disturbances in telephone circuits by alternating-current installations. Bláthy and Kandó.

11124. Electric lampholders. Joseph.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	9¼-9½
Brush Company, Ordinary	3	1¼-1⅜
—— Non. Cum., 6 per cent. Pref.	2	1¼-1⅜
—— 4½ per cent. Debenture Stock	100	105-109
—— 4½ per cent. 2nd Debenture Stock	100	93-97 xd
Callender's Cable Company, Debentures	100	108-113 xd
Central London Railway, Ordinary	10	9¾-10¼ xd
——	6	5¾-6¼ xd
Charing Cross and Strand	5	13-14
Chelsea Electricity Company	5	9¾-10¼ xd
—— 4½ per cent. Debentures	100	110-113
City of London, Ordinary	10	23¼-24½
—— 6 per cent. Cumulative Pref.	10	17-18
—— 5 per cent. Debenture Stock	100	129-131
City and South London Railway, Consolidated Ordinary	100	59-61
—— 4 per cent. Debenture Stock	100	137-139
—— 5 per cent. Pref. Shares	10	15½-16
County of London and Brush Provincial Co., Ordinary	10	12¾-13¼
—— 6 per cent. Cum. Pref.	10	15-15½
—— 4½ per cent. 2nd Debenture Stock	10	14¾-15¼
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1⅞-2⅛
—— 5 per cent. Debentures	—	90-95
Edison and Swan United Ordinary	3	2⅛-2¾
—— 5 per cent. Debentures	5	3⅞-4⅛
—— 4½ per cent. Debentures	100	103-108 xd
Electric Construction, Limited	2	1⅞-2
—— 7 per cent. Cumulative Pref.	2	2⅛-2⅜
Elmore's Copper Depositing	1	⅛-¼
Elmore's Wire Company	2	⅛-¼
W. T. Henley's Telegraph Works, Ordinary	10	19-20
—— 7 per cent. Preference	10	18¼-19½
—— 4½ per cent. Debentures	100	105-113
House-to-House Company, Ordinary	5	8¼-9
—— 7 per cent. Preference	5	10-10½
India Rubber and Gutta Percha Works	10	20½-21½
—— 4½ per cent. Debentures	100	106-108
Kensington and Knightsbridge Ordinary	5	12⅞-13¼
—— 6 per cent. Pref.	5	8-8½
London Electric Supply	5	1⅞-2⅛
Metropolitan Electric Supply	10	16¼-17½
—— 4½ per cent. First Mortgage Debenture Stock	100	118-122 xd
National Telephone, Ordinary	5	6⅜ 6⅞
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	15-17
—— 5 per cent. Non. Cum. Third Pref.	5	6-6½
—— 3½ per cent. Deb. Stock	100	103-107 xd
Notting Hill Company	10	15-16
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8½-8¾
—— £4½ shares	4½	7¼-7½
Oriental Telephone and Electric Company	1	⅜-½
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	102-104
St. James's and Pall Mall, Ordinary	5	15½-16½
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	37-40
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	8	10¾-11¼ xd
Westminster Electric Supply, Ordinary	5	15-16
Yorkshire House-to-House	5	8½-8¾

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NOTES.

The Marconi Telegraph.—Mr. Marconi has returned to Italy, and has been exhibiting his invention at Rome to the King and Queen of Italy.

National Portrait Gallery.—Among the portraits recently acquired by the trustees of the National Portrait Gallery is that of Sir Francis Ronalds (1788-1873), the inventor of the first working electric telegraph.

Book Received.—We have received from Messrs. Macmillan and Co. a little book by Mr. F. W. Sanderson, M.A., entitled "Electricity and Magnetism for Beginners." Without entering into the question of matter and method in this acknowledgment, we must give great credit to the publishers for the excellent way in which their books are turned out.

Lightning Conductors.—The following tale is told in connection with the recent storm in Essex in a certain parish in that county: "Amongst various questions put by the bishop to the churchwardens relating to the structure of a church was one, 'Are you provided with a lightning conductor?' The reply was, 'No, we burns candles.'" But really the recent Essex storm was anything but a joke or a subject to joke about.

In Place of the Siphon Recorder?—Mr. Ader has communicated to the Paris Academy of Sciences the details of a new self-registering apparatus for submarine cables. The wire carrying the cable current forms part of a minute dynamometer, placed in a powerful magnetic field formed by a permanent magnet. The oscillations are recorded photographically. It is stated that a practical trial over the Brest-St. Pierre and Marseilles-Algiers cables showed that the number of signals transmitted per minute was from 1·5 to 2·7 times that of the maximum obtainable by the Kelvin recorder.

American Electrical Engineers.—The following letter from Mr. R. W. Pope, the secretary of the American Institute of Electrical Engineers, has been received by Mr. F. H. Webb, secretary, Institution of Electrical Engineers: "Sir,—As it seems quite possible that several of your members are likely to visit America on the occasion of the meeting of the British Association, I have been directed by the council to extend to the Institution a general invitation to its members to attend the general meeting of the institute, which is to be held at Greenacre-on-the-Piscataqua River, near Portsmouth, N.H., July 26 to 28."

Marine Engineers.—The members of the International Congress of Naval Architects and Marine Engineers, which has been taking place during the week, were entertained by the Royal Institution of Naval Architects at a conversazione on Monday at the Hotel Cecil, when there was a very large gathering of ladies and gentlemen. The guests were received by Lord Hopetoun, the president of the institution, and there were present a large number of British and foreign visitors to the congress. The reception committee included the Lord Mayor, Lord Armstrong, Sir F. Bramwell, Prof. A. B. W. Kennedy, and many others.

Heating by Electricity.—The fact that electric heaters are somewhat more expensive than some other systems of heating with which they have to compete, does not necessarily mean that they are out of the running. There are many places where a safe and dry heating apparatus is essential, and where the convenience much more than balances the small extra cost. Thus we hear that at Frankfort the large banking firms associated with the name of Rothschild have had electric heaters placed in all their extensive vaults and large strong rooms. The convenience and safety with which a uniform temperature can be thus obtained in summer or winter has given the firm every satisfaction.

Ventilating by Electricity.—The *Canadian Architect and Builder* comments on the ease with which large halls can be ventilated where electric motive power is available. The point in the note is the success of the ventilating scheme employed in the House of Representatives and the Senate Chamber of Washington. In this case the fans, which are 72ft. diameter and are coupled to 18-h.p. motors, are placed under the floor. There is also an 8-h.p. motor in the roof. The air is dried and purified before being delivered into the rooms, and is also either cooled or heated according to the season of the year. The air is discharged at the front of each senator's desk; and our contemporary thinks the system is a step in advance in the matter of ventilation.

Municipal Lighting in Burmah.—Our enterprising contemporary, *Indian Engineering*, has its knife into the Rangoon Municipal Commissioners in its recent issue. It appears that Sarkies Hotel has just been lighted up, and that the proprietor has had to instal his own plant. It seems that the remiss commissioners are acting "the dog-in-the-manger" policy, as they neither do the work nor allow others to do it. We would suggest that the Corporation of York be invited to Rangoon for a few years, so they may enjoy the oil lighting at present in use there. When they return, the people of York would stand a better chance of enjoying the electric light than they do at present, in spite of the numerous reports, schemes, and tenders which have been wasted on the City Fathers.

Burglary by Electricity.—A Dalziel telegram from Cleveland, Ohio, says that bankers there are excited owing to the discovery of an attempt made by burglars to open a safe in one of the banks by using the electric current supplied for the propulsion of the trolley street cars. "The burglars attached a wire to the trolley line of an electric railway, and led it through the transom to the safe. They then attached a second wire to the rail of the car track, and led it also to the safe, and fastened carbons to the ends of the wires. With the arc light thus formed they nearly melted the knob of the safe, and only failed because the current was turned off at midnight." The expert who is responsible for the description of these arrangements adds that if they had had the current for 10 minutes longer the safe would have been opened and robbed. The burglars were not caught. We think seven years (more or less penal) servitude as an electrical apprentice would have met the case. But to insist on your correspondent producing his burglar, not necessarily for sentence, but as a guarantee of good faith, would seriously hamper journalistic enterprise.

Mica.—Mr. C. W. Jefferson, writing to the *Electrical World*, comments on the proposed duties on mica under the proposed new American tariff. He concludes that the general idea is that mica is too cheap, and that, keeping on the protection policy, an increased price would mean increased wealth to the nation. He explains the fallacy of this view, and says that the true cause of the low price of mica is the fact that the supply greatly exceeds the demand. And, even at the present low rate of prices, the material is looked upon as a necessary evil, on account of its cost, by every consumer, and the tendency is to use pieces as small as possible. The smaller the piece used the greater the labour entailed, so in all cases an equilibrium has to be struck which balances the price of the mica with the subsequent labour. It seems that even now the best qualities of mica obtained in America are not used by the electrical manufacturers there on account of expense, as

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mica from Canada and India is cheaper, and of sufficiently good quality. Mr. Jefferson concludes that a heavy import duty would not do any good either to the owners of mica quarries or to the manufacturer.

Iron in the Eye.—The *Illustrated American* has a description of a large electromagnet with pointed poles (both are pointed) designed for extracting iron filings or splinters that have lodged in the eye. Our contemporary gets quite graphic in describing the operation. "The instrument has a drawing force of 16lb. As the eye of the patient is pressed toward its point the subtle magnetic power begins to draw upon the splinter. The metal, struggling for release, bulges the eye from the socket. If not too deeply imbedded the splinter will yield to the force, and, leaving the eye, become attached to the point of the magnet. But, as only too often occurs, the metal may strike with such force as to perforate the coating and drop down into the cavity of the eyeball. Especially is this the case when it passes through the iris or the pupil. One instance was mentioned by the attendants at the hospital of a splinter which passed entirely through the eye and lodged in the coating on the other side of the ball. Applied to the eye, the big magnet will reveal with accuracy to the skilled sight of the physician the position of the troublesome particle. Knowing this, he can remove it by an operation. Only in the most desperate cases need loss of sight follow."

Johannesburg.—The city engineer of Johannesburg happens to be in this country just now, and as the city he represents and the surrounding district has perhaps invested as much money in installation work over a given area as any other district in the world, it may be well just to give some idea of the city lighting. Both gas and electricity are used, but, of course, we prefer electricity. The total gas distribution in the year was 25,435,800 cubic feet, while 400,798 units of electricity were generated during that period. If we take a unit of electricity as equivalent to, say, 125 cubic feet of gas, we shall see that the former has caught up and long since passed the latter. At present about 14,000 equivalent 8-c.p. lamps are connected and 8,500 awaiting connection. There are 237 customers. The distribution is by overhead wires, of which there are about 42 miles, 20 miles having been added during the year. Of course, Johannesburg may be happily situated for electrical progress, seeing that the price of gas is exceedingly high, averaging 18s. 9d. per 1,000 cubic feet. Still, the moral is pretty clear. There are other towns rising and risen in South Africa which ought to be, as they are being, exploited by our manufacturers, and we trust that the result will be to largely increase our business in that direction. We congratulate our friend Mr. C. Abutrow upon the very satisfactory report he has given us in this direction, and hope that future reports will show equal progress.

Salford Technical Institute.—The statutes of the Victoria University relating to the admission of candidates to the ordinary degrees of B.A. and B.Sc. have been amended, and now provide that students of approved colleges and institutions who have attended at such college or institution a course approved for the purpose by the university, and have passed the preliminary examination (of the university), shall be permitted to proceed to a course of study for the intermediate examination, and to present themselves for the final examination for those degrees after two years only of attendance in a college of the university upon the course prescribed. This modification has been made upon the proposal of the principal of the Owens College, in accordance with the terms of the arrangement recently come to between the council of the college and the committee of the Salford Royal Technical Institute. By means of this arrangement students who have completed a three years' course in the technical institute and who desire to proceed to higher university education will be enabled to save one of the three years' subsequent attendance at the university which has hitherto been necessary. It should be added that students presenting themselves for this university course must not be less than 18 years of age. The age fixed for admission of day students of the technical institute is 15 years, and the course of study is arranged for three years. It will, therefore, be seen that a student, after passing through this course and proceeding to the university, could present himself for the final degree examination after a two years' course there.

Subways for Electric Conductors.—A series of articles by Mr. William Mavor, jun., is now running in the *Electrical World*, which is well illustrated. In the number which has just reached us a description of a submarine conduit is of special interest. The conduit in question was laid under the Harlem River at New York. The conduit consists of four ducts of wrought-iron pipe, jointed in the usual way, and is surrounded by planking held together by hoops of wrought iron. The conduit was constructed on the bank of the river, on a slipway not unlike those used for launching a ship. When the whole length of conduit was ready it was launched out into the river, and was sunk to its place on the bottom. No attempt was made to keep the conduit watertight, and the ducts were rodded and the cables were drawn in in the usual manner. Hence the conduit is only used as a mechanical protection for the cable. The author then refers to the question of the ventilation of electric conduits in order to prevent accumulation of gas likely to cause explosions. He details the method used in New York of forcing air into the subways at different points. He thinks the success of this system is due to keeping the internal pressure of the air in the conduits higher than that of the outer air. In this way the ingress of gas is prevented, to which, rather than the circulation of air, he attributes the immunity of explosion of this system of conduits. In other towns where natural draught only is employed, the author considers that the success or non-success of the ventilation in preventing the accumulation of gas to be a function of other local conditions.

The Crookes Tube in the Custom House.—According to telegrams from Paris, some further experiments with the Röntgen radiations have been performed at the Bercy Customs warehouses in presence of Mr. Pallain, the director-general of Customs, Messrs. Mascart and Troost, members of the Academy of Sciences, and a distinguished audience. A tube containing a fluorescent screen has been designed by Mr. Seguy, assistant-lecturer at the School of Pharmacy. The apparatus, which has been purchased by the French Customs, is like an opera-glass, the place of the lenses being taken by discs covered over with a fluorescent substance, which the correspondent states to be a uranium salt. Hitherto it has been found almost impossible to prevent smuggling by parcels post. The Röntgen rays "will now enable Customs officials to look into parcels without opening them. The audience were delighted with the results of the experiments. A case labelled china was first examined. The opera-glass showed it contained an oval dish. Another parcel, invoiced as boots, revealed a pair of lady's boots, but along with them were two round balls. 'Open,' ordered Mr. Pallain. The two balls were found to be apricots sent from Algeria. A box returned as 'samples' aroused the suspicion of Mr. Pallain, who remarked that this word was often a euphemism for tobacco. The opera-glass was directed upon it, when

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three tin boxes were seen, each of which contained a hundred Egyptian cigarettes. Two boxes of English matches were packed up with them. These experiments were continued for an hour and excited great enthusiasm." The apricots in the boots are a hard saying, but the tin box is, of course, easy work, though it might have contained "samples" after all.

Kites for Electrical Experiments.—The following is from a provincial contemporary—the original source is unknown to us: "Experiments with atmospheric electricity of the high tension developed in storms are highly dangerous, and ought not to be taken without adequate precautions being adopted to ensure the safety of experimenters. It is not, however, necessary for the purpose of experiment to wait for the occurrence of storms, as electrical kites will draw electricity from the atmosphere at almost any time, even when the sky is perfectly clear of clouds. An ordinary paper kite, with a good conducting line (for it is the line that collects the electricity), will answer very well. Various methods have been tried for improving the conductivity of the common strings used for electrical kite-flying, but these may be passed over, as it is better to use a metallic wire in place of a string. This may be easily done if proper means are taken, as wire will serve the double purpose of flying the kite and furnishing an efficient conductor of electricity. The kite must be of a size sufficient to carry upwards of 200 or more yards of wire. With this length out, if properly insulated, by attaching a foot or two of silk cord or ribbon to the lower end, electrical sparks ½in. or so in length may be obtained. The sparks, if taken by the hand, will be found very pungent, resembling in effect the discharge from a small Leyden jar. With the electricity collected by the kite, many of the experiments performed with electrical machines may be repeated; by using an electroscope the electrical state of the air, positive or negative, may be readily ascertained." We do not recommend anyone "to wait for the occurrence of storms" and then kill themselves. It has always been somewhat of a marvel that Franklin escaped.

Technical Education.—The June issue of the *London Technical Education Gazette* contains the recent awards of evening exhibitions in science and technology under the London County Council's scheme. The examiner's report on the subject of electrical engineering is worthy of reproduction. He says: "The papers in electrical engineering were fairly well done. Four of the candidates did excellent papers and showed that they could probably have dealt with a harder paper. In some cases, however, the answers and sketches were very poor. The papers on the whole are about equal to the elementary stage in the City and Guilds of London Technological Examinations. The best paper is that of T. F. G. Shephard, aged 20·3, of the South-West London Polytechnic; another of nearly equal merit is that of P. J. Barnes, aged 19·11, of the People's Palace. The practical work consisted of specimens of joints submitted by seven candidates, including straight, T, and V joints. Two sets were placed in the first class, and nearly all showed sound practical workmanship. In one case there appeared a tendency to carry out the work in a manner which would prove too costly for ordinary practice. One candidate submitted a Wimshurst machine, well made as an example of amateur work, but belonging to an entirely different class of workmanship from that of the majority of work submitted." The fact that the 20·3 lad beat the lad who was only 19·11, although their papers were of nearly equal merit, is perhaps due to the disadvantages of the second decimal place. We suppose from the above that the sharp boy of the future will be able to give his age to the third place of decimals when asked. We are glad to note that both the above lads received exhibitions, and trust that the English of the year's report will be better than that of the above.

Tractive Force on Common Roads.—The United States Department of Agriculture has recently ordered a new set of tests to determine the tractive and starting force required by vehicles on modern roads. The report on the trials was drawn up by Mr. S. T. Neely, assistant engineer. A simple arrangement of levers and springs was used to show the force required to move a heavy farm wagon loaded with cotton bales. No attempt was made to check the oscillation of the pointer on the springs. The author concludes as follows: On the smoothest possible macadam road surface the force of traction varies continually over a range of 50lb. On the ordinary dirt road the force varies from absolute zero up to 700lb., with a gross load of 3,000lb., and becomes in effect a rapid succession of jerks. On heavy grades, in the case of smooth roads, the force is more nearly constant. As regarded starting effort, on a smooth road this is about four times as great as the force required to draw the load at a uniform pace after it is started. On a dirt road this starting force reaches as high a figure as one-fourth of the gross weight moved. The author practically proved by experiment that the exhausting effect of the succession of jerks on the bad road wore out the horses more rapidly than an equivalent steady pull. The following actual figures will be of interest to compare with older records: On a level asphalte road a tractive force of 29lb. per ton; on a good level macadam road this figure rose to 42½lb., while 108lb. per ton was required on a level dirt road in good condition. For a 10 per cent. up grade on a macadam road a pull of 265lb. per ton was required. Mr. Neely compares these results with those given by six prominent engineers for a macadam road. These six results average 46lb. per ton moved. He also recalls the well-known facts that the force of traction varies inversely as the diameter of the wheel, and increases with the speed upon hard roads, although not in proportion with the velocity. The width of tyre has no effect on the tractive force required on hard roads, but naturally has an effect on the life of the road. These points will be of interest to those working on the motorcar problem.

The Pender Memorial.—The Marquis of Tweeddale presided at a meeting held in the Botanical Theatre of University College, Gower-street, last Friday, for the purpose of inaugurating the personal memorial to the late Sir John Pender. Among those present were Lord Kelvin, Lord and Lady John Hay, Sir Robert Herbert, Sir James and Lady Pender, Sir Douglas Galton, Sir Anthony Hoskins, Dr. Muirhead, Mr. and Mrs. J. Denison Pender, and Mr. Onslow Ford, whose bust of the late Sir John Pender was on view in the theatre. The Chairman, in the course of his address, said he had much pleasure in handing to the college authorities a cheque for £5,000 to endow the electrical laboratory at University College. A sum had also been expended in the bust of Sir John Pender, which was now before them, and the remainder of the amount subscribed would be given to the Glasgow University and the West of Scotland Technical Institute. He claimed for Sir John Pender the merit of having above all his contemporaries realised the immense value, political, commercial, and social, of the establishment of rapid communication by telegraph. In moving a vote of thanks, Mr. Haldane said he hoped the foundation of the electrical school would do much to spread these principles of a science in which so much had been done in the past, and which it was believed was capable still of infinite develop-

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ment. Dr. Fleming seconded the vote of thanks to the Memorial Committee for their gift to the university. Lord Kelvin, who was warmly received, said that it gave him great pleasure to have the opportunity of expressing his hearty concurrence with the resolutions of the Pender Memorial Committee as to the mode in which the fund collected should be distributed. He wished to speak of his own knowledge of what Sir John Pender had done. He remembered the first experiment that was made to lay a cable across the Atlantic. The scheme was supported by the then Mr. Pender, who in 1858 was one of the first directors of the company which was started to carry out the work. It was well within his recollection that all the directors resigned one after the other when the temporary success which attended the laying of the cable was followed so soon by failure. It was certainly a most discouraging result, but Mr. Pender was not to be disheartened. He was the only one to have the will and the power to keep the undertaking afloat, and from 1858 to 1864 he kept it afloat. The success which ultimately attended his efforts they all knew, and our Colonies, he was glad to say, were now brought within speaking distance of the mother country.

The Electric Light in Rheumatism. — Dr. Kozlovski, a St. Petersburg physician, publishes in the *Vrach* an account of his method of treatment of rheumatism and neuralgia by means of exposure to the electric arc. He was induced to make these observations by the statement of Dr. Ewald, who is medical officer to some large ironworks, that he had noticed that since the introduction of the system of electric welding there had been a notable diminution in the number of cases of rheumatism, neuralgia, migraine, and other nervous diseases among the workmen, which he attributed to the beneficial effect of the electric light. In order to bring this therapeutic agent within the reach of ordinary patients, Dr. Kozlovski has fitted up consulting-rooms with a suitable plant for producing the electric arc, which consists of a 6-h.p. oil-engine, a dynamo, 35 Tudor accumulators, a rheostat, amperemeter, and electric arc lamp with reflector. With these he obtains an E.M.F. of 50 or 60 volts and a current of from 250 to 300 amperes. The patient is placed at a distance of 1½ metres from the light and protected by blue spectacles and also by a screen of cardboard in which an aperture is cut to allow the light to fall on the affected region of the body. To this it is exposed for from three-quarters of a minute to two minutes. At the time the patient feels a slight sensation of heat, though the temperature is never raised more than 4deg F. where the light falls on the skin, but nothing more until six or eight hours afterwards, when itching and tingling are felt and the skin becomes reddened. Some 48 hours later desquamation occurs, which lasts for two or three days. In the course of three months Dr. Kozlovski has treated 38 patients, varying in age from 13 to 70 years, by the electric light. There were eight cases of sciatica, all of which recovered; four of neuritis (locality not stated), two of which recovered; 18 of chronic rheumatism, 14 of which recovered; and three of lumbago, all of which recovered. In most cases three or four sittings produced an amelioration of the pain. They were continued at intervals of three or four days, according to the amount of cutaneous irritation, but the total number of sittings never exceeded a dozen. This extract we culled from the *Lancet*, and are glad to note that as the electric welder was developed by exaggerating the faults of a transformer, so the ill-effects of the rays from the welder has some compensating good properties. We suppose that shortly the electric lighting station will be dispensing two-minute doses of strong arc light to rheumatic consumers.

The Victorian Era Exhibition.—Mr. Charles Bright has written the review of the progress of science during the past 60 years for the catalogue of the above exhibition. The review in question is allotted some 17 pages only, and hence if some events or landmarks should be missed by the expert in glancing through the part devoted to his particular subject, he must remember the limited space at the disposal of the author. As a whole, the matter is most carefully prepared, and shows that the author has devoted considerable time to its preparation. Of the author's special hobby—submarine and general telegraphy—he says: "The railway train and the steamship constitute, with the electric telegraph, the three most conspicuous emblems of latter-day civilisation. The telegraph was first perfected for practical use on both sides of the Atlantic by men of our own race and speech, such as Cooke, Wheatstone, Morse, and Bain. The first telegraph line in the world—namely, that on the Great Western Railway from Paddington to West Drayton—was opened in 1838, the year of the first trunk line of railway, and the first ocean steamer. Improvements and novelties in telegraphic instruments were then being made by inventors from all the leading civilised nations, such as Morse, Vail, Royal E. House in America, Breguet in France, Siemens and Halske in Germany, and Schilling in Russia, and Alexander Bain, Hughes, and Jacob Brett in this country. Werner Siemens, again, led the way in employing guttapercha as an insulating cover for wires under water. The first effective submarine telegraph cable was laid under the Straits of Dover by the late Mr. T. R. Crampton in the autumn of 1851. The first cable successfully linking Great Britain with Ireland was laid by the late Sir Charles Bright. He it was also who first succeeded (1858) in demonstrating the feasibility—scouted at by most—of laying 2,000 miles of continuous cable at a depth of two miles under the Atlantic Ocean. This accomplishment was, from the engineer's point of view, even a more historic event than that of the first Channel cable or the first land line. By the year 1866 a good many shorter lengths of cable had been laid in different parts of the world, all by Englishmen. Since this time the enormous network of land lines and ocean cables which has been created has placed the whole civilised world, together with many parts of the globe which cannot yet be dignified by that title, in electrical communication." The section devoted to lighting, both public and domestic, is made to cover both gas and electric lighting. This treatment, we consider, is rather a slight on one particular branch of public and domestic lighting. Perhaps it is the shortness of the paragraph rather than the association with such a rich neighbour as the gas industry that causes a feeling of discontent. The reference to the first few years of electric lighting, when the word "electric" was used to draw money from the public without the slightest hope of a return, is mentioned. This recalls unpleasant history, but the record of the past 10 years and the various successful systems employed should, in our opinion, have had more attention given to it. The other department with which we are interested is electrical distribution of power, and transmission of power also should have had more space allotted to it now it has become so largely used.

Electricity as an Investment.—The *Financial Times* says it has been rather startled! What has startled our *couleur de rose* contemporary is the price of ordinary shares of the City of London, the House-to-House, the Metropolitan, the Notting Hill, the St. James's and Pall Mall, and the Westminster Companies. Of these six companies, in four cases the capital value in the market has doubled, or more than doubled, in less than six years, and in two cases of the four it has trebled, while

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another comes very near to that distinction. "In the two remaining cases the increases are surely substantial enough to satisfy even cupidity. The increase of capital has naturally been considerable during the intervening years, but to the fact that the fresh money has not been mis-spent the above figures bear testimony as eloquent as could be asked for." Part of the increase in the valuation of shares is no doubt due to the decreasing value of money, the scarcity and dearness of gilt-edged investments, and the timorous feeling which ever since 1890 has tended to keep British capital in British hands." Here was a case of the development of a great new experimental enterprise, in good and clean hands. But the *Financial Times* holds that increasing dividends have had much more to do with increased prices than have the conditions of the money market. "The progressive character of electric lighting undertakings, and the belief in them entertained by those who know the ropes, is manifested by the high prices at which the shares stand in relation to the yield which they afford to a purchaser. They do not make much stir in the market, but they are being firmly held and steadily bought. The fact that while this is the case there is no excitement—no boom in the ordinary sense of the word—is pregnant with significance. It shows that the buying is of the well-informed character, not of the ragged kind which comes in to snatch a profit in one of the unreasoning booms with which we are all familiar." For corroboration of this view expressed reference is made to the fact that at the end of June, the calculations being based upon the dividends of the previous year, the actual income from the shares is, with one exception, under 2¾ per cent. But while blessing supply companies, manufacturing concerns are banned altogether. "As regards electrical manufacturing companies, we are unable to record any such remarkable advance as in the lighting companies. From the time of 'Father Brush' down to the present there seems to be a ban on such undertakings." Yet, did they not exist, the prosperity of the lighting companies would have been impossible. The latter could not have entered into contracts for the supply of electric light in given areas unless they had the means at hand for procuring the requisite plant from companies or firms accustomed to the particular class of work required to be done. But it has come about that the electric lighting companies can practically dictate their own terms to the few competitors in the business of manufacturing the plant and machinery. "The electric lighting companies can say to the manufacturers of plant and machinery: 'If you do not care to do the work at our price we shall start factories of our own. And you cannot retaliate in kind, because we have monopolies in our own areas, and you cannot break up the streets to get your mains built. On the other hand, we can; and, moreover, we can become whenever we choose rivals of yourselves in your own line of business, with ourselves as our best customers.' The contractor dealing with monopolists is always at a disadvantage." Finally, the shareholders are protected against competition, and "have the gratifying anticipation that if they succeed in their business it is probably only a question of time and of terms for the Government to buy up their undertakings." A little more attention to time and terms at and on which the local authority, not the Government, will be entitled to do this would have been well before penning the last paragraph. Ill or well, the manufacturer may go on for ever.

Safety Rules for Generating Stations.—The second interim report of the department committee appointed by the Home Office to enquire into and report upon certain dangerous trades has been issued as a parliamentary paper. This report, which is signed by all the members of the committee, including the additional member, Mr. C. V. Boys, F.R.S., deals with electrical generating works. The committee do not deal with electrical stations supplying currents at extra high pressure, as there is only one example of the class in this country; but with regard to the projects which, they understand, are on foot for employing 10,000 volts, or some other number constituting extra high pressure, in connection with electric railways, they are of opinion that special rules will have to be drafted and issued for the protection of the workpeople employed when the schemes have assumed a more definite shape. The danger peculiar to electrical generating works is the liability to shock, which may be fatal if, by accident, anyone comes in contact with the conductors when charged to a high pressure. The contact need be neither very perfect or direct. Provided two parts of the body are made to touch conductors differing in pressure by 1,000 volts or more, or even by much less if the contact with the flesh is very good, a dangerous and possibly fatal shock will result. Bare overhead high-pressure conductors may lead to accident in case of breakage or by swinging into contact with buildings, etc., or by earthing at the points of support in consequence of damage to the insulators; or they may become sources of danger to persons who unintentionally put themselves into contact with them by a ladder or other means. High-pressure overhead wires, even if insulated over their entire length, can never be considered as entirely free from risk. With a view to ascertaining the cause of death and devising means for resuscitation, a number of experiments have been made from which it appears that the cause of death is arrest of the heart's action, and the best method of restoration is artificial respiration. In all cases, therefore, of apparent death from electric shock, artificial respiration should be resorted to at once, and persisted in for a considerable time, for recovery is known to have taken place after fully half an hour. Meanwhile the committee has framed several regulations which they recommend should be applied in all cases where electricity at high pressure is in use. It is not intended that they should apply to low-pressure systems. The recommendations include the following regulations: the frames and bedplates of all generating machines shall be efficiently connected to earth. The rails fencing dynamos or other generating machines shall be made of wood or other non-conducting material. The floors of all places where it would be possible to make connection with metal at high pressure shall be covered with an insulating mat of suitable material and kept in a state of efficient insulation. In switchrooms, and on the front of switchboards, the main switches, main fuses, main terminals, omnibus bars, and all other metallic parts shall be insulated or arranged in such manner as to render it impossible for any person by accident or inadvertence to touch them. All switchboards erected after the application of these rules shall have at the back a clear space of at least 4ft. This space shall not be utilised as a storeroom or lumber-room, or be obstructed in any manner. Any person at work upon a cable or portion of the mains under high-pressure shall wear indiarubber gloves on both hands, and the gloves shall be supplied by the occupier, and it shall be the duty of the manager to see that they are in a proper state of repair, and are worn by the workpeople. Mr. H. J. Tennant, on behalf of the committee, expresses the deep sense of obligation to Mr. Boys for the invaluable assistance he has rendered them. It appears that in electrical generating works and sub-stations during the last five years, 14 fatal accidents have occurred, including five since the appointment of the committee.

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MUNICIPAL ELECTRICAL ASSOCIATION.

SECOND ANNUAL CONVENTION, MANCHESTER, JUNE 30.

Presidential Address.

(Continued from page 18.)

In the first place, the example set with reference to chief engineers should be followed by corporations with respect to their principal assistants. They must be adequately paid, and in the case of large towns they must be paid such salaries as are at least as good as, and preferably above, those paid to the engineers in charge of smaller stations. This is a *sine quâ non*, for, whether rightly or wrongly, a man will naturally always prefer to be chief of his own little station rather than be an assistant at the same salary in a larger station.

Next, there is the problem of filling up vacancies occasioned by the removal of assistants. Whatever the system of supply adopted, there is in every station a large amount of detail work peculiar to that station, and no stranger coming in fresh to the work is of the slightest use as an assistant until several months, or at any rate a good many weeks, have elapsed. There should always be a number of understudies in a large works ready to step into the shoes of the man ahead of them at a moment's notice. How are these understudies to be provided? In my opinion there is but one way, and that is by the taking of engineering pupils. There is everything to recommend this practice, and nothing substantial against it. Central-station work is a specialised form of engineering. It can only be learned in a central station, and therefore it is as well to recognise at once that the work must be taught. To take another aspect of the question, not only is the teaching of experience valuable to the pupil, but, if properly selected, the services of the pupil are of value to the corporation, and they tend to diminish the cost of production, inasmuch as they are rendered without payment. Again, the premiums paid by pupils afford a ready means of increasing the salary of the chief engineer without an undue augumentation of the works' costs. As regards the payment of such premiums, there can be no doubt that they should be receivable by the engineer and not by the corporation, for he has the trouble and responsibility of imparting knowledge to the pupils, while the corporation receives the services of the pupils gratis as compensation for the use of their plant for teaching purposes. In my opinion a percentage of the premium should be paid to the principal assistant, as undoubtedly a portion of the work falls upon him. What then I consider an ideal arrangement of staff is the following: Each year a certain number of pupils, say three, would be selected carefully by the engineer from men who had just completed their education at a technical college, and who had, if possible, had experience for a year or two in mechanical workshops. Such men would be useful very soon. They would be articled for two years. At the end of that time, if vacancies existed, they would become junior assistants, and would be paid a moderate salary. If no vacancies existed, they would readily find employment as assistants in smaller central stations. When they had become assistants, or had left, there would be in the works three pupils each with a year's experience, and three new pupils. Those who were selected to remain as junior assistants would be competent to take charge of a shift, and would remain with small annual increases of salary as assistants until the principal assistant left, or some suitable berth offered in another station. The chief assistant would have under him the junior assistants, and it should be the policy of the corporation to retain this chief assistant permanently, provided, of course, that he renders loyal and efficient service to the undertaking. They then have an understudy for their chief engineer should he relinquish his post or succumb to the wear and tear of its responsibilities. Briefly then, the chief engineer and his principal assistant should be encouraged in every way to remain as fixtures, while the fact should be faced that there must of necessity be a constant succession of junior assistants, the supply being kept up by means of pupils trained in the works where they will be required. Such a course as that above sketched out would not only tend to the convenience and efficient working of municipal concerns, but would inevitably tend to materially raise the status of supply engineers; for instead of their being selected at random, and drawn from any class haphazard, they would all have gone through a perfectly definite training, which would be on a par with that required in other branches of civil engineering.

The large amount of work to be disposed of at this convention makes it my duty not to take up an undue amount of your time. I will therefore conclude by thanking the members of the council for the energy which they have displayed in conducting the business of the association during my presidency, and, while it would be invidious to make any distinction, I feel that I must bear testimony to the extremely able and energetic manner in which our honorary secretary, Mr. Mountain, has performed the onerous duties which have fallen upon him.

On resuming on Thursday morning,

The Chairman said the discussion had shown a tendency to drift into the question whether a corporation should undertake wiring. It was really outside the question, but his own view was that the corporation should act as consulting engineer, but not carry out work. He also held that it was wrong for a company to come between the corporation and its clients and take toll of the money received. As a matter of policy it was wise to make no charge for connecting consumers to the mains, although they were entitled to do so. Nor would he charge for an extension of the service main beyond 60ft., because, though it might not pay at first, other consumers speedily came on, and then there was simply the alternative of making repayments to the first consumer or incurring his hatred as a man who had been treated unfairly. The day load was in danger of becoming a sort of fetish. In his opinion, the only reason for a rebate should be long hours of consumption. As to supplying lamps free in exchange for old ones, it might work in a small town at first, but as they extended it would be found to involve an immense amount of difficulty to ascertain exactly who was entitled to new lamps and how many. At least he thought so when the lamps came to be counted by the hundred thousand. If it was desirable to do something of the sort in view of bad lamps, probably the best way to face the matter would be to contract to supply light instead of energy. The lamps would then be maintained by the corporation, and locked so as to prevent the consumer changing an eight for a sixteen. It was done in this way in America, but unless compelled he would not care to tackle the job.

Mr. Gibbings then replied. The things he had suggested he did not take the responsibility of recommending; what he had done was to bring them forward for consideration. It was important, in view of competition, that the corporation should have power to borrow for those items, though having the power they would probably not be compelled to use it. No private company should hire out motors or heating apparatus at present; it would not pay them. Power to supply gas-stoves enabled the gas department to largely increase their gas supplies, and the electricity department should be in the same position.

Before taking the next paper, the **Chairman** suggested that the papers, which up to the present had been read in a shortened form, should be taken as read. There was a little discussion on the question of brief abstracts or nothing at all, and ultimately it was left to the authors. In general, the authors contented themselves with little more than was sufficient to recall what was dealt with in the papers, but with some of them even this formality was dispensed with, and nothing but the title was mentioned. In the order of the proceedings the next papers were:

Street-Lighting by Means of Rectifiers.

BY C. D. TAITE, A.I.E.E., BOROUGH ELECTRICAL ENGINEER, SALFORD.

Taite, C. E., A.I.E.E.—Was educated at Norwich Grammar School, and passed from there to Ronald A. Scott's works, Actonhill, where he was apprenticed. As the experience at these works did not come up to anticipation, he left at the end of 18 months, and took the two years' course at Faraday House. On completion of his training there he obtained an appointment in January, 1894, with Messrs. Ferranti, Limited, with whom he remained for nearly two and a half years, doing erecting work for them at various towns, notably at Portsmouth, Southport, and Hanley. In May, 1896, he was offered the post of borough electrical engineer to the Corporation of Southport, and has since had charge of the important electricity works in that town.

Series arc lighting by means of rectifiers is now becoming so general that a few facts relating to their use may be of interest, and as the writer has had special opportunities of studying their behaviour at Southport, he trusts that this will be a sufficient excuse for so frequently quoting the results obtained there in preference to those obtained in other towns.

The constituent parts of a rectifying set, as used for series arc lighting, are a synchronous motor, a commutator having the

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same number of sections as the motor has poles, and mounted on the same shaft, and a constant-current transformer. The latter is perhaps the most interesting part of the whole apparatus: its construction is so simple and its automatic regulation so perfect.

Since the introduction of rectifiers about three years ago into practical work at Portsmouth their use has spread very rapidly, so that at the present time they are being employed at no fewer than 10 electricity supply stations, and they have been specified for at least three more stations now in course of construction.

Under these circumstances it will not be out of place to enquire into the causes which have led station engineers to adopt rectifiers in place of the old Brush and Thomson-Houston arc lighters. These causes appear to the writer to be (*a*) efficiency; (*b*) small upkeep; (*c*) minimum of floor space. The one which undoubtedly appeals most strongly to the engineer is efficiency.

It is very difficult to obtain exact details as to the saving in steam consumption through the use of rectifiers, but it is evident that where one engine can be run to do both the incandescent and the arc lighting there must be a considerable economy in coal. This is evidenced by the coal returns of Portsmouth (·67d.) and Southport (·47d.).

The electrical efficiency of a rectifier where a number of lamps are run in series is high. At Southport 43 15-ampere arcs are worked in series. The input given to the rectifier, including both the motor and the constant-current transformer, averages 33 units per hour; the output is 15 amperes at 2,050 volts, or 30¾ units, giving an efficiency of rather over 93 per cent.—that is, at full load. At half load the efficiency is still good; the units per hour required with 22 lamps burning are 17·5, and the output is 15 amperes at 1,020 volts, giving an efficiency of 87·4 per cent. The above tests extended over several months, the power taken by the rectifier being measured by Thomson-Houston wattmeters, and the output by a Kelvin voltmeter and two Nalder ammeters.

It will be noticed that the average power per lamp at full load is 767 watts, and at half load nearly 800 watts. In order, therefore, to test the accuracy of the results obtained from the wattmeters, the engine was indicated with (1) 43 lamps burning,

(2) 22 lamps burning. The average results of three sets of diagrams taken in each case showed a difference of 20·4 h.p.—that is to say, when 21 lamps were cut out the power required from the engine was reduced by 20·4 h.p., thus confirming very closely the results obtained from the wattmeters.

This high efficiency at small loads is a very important matter when it is not intended to run the rectifier always fully loaded. The power factor was not so satisfactory, being 87·3 per cent. at full load and only 45 per cent. at half load.

With a few lamps in series, as, for instance, at Cardiff, where only 12 lamps were run off each transformer when the rectifiers were first installed, but with the motor running two commutators, the efficiency is much lower, being not more than 80 per cent. at full load. This is accounted for by the relatively greater amount of power required by the motor in this case, and by the loss of power due to using two transformers in place of one.

Where the cost of land is at all great a considerable saving may be effected by using rectifiers. Two rectifiers complete require about 5ft. by 13ft., and this space includes 17in. at the back and in front of each set, as well as 2ft. between them, and 1ft. on each side. The first cost is not very heavy, and the upkeep is low. Thus, at Southport the total repairs and maintenance, including brushes, amounted to £19. 15s. during the last year. Of this amount, rectifier brushes cost £6. 15s. and renewals to commutators £10, leaving £3 for the cost of oil, grinding gear, etc. The gross income from the lamps was £840. Thus the repairs, etc., to the rectifiers work out at 2·35 per cent., or since 94,400 units were rectified the repairs per unit amounted to ·05d. In stations where so much power is not dealt with on the commutator these costs could be still further reduced.

With only one or two rectifiers running at once, the writer has not found it necessary to employ any extra labour, or, in fact, any specially skilled labour, to keep the apparatus in order. The attendants very soon pick up the special points which it is necessary to keep in view in order to obtain satisfactory running. Amongst the most important of these is to keep the brushes well trimmed and accurately set, and to be careful to see that the commutator is clean. The voltage is another point which requires close attention; the highest pressure, consistent with steady running, is the best, as the higher the pressure the better the motor stays in synchronism, but a large variation from a certain definite mean (which may be slightly different for each motor) is not permissible, as hunting is sure to be the result. Every motor the writer has yet come across will stand 10 per cent. variation in pressure either up or down, but beyond that it is not safe to go; it is well, therefore, to find out at the commencement the best pressure for the motor, and as far as possible to always run it at that particular pressure.

There is one other point essential to really satisfactory running—*i.e.*, an even turning moment on the crankshaft of the engines—any irregularity is instantly reflected by a beat in the motor and a consequent lengthening and shortening of the spark on the commutator, but given a good drive, well-trimmed motor brushes and ordinary care, there is little fear of the motor giving any trouble.

Street-Lighting by Electricity.

BY S. E. FEDDEN, ELECTRICITY MAINS SUPERINTENDENT, EDINBURGH.

Fedden, S. E.—Commenced his technical career by a course of training in the Hanover-square School. Leaving there in 1890, he entered as improver with the firm of Messrs. Robey and Co., going through all the shops in turn. Leaving Lincoln, he joined the staff of the Westminster Electric Supply Corporation, and stayed with the company in various capacities till 1893, when he went to America to gain experience. Over there he was with the General Electric Company at Schenectady, and also got on to their outdoor staff. Returning to England, Prof. Kennedy recommended him to Mr. Monkhouse, and since then he has been engaged on the electrical staff as mains superintendent. The rapid increase in the demand for light in Edinburgh has brought out Mr. Fedden's energy in keeping his mains up to the work demanded of them.

It is the author's intention in the present paper to give a short account of the street arc lighting as carried out in Edinburgh. The Edinburgh street-lighting is on a somewhat extended scale for a city which only adopted electric light two years ago, and in the author's opinion its introduction has been an almost phenomenal success. The number of lamps now in use are: Crompton-Pochin low-tension 240, Brockie-Pell 82, Crompton-Pochin rectified 147, making a total of 469, and there are about 150 more to be put up this year.

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All the lamps have worked in a satisfactory manner. The repairs and maintenance of 300 lamps for one year amount to £150, or an average of 10s. per lamp per year—that is to say, about 5 per cent. of the cost of the lamp. The annual charge for arc lamps was £20 in 1895 and £18 in 1896, and the committee, acting on Prof. Kennedy's advice, has decided to further reduce the price in 1897 to £16 per lamp, partly because of the liberal way in which the lighting had been taken up in Edinburgh, and partly because of the low cost of generating.

The lamp-posts, which were manufactured by Messrs. Mackenzie Bros., of Edinburgh, are 28ft. high and weigh 18cwt., the height of the arc from the ground being 23ft. All lamps are suspended at the same distance from the ground, and in the author's opinion this gives the best effect with regard to surrounding buildings, though on the Continent he believes they are placed at different heights, according to the nature of the streets and buildings. On this point he would like to hear the views of the meeting. The posts are placed from 50 to 60 yards apart, the variation in distance being necessary in order to utilise lamps in side streets by placing them at corners where possible.

Princes-street, which has shops on one side only and gardens on the other, is lighted on the shop side with 15-ampere 750-watt lamps, and there is a splendid line of 35 arcs from the west end of Princes-street to Calton-hill, nearly a mile in length. The width of the street is 95ft., but the light is excellent on both sides, and it is quite easy to read a newspaper on the tramcars. Of course opinions differ as to whether it would not have been better to light the street from both sides, but the effect as it is now is very fine. The other streets are lighted generally on both sides, except where circumstances, such as the presence of cellars, etc., would not allow it. In the case of very wide streets, however, the posts are placed down the centre. The lamps are 10-ampere 500-watt Crompton-Pochin and Brockie-Pell lamps.

The low-tension lamps are run in the ordinary way, four in series at 230 volts, but it is hoped as soon as the change is made to 460 volts to get nine lamps in series, because after adding the extra lamps there will still be 30 volts to spare, there being now four on 230 volts, and it will still be possible to have some line resistance to keep the feeding steady. At the present time five lamps have been run in series on 230 volts in some streets, but the result has not been satisfactory.

Switches are placed on the positive end of every four lamps, and the trimmers are responsible for the switching on and off of their all-night lamps, night and morning. A man on a bicycle goes round at 12 o'clock to switch off the half-night lamps, and it takes him over an hour to get over his seven-mile circuit. The switching at so many points is very troublesome, and in the author's opinion a better plan would be to have switch centres, where a number of streets intersect, with a 60-ampere switch, so that half a dozen circuits might be dealt with at once. The main with this switch in it need only go to the commencement or positive end of each circuit. The other ends of each circuit could be connected to the negative main where most convenient, with a fuse to carry the current for each individual circuit. The rectifier lamps takes 12 amperes, and are run 30 to 35 on each rectifier.

Edinburgh experience of rectifiers is that they are very tricky, because when one goes wrong, or a fuse blows, the others which are running are liable to follow suit, run out of phase, flash over, cause the lamps to pump, and eventually stop. It is then necessary either to switch all the lamps out or to run alternating current through them, with the result that either the town is in darkness or the lamps are damaged. The author would suggest as a means of getting over this difficulty, a continuous-current motor-alternator with a rectifying commutator attached for each circuit. A good alternating arc lamp is badly wanted to cope with arc lighting on a large scale, so that circuits of 40 or 50 lamps in series might be run direct off a 2,000 or 3,000 volt alternator.

Experience in Edinburgh also shows that it is not feasible to run rectifiers off the same machine which is running the incandescent lighting, as it is almost impossible to switch on a circuit of arc lamps without causing the pressure to jump, but, of course, the effect of this would be felt less if there were a big load on the lighting circuit. The practice is to run up rectifiers on a separate machine to switch on the lamps, and then to synchronise and parallel on to the circuit machines. The highest efficiency of an arc circuit is maintained by never letting the lamps out, and where the gas lamps are removed this should be studied a great deal more than a mere percentage efficiency, and the author contends than an arc lighting plant with an efficiency of only 60 per cent. and constant light, is far preferable to one with 80 per cent. efficiency and constant and vexatious interruptions in the light.

Tower ladders are used when trimming the lamps; each lamp requires two men in ordinary weather, and these trim from 50 to 60 lamps, according to the district. In high winds, however, it takes in some very exposed places as many as five or six men to hold on to ropes lashed to different parts of the ladder to keep it from being blown over. The ladders are a great source of trouble and expense, and seem to fall to pieces in a very short time from the jolting on the granite setts, and the author does not consider them at all satisfactory, as they have to be practically rebuilt after six or nine months' use. Some good method of lowering the lamps, so as to enable them to be trimmed from the ground, is badly needed.

The main benefits of arc lighting on a liberal scale are as follows: (1) it has the desired effect of bringing up the load factor of a station, although it comes on top of the peak, but this would happen with any load; (2) it gives long and steady hours of running the engines fully loaded after 12 o'clock at night, when they would otherwise be running half empty and at a very low efficiency; (3) in densely-populated districts into which the arc lamp has been specially brought into Edinburgh it has most decidedly reduced crime; (4) it brings in many consumers who would otherwise not take the light in the streets where mains are run and arc lamps erected; (5) it reduces station costs in every direction.

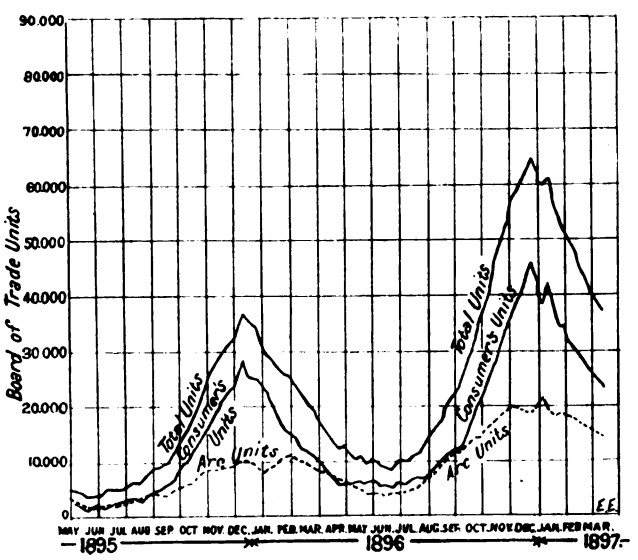

FIG. 1.

The author has prepared curves relating to two years' running. In Fig. 1 the top line represents total units, the second line units supplied to customers, the third line units used for arc lighting. The large proportion of the units used for arc lighting, compared to the total output, will be readily seen. In Fig. 2 is shown the increase in two years (1) of total 8-c.p. lamps on circuits including arcs; (2) of total 8-c.p. excluding arcs; (3) of arc lamps in their equivalent of 8-c.p. lamps.

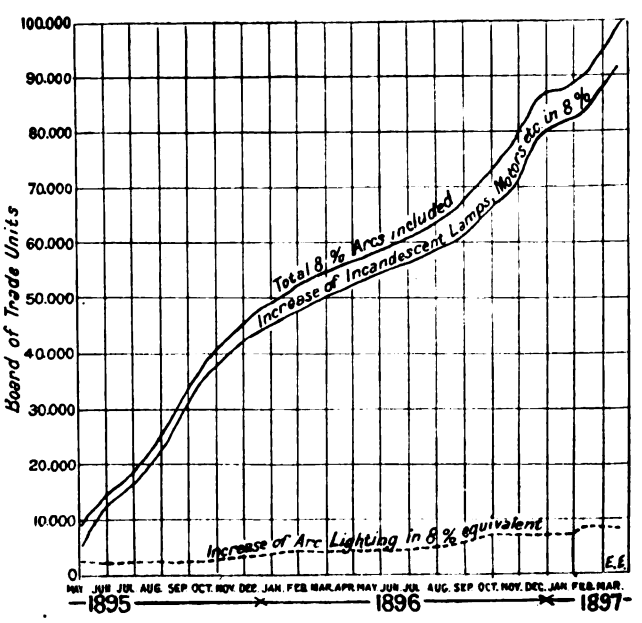

FIG. 2.

In conclusion, the author would express the hope that his paper will impress on every resident engineer and municipal committee the importance of arc lighting on a liberal scale from the very commencement of any electric light undertaking.

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Street-Lighting.

BY H. L. P. BOOT, A.M.I.C.E., A.I.E.E., BOROUGH ELECTRICAL ENGINEER, TUNBRIDGE WELLS.

Boot, H. L. P., A.M.I.C.E., A.I.E.E.—Was educated at the City of London School; on leaving there he attended the day course at the Finsbury Technical College under Dr. S. P. Thompson. After passing through the "shops" of Messrs. Johnson and Phillips, of London, he obtained the appointment as assistant engineer and draughtsman at Messrs. Laurence, Scott, and Co., of Norwich, where he was engaged on the Norwich and Ipswich central stations He then became assistant manager and engineer to the Gulcher Electric Light and Power Company. He afterwards acted as engineer and manager to Messrs. Curtis, of Dublin, where he had charge of the installation of several big plants for the Government. Finally, in 1895, he obtained the appointment of borough electrical engineer to the Corporation of Tunbridge Wells, which position he now holds. He also advises the Corporation in matters of extensions and of ordering new plant.

This subject forms one of the most difficult questions that confront the electrical engineer in connection with the supply of electric energy, especially in towns where considerable opposition is experienced from local interests. People expect great things when making alterations to their public lighting, and experience shows that they are not satisfied by being given the same amount of light in another form, although it may put money into their own pockets instead of into a rival company's. It is exceedingly difficulty to convince councillors and the public generally that by lighting their streets in a manner which is worthy of the nineteenth century, they are decreasing crime, assisting in maintaining law and order, and educating the people one step further in civilisation. Referring to the early days of the illumination of public streets it was considered, and that not very long ago, that it was unnecessary to light them at all, except a few of the principal ones, and these only with the poor light afforded by an oil-lantern; hence, if we trace the steps of civilisation, we find that every year there is a general advance in obtaining better lighted streets. There is, however, the cry of the so-called "economist," whose main object seems to be to keep down the rates at the expense of efficiency. No better or greater benefit that can be conferred on the public generally than by giving them perfectly lighted, watered, cleaned, and paved streets in the borough. The main object in carrying out these duties should be to execute them in the best possible manner and at the least possible expense, but not because of the expense neglect them, or do them in an inefficient manner. The object of the author in submitting this paper is to afford an opportunity for discussion for towns that have started their electricity works, but have not finally made up their minds as to the value of electricity as a street illuminant—the paper only applies to towns in which both public and private lighting are undertaken by municipal authorities, and with works supplying energy on the high-tension system. The first point that should be considered, or perhaps which is considered, is that of expense, and it has been the author's practice to endeavour to light the public streets with electricity in preference to gas at the same cost. This could be undertaken provided the authorities and the public were satisfied with the same amount of light; unfortunately, this is not the case, and we find them clamouring for more light, and clamouring because the light costs more. No doubt most works that have been started some time have gone through this stage and are appreciating the value of good public lighting. An intelligent ratepayer would have no objection to the rates being slightly higher provided he gets good value for his money, which can undoubtedly be supplied. To undertakings about to start, it is often proposed that public street-lighting should be postponed until such time as the profits on the private consumers are sufficient to pay the additional cost for better lighting. Surely this is a most unfair and unjustifiable manner of proceeding. When should arrangements be made for street-lighting? Undoubtedly the answer to this is—at the same time as the private lighting cables are being laid; and the time is not far distant when we shall find that wherever there is an electricity cable laid for the supply of energy, the streets will be lighted by the same agent; therefore the answer is that it should be undertaken when the works are first laid down, and then not in a half-hearted sort of manner (as is too frequently the case), because at a future date the cost of remedying this want of courage and foresight is heavy, and handicaps the extension of public lighting. Under our present system of loans, let us briefly consider the various methods by which electricity can be used for public lighting:

(1*a*) *By Arc Lamps.*—This leads us to ask the question when and where should an arc lamp be used, as there is no doubt arc lamps are used in places where they certainly should not be, also *vice versâ*, incandescent lamps are used where arc lamps should be. It is an accepted theory that wherever the largest amount of traffic and the greatest number of people congregate, such as principal streets, squares, and open places, the most light should be given. The position in which an arc lamp is placed very often determines whether it is a success or a failure; the best position, if the street or road be wide enough, is certainly in the middle, where a better diffusion of light all round is obtained. The distance apart at which arc lamps are placed must of course vary according to circumstances, but the author is of the opinion that it should never exceed 100 yards. Below is a table showing the distance in yards of the arc lamps in several towns:

Chelmsford	80 yards
Cardiff	55/70 yards
Newport	70 yards
Blackpool	50 yards
Portsmouth	90/100 yards
Derby	45/90 yards
Kingston-on-Thames	110 yards
Londonderry	75/300 yards
Brighton	70 yards
Hanley	60/70 yards
Bedford	40/60 yards (incandescent lamps)

From the table it will be seen that few towns seem to be of the same opinion as to the correct distance. This is in many instances influenced by the following points: (*a*) economy, or the desire to displace as many gas lamps as possible with one arc; (*b*) the position of side streets off the main. It is also a disputed question as to what is the most efficient candle-power for an arc lamp to give, for we find that the watts consumed (granting that the lamps are of a fairly equal efficiency) in various towns is different; the author's experience has been that the best effect for the money can be obtained by using rectified arc lamps of 500 watts, or alternating arc lamps taking 570 watts.

(2) We will consider the question of arc lighting under the following heads: (*a*) By separate plant. That is, putting down a separate engine, and direct-current high-tension dynamo, running the arcs in series. There are very grave objections to adopting this plan. Firstly, the capital outlay is heavy; secondly, the efficiency of running the plant is poor, inasmuch as the street-lighting load should undoubtedly be taken from the same 'bus bars that supply the energy for private consumers; thirdly, a separate plant requires a separate repairs' item to itself, extra outlay per kilowatt, expense of steam and exhaust piping, separate consumption of oil, and separate stand-by in the event of failure. There is in the future every chance of this system becoming obsolete. (*b*) By motor-generator. The author is not aware of any station that is operating by this method, but it certainly has a slight advantage over a separate plant, inasmuch as the total energy going out from the station is supplied from one common 'bus bar, and therefore the plant can be worked more efficiently. (*c*) By rectifiers. This is far and away the best method of lighting the public streets for the following reasons: (1) the arc lamps require no more energy than the direct-current lamp; (2) they give a higher candle-power; (3) the lamps require very little attention probably on account of the fact that there is sufficient vibration to keep the lamp feeding and prevent the mechanism sticking; (4) the capital outlay is not so heavy as a separate plant or motor-generator: the repairs' item is exceedingly small where properly managed—in fact, in the author's special case the rectifiers have not cost 1d. since the day they were put down; (5) the constant-current transformer supplied executes its work in a most efficient manner, and regulates the current perfectly, even when 75 per cent. of the lamps are turned out; (6) they have the advantage of keeping the units working at their

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highest efficiency, as during the hours of darkness the public and private supply can be run off the same 'bus bars; (7) little attention is required—in fact, no more than if a high-speed plant were running, the rectifying commutator only requiring oiling occasionally. *Disadvantages.*—There is of course a certain liability of the motor running out of synchronism, thus causing the rectifying commutator to "flash over"; this is especially noticeable when the load is coming on rapidly, also when the motor is new. (*d*) Using the same plant entirely as supplies the private lighting. To alternate-current engineers this seems the easiest solution of the problem, and now that manufacturers are placing upon the market alternating-current lamps that are equal to direct-current, it seems where extensions to the public lighting are required, provided the private supply cables are already laid, this system will be largely adopted.

Before considering the capital outlay involved on the various systems per lamp, the author submits a table giving particulars of several towns and what they have done in the way of public lighting.

Referring to this list, one cannot help being surprised at the great difference given in the cost of supplying energy to public street lamps, and the only way it can be explained is that in every town the capital outlay per lamp varies according to local conditions, from which it is evident that the price at which energy can be supplied for public lighting is governed by—firstly, the cost of fuel to enable that supply to be given, and secondly, the interest and sinking fund charges on the capital outlay expended on that lighting; thirdly, the amount of public lighting undertaken. It is therefore important in considering which system to recommend any corporation to adopt to consider the above points carefully, also what they are paying for their present public lighting. We will therefore consider the systems from these points of view—firstly, taking lighting the streets by public arc lamps the following is assumed: that the loans are granted for 25 years—in other words, are repayable in that time; secondly, that the cables are laid separately, and not when the other feeders are laid, as if the latter were the case, the cost of excavation and making good should be deducted or shared between the number of cables that are being laid at any one time; thirdly, that all lamps require to be turned on in position—that is, not being controlled at the works—are turned on and off by the policeman, when passing that post on his usual beat, by a special key. Mention may be made here that this system of the police turning on and off the incandescent lamps when passing on their beat, has now been in vogue some 16 months with perfect success at Tunbridge Wells. The only precaution that has to be taken is that the switches and keys must be made extra strong, or else the "custodian of the law" will very soon break them, owing to the fact that he treats them as roughly as he would a criminal. It has not been found necessary to in any way alter the men's beats, the entire force having keys, so that the man passing the lamp at the nearest hour at which it should be lighted or extinguished operates same. From the author's previous remarks, it is evident that he considers the rectified system of arc lighting superior to any other system introduced, and it will be interesting to take an actual example of the cost of public lighting by this system in the town which he represents. The capital outlay is worked out on the assumption that there are only 25 arc lamps to be supplied on one circuit:

Capital Outlay.	£	s.	d.
Cost of rectifiers complete (including one spare)	373	3	6
,, 25 arc lamps (including four spare ones)	262	10	0
,, 25 arc lamp columns (at £10. 10s. each)	262	10	0
,, 25 high-tension switches for isolating purposes (at £2. 9s. 6d.)	61	17	6
,, one trimming ladder (at £13. 10s.)	13	10	0
,, arc lighting cable (at 1s. 8d. per yard)	231	0	0
,, laying, excavating, making good pavement, etc.	288	15	0
,, 25 service boxes (at £1 each)	25	0	0
,, seven straight-through boxes for jointing lengths of cable	4	5	0
,, labour in connecting boxes, sundries, etc.	48	0	0
Total	£1,570	11	0

Cost of Supply.	£	s.	d.
Interest and sinking fund charges amounting to 6 per cent. on capital outlay	94	4	7
Labour in trimming, attendance, etc.	156	0	0
Cost of supplying energy, 25 by 920 units (at 2d. per unit)	191	0	0
Carbons	30	12	6
Total	£471	17	1

From which it will be seen that the labour item is heavy. This is accounted for by the fact that the area covered by the lamps from which these costs were taken is extremely large and scattered; and secondly, that the small number of lamps to be dealt with causes this item to appear much higher than if there were twice the number, inasmuch as the cost of labour would be the same; the same number of men would only be required to trim twice or three times as many. Dividing the above capital outlay by the number of lamps, we find that it costs £62·8 per rectified arc lamp; and the cost of supplying, including all capital charges, 4·92d. per unit, or £18·9 per annum.

Scanning the figures in the capital outlay, one naturally endeavours to find which item can be reduced, so as to reduce the actual cost per unit, and the only figure in which a substantial reduction can be made is that of laying the cable, or rather the cost of the trench work, amounting in this instance to £288. 15s. This cost arises from the timidity of the public, as if the cables were laid at the same time and in the same trench as that prepared for the reception of the feeders, this outlay would be entirely saved. This forces us to the conclusion that the most economical policy to adopt is, wherever cables are being laid or extended, to make arrangements for the lighting of the public lamps along that route, either by means of the same distributor that supplies private consumers, or where the houses are isolated and some distance from the road, to run a small distributor along with the feeder, placing a small pit transformer capable of supplying the required number of lamps, both up and down the road in which the feeder has been laid, that transformer being fed off the aforesaid feeder; that is the only method by which the public street-lighting in outlying districts can be undertaken at anything like the same price as that charged for gas.

It is unnecessary to go fully into comparisons or the cost entailed by adopting the various methods of arc lighting, means of supply, and method of control mentioned in this paper, but it will suffice for our purpose to consider one other system, which competes very favourably, that mentioned in paragraph 2, item "D." We will now proceed to treat this in the same manner as we did the cost of rectified arcs, but with the following assumptions: (1) that the lamps are turned on and off by the policemen at required times; (2) that the arc lamps are only required in districts where high-tension feeders are already laid.

Capital Outlay.	£	s.	d.
Cost of 25 service boxes	25	0	0
,, 25 arc lamps (including four spare ones)	262	10	0
,, 25 lamp-posts	262	10	0
,, 25 transformers	200	0	0
,, 25 switches	61	17	0
,, 1 ladder	13	10	0
,, service cable at £1 per post	25	0	0
,, labour in fitting boxes	48	0	0
	£898	7	0

Cost of Supply.	£	s.	d.
Interest and sinking fund charges at 6 per cent. on capital outlay amounting to	£54	0	0
Labour attendance, trimming, cleaning, repairing	156	0	0
Generating, lamps alight up to 12 o'clock (570 watts)	217	10	0
Carbons	30	0	0
	£457	10	0

The figures above show that the capital outlay by using the alternating-current arc lamp amounts to £35 per lamp, as against £62·9 for rectified. The cost of supplying energy to same, including interest and sinking fund charges, works out at £18·2 per lamp, as against £18·9 for rectified ones. Each arc lamp erected on the alternating-current system costs about 15s. per annum less to the electricity works than if it were run on the rectified current system. In Tunbridge Wells we have both systems in use, and undoubtedly we would have extended the rectified arc lamps but for the fact that it is an extremely scattered town, and it would be necessary to run a very long cable from the works before any lamps were taken off it at all, and for that reason alternating-current arc lamps are being used. In comparing the two systems, it is fair to mention that there is practically no difference in the amount of light given by each lamp, as the consumption of the alternating lamp is taken at 570 watts, and that of the rectified at 500. It is unnecessary to consider the plant required for incandescent street-lighting, as this is the same as used for private lighting.

Method of Control.—By running a separate cable from the works using rectified or alternating lamps in series, and controlled at the works by a special switch-gear. The advantage of this method is that the street-lighting can be switched on and off at the desired time by the engineer-in-charge at the works. The disadvantages are: (1) the enormous capital outlay; (2) more chances of breakdown, owing to depending on automatic devices for cutting out lamps in the event of the carbons sticking; (3) handling the lamp when alive is dangerous; (4) an accident to the cable would disable the entire public lighting, at least that circuit. The above remarks apply to incandescent lighting where separate cables are run.

The objection to switching on the heavy load—that is, if the public lighting forms a considerable portion of the total, is the irregularity in the pressure caused during that moment, although special water resistances or chokers are provided.

By separate cables from sub-stations. These would only be used when alternating lamps are in series, or for the lighting of

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Name of town.	No. of arcs.	Incandescents.	Distance apart in yards. Arcs.	Incandescents.	Capital outlay per lamp. Arcs.	Incandescents.	Cost to electricity works. Arcs.	Incandescents.	Number of hours burning. Arcs.	Incandescents.	Price charged per lamp. Arcs.	Incandescents.
Chelmsford..	20	578	80	50	—	—	—	—	3,687	3,687	£22. 10s.	£2. 6s. 10d.
Cardiff	52	—	55/70	—	£34	—	£32	—	3,824	—	£18	—
Newport ...	42	—	70	—	£48	—	£18. 10s.	—	2,787	—	£25	—
Blackpool ...	105	—	50	—	£47	—	—	—	2,000	—	4·8d per	unit.
Portsmouth.	264	482 (32-c.p.)	90/100	—	£40	—	1¾d. per unit.		1,800	2,165	£18	—
Halifax	11	22 (32-c.p.)	Placed o spa	nly in open ces.	£19	£2	—	—	till 11.30	11.30 to daylight	4½d. per	unit.
Derby..... ...	77	4 (50-c.p.)	45/90	—	—	—	2d. per hr. arcs	—	3,500	—	4½d. per	unit.
Kingston-on-Thames	36	2 (32-c.p.)	110	45	£69. 3s. 4d.	—	£14. 10s.	£3	3,400	—	£20	£3. 10s.
Londonderry	174	—	75/300	—	£108	—	£12. 6s.	—	3,000	—	£20.12s.5d.	cost.
Brighton ..	252	580 (8-c.p.)	70	40	£55	£2. 5s.	£27. 7s.	£3. 2s.	3,864	—	average pri for both	ce 3·44d. kinds.
Hanley	60	30 (16-c.p. & 25-c.p.)	50/140 w lamp mi	ith a small dway 60/75	£50	£6 without column	£16 (8d.) larger at 2·5 per unit.	£3	3,900	—	£16	£3
Bedford	—	350 2 8-c.p. or 2 100-c.p. on one post	40/60	—	—	£12	—	—	—	—	2½d. per standing of £1	unit plus charge 5s. 9d.

public incandescent lamps. *Advantages*—Small capital outlay. *Disadvantages*—Necessity for a man visiting the sub-station at lighting and extinguishing time.

From the high-tension mains (which supply private consumers) with a separate transformer, the double-pole switch and fuse being placed on the primary.

Advantages.—Practically no capital outlay for cable; (2) lamp can be easily handled when burning; (3) different feeders can be used for various alternating lamps, so that the likelihood of a total extinction is extremely improbable. *Disadvantages*—Arrangements must be made for switching on and off at lighting and extinguishing times; (2) cost of special transformer. The transformer would convert from the high pressure to the lamp pressure, no choker being necessary.

From the low-tension distributors with transformer to convert to the lamp voltage. This is only advisable where the distributors are not run along with the high-tension feeders. It may be interesting to give a few details as to the cost of an extension carried out for incandescent street-lighting; however, to avoid a complication of figures, only the first extension undertaken on this system will be given. The extension in question was for a house situated 2,000 yards away from the nearest high-tension feeder. The committee were recommended to extend the cable, provided the public lighting along that route was undertaken. To enable this to be done, 20 gas lamps of 16 c.p. nominal were to be replaced by electric ones. The capital cost on 20 lamps was as follows:

Cost of transformer to convert from 2,000 volts to 200 volts ..	£12	0	0
,, labour on joint-boxes	8	0	0
,, building pit, frame, and cover	5	0	0
,, 16 joint-boxes	14	0	0
,, switch-gear to enable primary of transformer to be switched on and off, levers, etc.	1	10	0
,, 20 columns complete, with globes, lamp-holders, etc.	35	0	0
,, wiring columns	15	0	0
,, 2,000 yards of low-tension at £60 per 1,000 yards	120	0	0
,, sundries, say	5	0	0
	£215	10	0

Cost of Supply.

6 per cent. on £215 will be	£12	16	0
Cost of energy, 3,800 hours, burning at 2d. per unit ...	35	0	0
Cost of renewals	4	0	0
Painting, cleaning, etc.	10	0	0
	£61	16	0

showing that each 16-c.p. lamp replaced by an electric lamp of similar power, including interest and sinking fund charges, amounts to nearly £3 per annum, and that is taking the electric energy at a price of 2d. per unit, which cost, when the whole of the borough is lighted by that means, will no doubt be considerably reduced. In many towns the cost of a single gas lamp, including painting, cleaning, hire of column, cost of post, lighting and extinguishing exceeds this figure, so that it is within the scope of practical possibility to light a town economically and successfully by adopting the above system. It also adds an inducement to the extension of cables into re note districts, where the demand is too meagre to warrant the capital outlay, as the cost of that feeder would then have the revenue obtained from the public lighting on its way—*i.e.*, against the cost of that feeder would be placed the revenue obtained from the public lighting plus the revenue of the consumer to whom it was extended. This arrangement is, of course, not necessary where probable consumers are sufficiently close together to enable distributors to be run from the sub-station, in which case the same cable that supplies the private consumers could be tapped to supply the incandescent lamps. Referring to the figures above, it will be seen there is an item of £120, also a transformer £12, pit frame and cover £5, which items would not appear in the capital outlay, when changing these gas lamps over to incandescent lamps, if taken off consumer's main, and where the same distributor supplies the public lamps as well as the private consumers, we have the extra capital outlay in conversion of 20 gas lamps as follows:

Cost of 20 lamp columns, with globes, holders, etc.	£35
,, 20 watertight switches, at 10s. each	10
,, 20 service boxes, at 15s. each	15
,, labour in connecting	5
,, service cable	12
,, sundries	5
	£82

Cost of Supply, including Interest and Sinking Fund Charges.

Interest and sinking fund charges on capital outlay	£5
,, 4,200 units at 2d.	35
,, lamp renewals	4
,, labour, cleaning, painting, etc.	10
	£54

The results shown are for replacing the gas by the electric light, and do not include giving the ratepayers any more illumination than they had previously, but it would be advisable in making the change to charge a few shillings extra per annum and use some sort of device for multiplying the amount of light by reflectors.

In conclusion, the author invites criticism from his colleagues, since the question of costs of public lighting when mingled with the private costs is most difficult to extract, and it is only in comparing different engineers' opinions as to the actual cost of supplying public lighting that we can arrive at any definite basis to charge this upon. The system proposed by our late president does not appear to the author financially sound for this reason: he ranks the private consumer on exactly the same basis as the public lighting, although the private consumer has paid for his installation out of his own pocket, and the electricity works do not have to pay on this their 6 per cent., whereas with the public lighting the standing charges should be higher, because they should be made up on their proportion of capital outlay upon the plant at the station, plus the capital outlay involved in the purchase of cables, columns, etc.; to make it clearer, if the corporation undertook the wiring of the consumers' premises, they would then be more or less on a par with regard to the amount of standing charges.

The author desires to thank heartily those gentlemen belonging to the towns mentioned for their kindness in supplying the information tabulated, and hopes that this paper may have the effect of inducing corporations owning their electricity works to undertake public lighting on a large scale, and not in the meagre way which has hitherto been done.

Discussion.

The discussion on these three papers was taken jointly.

Mr. Gay (Islington) said after going through the papers one would imagine that the whole of the subject turned upon rectifiers. There was an almost unanimous opinion that rectifiers

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were *par excellence* the thing for street-lighting. He (Mr. Gay) would have liked to have seen a paper on the supply of street-lighting from a low-tension centre. Mr. Fedden alone referred to it. Mr. Taite gave a good account of the reliability of rectifiers, but Mr. Fedden was of a different opinion, and said they were tricky. His experience with five of them at Islington confirmed that to a certain extent, but of three evils—namely, high-tension lighting with alternating-current lamps and a transformer in each lamp-post, a separate (continuous) plant altogether for the arc lighting, or rectifiers — the last was to be preferred. It had been said that there was nothing you could do with dynamos that you could not do with rectifiers, that paralleling was easy—in fact, it was impossible to get out of phase ; and if they did, a few seconds were sufficient to restore equilibrium. In fact, the rectifier was the most efficient and perfect thing ever invented. He had not found it so. Rectifiers were tricky, as had been said. They would run out, and you might get an alternating current through your lamps. In about six cases out of ten he was able to get a machine into parallel with the rectifiers with very careful management. They would jump and hunt, of course, but he meant without running out. The repairs were not so small as Mr. Boot said if the brushes were considered. What went on there would not be allowed in a Brush or a Thomson-Houston machine. As to lamps and trimming, Mr. Gay thought the connections should be permanent, and the lamps never lowered. He preferred the plan of the City Company, where climbing irons were inserted in the post. That saved one man out of two, not to mention the ladder. He had been much struck with the fact of there being 469 arc lamps at Edinburgh, with a possible 150 more. That was simply magnificent. In a place like London, where the load factor was very bad indeed, this big street-lighting work was a plum to make one's mouth water.

Mr. Tonge (Preston) said they had some arc lamps there, but the Corporation was economical, and did not have more than five amperes in a lamp. The lamps were consequently not much to look at, but they ran all right four in series.

Councillor Pearson (Bristol) said their engineer at Bristol had not yet advised them as to extension of the street-lighting. The lamps they had run from the direct current were doing very well. They began at Bristol by thinking that street-lighting would not pay, and had set a price on it of which they were now rather ashamed. The Corporation had been induced to take 300 instead of 100 lamps at a reduced price, and they believed that the City Council would be the committee's best customer. He could not think it was right to fight the gas company in the streets with the incandescent lamp. The improvement was not marked, and if the gas lamp was to be fought it was necessary to simply overwhelm it with light as the arc did.

Mr. Quin (Blackpool) was much surprised to find that at Edinburgh they ran four lamps in series on 230 volts. At Brighton they had succeeded in running five in series. That was a great gain. Nine lamps in series at 460 volts were spoken of. He (Mr. Quin) would try 11, and was confident that the steadying resistance would be sufficient. In disagreement with Mr. Fedden, he thought it desirable to couple street-lighting circuits only at disconnecting boxes. One hesitated at anything which might result in having to put a whole street in darkness. As to a good alternating-current lamp, it was still to be invented, and he thought must be designed upon an entirely different plan. The arc lamp as at present constructed had been really designed for the continuous current, and was extremely inefficient when fed with alternating. He would not use alternating arcs. Three gentlemen spoke about rectifiers. One said they were no good, another that they were good if you attended to them, and a third that they did not want attending to. He (Mr. Quin) had four, and agreed with the gentleman who said they were good if properly attended to. They did cost a lot in brushes and did have a knack of running out of phase. There was always one E.M.F. in the transformer for the motor which gave the best result, and it was not always the same. With an iron machine it was necessary to keep a higher E.M.F. than with a copper machine. With copper and iron machines in parallel it was necessary to strike a mean. All that sort of things had to be taken into account in running rectifiers, but nevertheless he believed the rectifier was at present the solution of the problem of running arcs from an alternating station. Mr. Boot made the rather astounding statement that lamps run on rectified current gave a higher candle-power for the same wattage than from continuous current. He would like some tests, as they seemed to him to give less light. He agreed with Mr. Fedden as to tower ladders. Both at Brighton and Blackpool, which were breezy places, there was the danger of getting them blown over. At Brighton 200 lamps were lowered with safety arrangements in case of the wire breaking.

Mr. Stewart (Derby) had heard various opinions about rectifiers, but the consensus of opinion was that they were very good things when one has alternating current in the mains. It was risky to advise changing from one way to another. He thought the thing to do was to put in motor-generators. There would be the synchronising difficulty, of course, but if trouble occurred they would have to take order with their assistants. Lowering lamps was not satisfactory, and a ladder was often necessary, after all, to get the lamps down. The contact ought not to depend on any automatic arrangement.

Alderman Miller (Croydon) said they had Ferranti rectifiers, which proved fairly satisfactory. He believed that was also the case at Portsmouth. They had tower ladders, which did well, although their streets were narrow.

Mr. Steinitz (West Ham) had gone in for 88 alternating arc lamps of the enclosed type. They took 570 watts, and were, as far as one could see, as good as any of the 15-ampere alternating arcs in the market. They had determined to follow the example of Hastings, where the effect was very fine.

Mr. L. Andrews (Hastings) said at Hastings they had 52 arc lamps (alternating) upon three miles of front. The transformer in every lamp-post made the capital outlay high, but he would strongly recommend the system if he were making an extension. They would have been much better off at Hastings without the public lighting, but that was on account of the hard bargain driven with the company by the Corporation. The terms were such as really left them about 0·6d. per unit for generating the current, and he would be glad of advice as to how to do it for that sum. The arcs took nearly half their current, and, allowing for the arbitrary depreciation and other things, left them with about £300 for it as against £4,000 or £5,000 from private consumers. So they could not reduce their price as they ought to do, and the enterprising person who put in the electric light had to pay for illuminating the Front for the general benefit. That, he thought, was not the right way. He could not quite make out what system Mr. Boot really preferred. A private company had to borrow at a much higher rate than a municipality, and that affected the estimate of £27. 7s. per lamp if they were to pay a dividend.

Mr. Mountain (Huddersfield) thought that the case was different in towns of different size, and in particular between towns in the North and in the South. The former were able to get their coal much cheaper, so that the coal bill was not such an important factor. With cheap coal a small town might be able to work incandescent lamps for street-lighting with advantage. It was complained that the incandescent lamp, though of equal or superior power, looked poorly in the streets in comparison with the gas flame. There was a certain amount of truth in it, and he had had special lamps made with a double filament in them to meet the point of want of breadth of radiating surface. Something of the kind he thought would be necessary in running the incandescent lamp against the gas lamp in the streets. He considered it most important to have the machinery of one kind. The arguments against alternating arc lamps were altogether imaginary. They had a bluish tinge, but there was not much to complain of as they had them at Huddersfield.

Mr. C. J. Sutherland (Hanley) had had no trouble with his rectifiers, or nothing which could not be stopped by adjustment of the brushes. It was true that a Brush machine required a higher voltage than a Ferranti. They could run in parallel. His experience was that it was usually the engine which was in fault, not the rectifier. He had had an experience in which the motor refused to run upon one of his engines. The engine was out of repair, but when it was put right the rectifier ran upon it, and it was almost impossible to make it run out. He used the tower ladder, and one man was sufficient—in fact, he refused to take anyone with him. They had Brush machines, and could use rectifiers for their arc lights. A trial showed a very considerable saving in the coal bill for running on the rectifiers. He was doubtful whether it was necessary to be so much better than gas in the by-streets. No committee would authorise arc lamps in side streets. Incandescent lamps would do all that was wanted there, but he would not use them in the main thoroughfares.

Mr. Chamen (Messrs. Crompton and Co.), referring to measurements in connection with rectifiers, wanted to know whether a wattmeter was used upon the rectifier side of the plant. He was sure there was a great deal of choke, and it seemed obvious that if a wattmeter was wanted for an alternating current it was also wanted for a rectified current. That might alter the efficiency Mr. Taite had shown. At Worcester there were 50 or so (arc) lamps in series. The lamps were fed with a compensating coil, which was a small choking coil with a single winding, which shunted a portion of the current when the arc lengthened. Its choke was so great that under normal conditions practically no current passed, but if the carbons burned out all the current passed through the coil, and the rest of the circuit remained undisturbed, as it practically choked back 35 volts. There was another way which was adapted for 220 volts on a three-wire distribution. It was to use a thing like a transformer with one winding, but there was another terminal part of the way down the coil. It was connected so that part of the winding acted as a primary, and the other part in some sense as a secondary, so that it was possible to take off only 10 amperes from the main. It was beyond denial that the alternating-current lamp had a poor appearance compared with the continuous. At the Agricultural Hall at Islington, for instance, they had 10-ampere continuous-current lamps. It was wanted to light the galleries also, and to avoid extending the plant alternate-current arcs fed from the Vestry's mains were tried. These took 15 amperes, and yet they could not hold a candle to the continuous-current lamps. Several kinds of alternate-current lamps were tried, and in the end it was found that it would require 20 to 25 amperes to get as good a light as from the 10-ampere continuous lamp, and the plant had to be extended. Climbing irons were used in London and Islington for recarboning, and so the street was not obstructed. A good method of lowering the lamps was desirable. Mr. Wright's arrangement seemed to work satisfactorily : the contact was made and broken each time the lamp was raised and lowered.

Mr. E. T. Ruthven Murray (Worcester) gave his experience at Worcester. He had great confidence in the series system. They had there two circuits, with separate transformers for each lamp. The power factor was naturally not good. So Messrs. Crompton had supplied them with a scheme, which they used, which was simple and effective. It was possible to put any number of lamps in series and to booster up and use any number of lamps. They had climbing irons in Worcester, but he would not take the responsibility of ordering their use, as he considered they were not safe.

Mr. J. A. Jeckell (South Shields) said rectifiers would run very

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well, but they must have first-class attention. If they were left to an ordinary man, there was trouble. In comparing alternating-current and direct-current lamps, the question had to be gone into financially on the basis of interest and depreciation to find out whether the extra current for the same light really cost more. If it was possible to get a really good alternating-current lamp, he would be in favour of simplifying the system by using it.

Alderman Miles (chairman of the Bolton Gas and Electricity Committee) said there was a tendency to ignore absolutely the fact that street-lighting for 60 or 70 years had been satisfactorily accomplished by the use of gas. A much better purpose would have been served had the papers dealt with the comparative success and cost of electricity and gas. When they were inaugurating their electric works at Bolton, he was told by a celebrated electrician that street-lighting by electricity was anything but satisfactory, and congratulated on the fact that he was not going to attempt it. His experience proved that. The system of arc lighting was not on right principles. They put up very elaborate lamp-posts, as they saw in Albert-square adjoining, some of them 20ft. high, with a fairly good illuminating power, and placed the posts a long distance from each other. That was not street-lighting at all. He advocated the use of pillars 10ft. to 12ft. high, remarking that at present there was plenty of light near the pillar, but a dark shadow intervening between the posts owing to their distance. What was wanted was something like what he remembered was done in the Avenue de l'Opéra at Paris or on the Thames embankment [*i.e.*, not the present lighting of the Avenue de l'Opéra, but the Jablochkoff candles of many years ago]. That was a far better system. The reason that electric lighting of the streets had not made further progress in Manchester, where they had only a few arc lamps, was that the system of gas illumination was as excellent as any that could be found in the United Kingdom. Electricity evidently did not appeal to the commercial instincts of the Corporation of Manchester to a very high degree. Some years ago he was in the South of England and saw the side streets of several towns lighted by electricity (incandescent lamps), and he never came across a more egregious failure of public lighting. They must put their lights so that they would not illuminate the tops of public buildings, but the street traffic and pedestrians. If they did this and put the lamps nearer together they would have done good work, but they would have to do it much cheaper than they were doing now. In the towns of Bristol and Croydon the gas company was in competition with the electrical company, but in Manchester the Corporation controlled both, and they could not therefore expect electricity to be substituted for gas until it could be accomplished with more efficiency and at a lower cost. He spoke in no spirit of antagonism to the electric light, but the question was a commercial one, and ought to be so considered.

Alderman Norman (Cheltenham) wished to follow the last speaker, as he disagreed with his views. The reason why electricity had been kept back was because two interests had been represented in the different towns by one individual body. He was glad to hear that in Manchester a division of the Lighting Committee had taken place, and he confidently predicted that where they could count the lamps in the streets to-day by tens they would be able to count them by hundreds next year. His experience at Cheltenham was entirely different to that of Alderman Miles. They had 55 arc lamps in the streets, and the difficulty was to keep people quiet while they were putting up new lamps. They hoped to have 100 by Christmas, and, perhaps, double in a year more. To compare gas lighting under its best conditions even with electric lighting under its worst was an absurdity. He might say that the lamps at Cheltenham were alternating-current ones, with transformers in the base of the lamp-posts. They were lighting a long avenue from pairs of posts with the lamps suspended over the centre of the road. The cost per annum was £19. 10s. From the day of starting their lamps they had not had a moment's anxiety.

Alderman Calvert (Huddersfield) thought that in Yorkshire they tried to make the best commercial bargain, but their views at Huddersfield were not the same as those of Alderman Miles. At Huddersfield the electric lighting was originally managed by a sub-committee of the Gas Committee, but it very soon became evident to the majority of the Council that the committees should be separated, and every encouragement given to produce the best result at the cheapest rate, whether it was by gas or electricity. He believed that for illuminating the streets electricity would win, unless there was some very great improvement made in gas lighting, and then, of course, electricity would have to go to the wall.

The **Chairman** said they might, of course, be mistaken, but he had thought that everyone in the room had looked upon the question of street-lighting by electricity as settled. Alderman Miles quoted the lighting of the Avenue de l'Opéra. He had only recently returned from Paris, and would hang his head for shame if he were asked to compare any electric lighting in England with it. They had been frightfully extravagant over it in Paris no doubt. The plan adopted was a number of lamps down the middle of the road about 100 yards apart, and also lamps on each side about 30 yards apart. The result was almost like daylight, and there were no shadows. [**Alderman Miles**: I referred to what was done in 1878, and complimented it.] That was an altogether obsolete system, which no one would think of adopting. As to the Manchester street-lighting, he (Mr. Wordingham) alone was responsible for the delay in introducing the electric light into the streets. The demand for the light for private premises had been so great and so difficult to keep pace with, that, as the person responsible for there being a sufficient supply, he had not dared to recommend street-lighting sooner. The Gas Committee, who had hitherto controlled the electric light as well as the gas, was certainly not to blame. The Gas Committee had been all along in favour of the experiment being made. The suggestion for the division of the committee had come from the chairman of the Gas Committee. As to the arc lamps in Albert-square, he held that it should be conducted in a commercial spirit, and not with a view to making a theatrical display regardless of expense. They were, as a matter of fact, giving the public five times the amount of light they had before for rather less than the cost of the old gas lamps. His view was to show the Manchester people that they were getting a better thing for the same money, not, of course, 50 times better, but four or five times.

Mr. Taite said he would reserve his reply for the *Proceedings*, but he would like to say he used rectifiers at Southport.

Mr. Fedden said he had six rectifiers running. As to their uncertainty, he might mention that he had experienced an instance where in putting on a machine the primary fuse went. That threw all the others out and put out all the street lights. It was not right that so small a thing as a fuse going should put out all the street-lighting.

Further replies were reserved for communication to the secretary.

The next paper was

Electricity Meters.

BY T. P. WILMSHURST, A.I.E.E., BOROUGH ELECTRICAL ENGINEER, HALIFAX.

Wilmshurst, T. P., A.I.E.E.—In 1885, entered the shops and office of the late Sir Charles Bright, mining and consulting engineer. In 1887 he was appointed to a post on the staff of the Taunton Electric Light Company. While in the employ of this company he had a large experience of pioneering work in various towns in the West. In 1889 he was appointed chief assistant to the Exeter Electric Light Company, then being formed, and in the following year he was made chief engineer. In 1893 he left Exeter on receiving the post of borough electrical engineer to Halifax. He was here called upon to design a complete scheme of electric lighting on the high-tension alternating system, which was successfully carried into operation. At the present time he is engaged in laying down an electric tramway system in Halifax, the power to be supplied from the existing electricity works.

In any electricity supply undertaking, one of the most important of the items which make up the distributing system and the connecting link between the technical and commercial sides of the business, is the meter. In considering the specification of a perfect meter, the following conditions should be classed as "essentials": (1) accuracy; (2) reliability; (3) durability; (4) low starting current; (5) noiselessness; (6) impossibility of being tampered with by consumers; (7) unaffected by stray magnetic fields; (8) reduction of moving parts to a minimum; (9) small loss of power; (10) absence of clockwork, liquids likely to freeze, mercury, contacts, or commutators; (11) if energy meters, should measure true watts; (12, 13, 14, 15) must be unaffected by vibration, alteration of temperature, frequency (if alternating), or barometric pressure. In addition, the following may be classed as "desiderata": (16) equally correct for direct or alternating currents; (17) capable of being checked by a short time test; (18) low cost. Although "low cost" has been placed at the end of the list, it is not to be implied that its relative importance is smaller than other items to which more prominence is given. Some of the above points may well be amplified and discussed.

1. *Accuracy.*—Before defining what we should consider a commercially accurate meter, let us for a moment enquire what,

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in the case of parallel undertakings, is considered an "accurate" meter. The Sale of Gas Act requires that "no meter shall be stamped which shall have an error of more than 2 per cent. in favour of the seller, and 3 per cent. in favour of the consumer," and the author believes that when new, at any rate, all the well-known gasmeters are within this limit. In the case of water-meters, there are no limits fixed by Parliament. The best makers, however, will guarantee their meters to have a variation not exceeding 2½ per cent. from the mean (an extreme range of 5 per cent), though the accuracy seems to fall off somewhat rapidly at low loads. There are few modern electricity meters which are not correct within the above limits. The author has adopted the following standard of variation, and almost all manufacturers appear to be ably to easily comply with the specification:

At full or half load	2	per cent. from normal.
At quarter load.....	3	,, ,,
At one-tenth load.....	4	,, ,,

And no meter is accepted in which this variation is exceeded. So far as the author is aware, no definition of a "correct" meter has yet been given by the Board of Trade. The rules of the London County Council contain the following: "A meter shall be considered to be correct when the registration shown by the dials is within 2½ per cent. of absolute accuracy at all points above one-twentieth load, or 1¼ amperes." To obtain this extreme accuracy, it need hardly be observed that the working of the meter should be based on what might be called a straight line law, and should not be "cooked" by numerous compensating devices to approximate correct readings, otherwise errors are extremely likely to creep in after a time.

2 and 3. *Reliability and Durability.*—Not only must the meter not show traces of undue wear and tear, but it should be impossible for the curve to alter appreciably after a lapse of time. Time alone will decide what constitutes a fair rate of depreciation. In this connection, the writer notes with satisfaction that several of our manufacturers have abandoned the thin tin case in favour of a more substantial one of cast iron. It is almost an impossibility to make even a moderately dust-tight joint where a tinned iron cover is used. Another weak point is the use of iron for the worm connecting the revolving spindle to the first wheel of the registering train. In many towns the worm is apt to rust after a short time, involving a serious loss of speed. The use of phosphor bronze is much to be preferred. Low speed is probably also an important factor in the question of durability.

4. *Low Starting Current.*—A good meter should start without fail, on not more than one-fiftieth of its maximum load. In this respect the energy meter, as distinguished from the quantity meter, seems to have a decided advantage. It is a matter of some interest to study the means adopted to ensure a low starting current. One maker adds a shunt coil, which, though solving the initial friction difficulty, introduces the losses inseparable from the shunt winding. Another obtains extreme accuracy at low loads, partly by the use of a shunt coil, and partly by making the lower jewel self-adjusting, the upper end of the spindle being held by a loose guide. A third shields the lines of force passing through the magnet and brake disc by interposing a copper plate, the eddy currents in the plate reacting on those in the movable disc, setting up a mutual attraction. A fourth has arranged that the disc shall float on mercury at low loads, the weight of the spindle being therefore entirely taken off the lower bearing.

10. *Absence of Clockwork, etc.*—It is hardly necessary to observe that any form of meter that requires periodical winding up should be avoided. Contacts and commutators, though working well for a time, will eventually be a source of trouble. The use of mercury, unless entirely enclosed, is a disadvantage. A momentary short-circuit is liable to cause the mercury to fly about inside the meter, even penetrating to the train of wheels.

12. *Vibration.*—With most forms of meter the effect of vibration is to considerably raise the curve at low loads; above one-fifth load the effect is practically nil. A moderate amount of vibration such, for instance, as is met with in a mill where the thud of machinery is perceptible, is sometimes sufficient to cause an energy meter to run on its shunt alone, if adequate precautions be not taken.

13 and 14. *Alteration of Frequency and Temperature.*—Experiments to determine the effect of alteration of frequency on alternating-current meters were published by Messrs. Cowan and Still two years ago. The results arrived at show that the variations of frequency due to the variations of speed met with in alternating stations have practically no effect on the correct reading of the best-known meters. The author's experiments in this direction, and also on the effect of change of temperature, entirely confirm the conclusions of the above-named authors.

A few words may now be said on the highly debatable question of quantity *versus* energy meters. The principal advantage claimed by the advocates of the quantity meter is the small loss of power in the meter itself, and this is undoubtedly a powerful recommendation in its favour. A quantity meter, however, usually exhibits the defect of requiring a somewhat large starting current, involving a loss of revenue at light loads. To obviate this defect, some makers have avoided Scylla only to fall into Charybdis by adding the much-condemned shunt coil to obtain a large initial torque. If this expedient has to be resorted to, the advantages of the quantity meter over the energy meter are largely discounted. It seems to be a fact, however, that the direct-current quantity meter is considerably better in this respect than the alternating-current meter. In alternating systems, needless to say that on inductive circuits one has no option, and nothing can be used but an instrument measuring true watt-hours. There are several so-called energy meters on the market which hardly deserve the name. One type when used on arc lamp circuits runs considerably slow; nor is this all, for if sufficient inductance be introduced into the circuit, the direction of rotation of the meter will actually reverse. This fault will have to be eliminated before this type of meter can be considered to approach perfection, as a consumer has only to switch on a choking coil across his mains on retiring to rest, in order to wind back the units he has consumed during the evening; he may even go further than this and present an invoice to the undertakers for current supplied to them! It may be urged that the vast majority of consumers on alternating circuits have non-inductive loads; as, however, it is probable that consumers will gradually introduce small motors and domestic appliances, the power factor of which is less than unity, it would appear to be the wisest policy to use true watt-hour meters, provided always that the shunt losses are so small as to be negligible.

In considering the magnitude of the shunt losses, it should be borne in mind that these losses, unlike the main coil losses, are evenly spread over the 24 hours. The cost of maintaining the shunt, therefore, should not exceed ¾d. per unit. In the author's opinion, too much importance is often attached to these shunt losses. Arguments by hostile critics often assume that these losses are as high as 10 or 12 watts, and therefore that an energy meter must be a very wasteful appliance. The following figures show the actual shunt losses in various modern meters:

Hookham alternating meter	1·5 to 2·5	watts.
Thomson watt-hour meter	2·3 to 3·3	,,
Westinghouse watt-hour meter	1·3	,,
Edmondson zero-torque meter	1	,,
Electrical Company's meter (about).	1	,,
Scheeffer (about)	1	,,

These figures are approximately correct, but vary somewhat for different sizes. The main coil losses, on the other hand, are, as a rule, quietly ignored. It is by no means an unknown thing for the $C^2 R$ losses to be between 12 and 16 watts, and these losses have their maxima at times of heavy load, when their importance is relatively great. In the case, therefore, of an installation in which there is a heavy demand for long hours the main coil losses may quite possibly far exceed those in the shunt.

While on this subject, it may be well to note that the only meters which have yet received the approval of the Board of Trade are those in which a shunt coil is absent. The most serious objection to the energy meter, and one which is far more important than the shunt losses, is the possibility in this type of running on the shunt alone. The author has observed this defect in over 6 per cent. of the energy meters received from the makers. The great importance of the point lies in the possible loss of confidence of the consumer in the apparatus, the correct registration of which determines his quarterly bill. In the Thomson meter, as is well known, a large initial torque is obtained either by fixing one terminal of the shunt on the lamp side of the main coil, this ensuring a sufficient field to just counterbalance pivot friction, or by fixing it on the supply side and using a subsidiary coil inside the main coil, thus giving an initial field when no current passes through the field coil. The refusal to run on the shunt depends, therefore, upon the energy absorbed at no load exactly counterbalancing pivot friction.

In the Hookham alternating-current meter, as mentioned before, a large initial torque is obtained by the interaction of a copper shield and the brake disc. An ingenious device is used to avoid shunt running by fixing a small piece of iron on the disc when this travels under a subsidiary brake magnet; the mutual attraction prevents the disc travelling further until the main circuit of the meter is closed through a lamp. Neglect of this simple precaution causes the meter to run on the shunt to the tune of over 140 units per annum.

In the Edmondson alternating-current meter, the principle of which is similar to the Siemens dynamometer, the torsion of a spring is balanced by the torque due to the attraction between the main and shunt coils. The shunt forms a closed circuit and when the lamp circuit is open, no current can pass through the main coil; there is no initial torque, and no registration can therefore possibly take place. In spite of the fact that there is no initial torque until the lamp circuit is closed, the meter com-

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mences to register at 1-100 of its capacity, and is, moreover, extraordinarily accurate throughout its range.

In the new Westinghouse watt-hour meter, described later, the working of the meter depends on the phase difference produced between the main and shunt coils. Unless the main coil circuit is closed through a lamp, obviously there can be no phase difference and therefore no rotation.

At the present time the number of meters in use in this country is somewhere in the neighbourhood of 100,000. Of these about 70 per cent. are quantity meters, 30 per cent. being of the energy type. It is perhaps only natural that the direct-current station engineer should not attach so much importance to the use of an energy meter as the alternating-current engineer, especially when the average voltage kept up does not exceed the declared pressure, and one finds, therefore, that in direct-current stations the quantity meter largely preponderates. In alternating-current stations, some idea of the relative esteem in which the two types of meters are held may be gained from the fact that there are about 25,000 quantity and 20,000 energy meters in use.

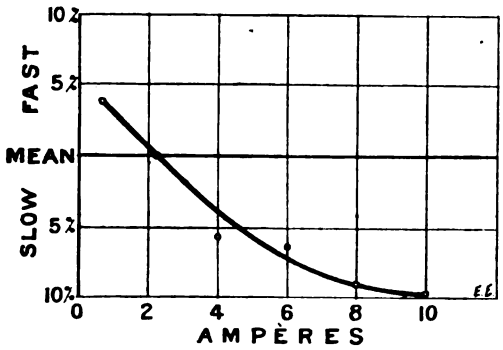

FIG. 1.—Curve of Bad Meter.

A large number of alternating-station engineers have been good enough to favour the author with their views on the question, and from the mass of information so obtained it is clear that there is a preponderance of opinion in this country in favour of the energy type, though in some cases the preference is so far only of the nature of a "pious belief." One engineer is so pleased with his energy meters that "in three weeks we shall not have a quantity meter left in the place." Another writes: "In our opnion all meters should be energy meters." A third naïvely admits—"We prefer the wattmeters because they scrape up most current." Another gentleman writes: "I should always prefer to use wattmeters, more especially in scattered districts where at some points you are supplying at, say, 105 volts, and others at 100 volts." The present writer abstains from giving any clue to the identity of this gentleman, as he might receive attention from the Board of Trade for neglecting to comply with the rules of that Department!

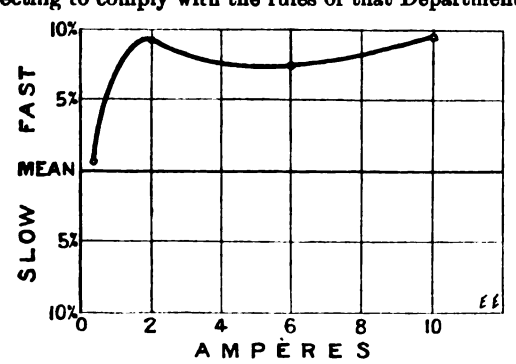

FIG. 2.—Curve of Bad Meter.

The quantity meter has, however, no lack of advocates. One engineer writes: "My experience is that the quantity meter, with all its faults, takes a lot of beating yet." Another writes: "Our quantity meters are very satisfactory, and it is a great consideration having no waste, all-day, shunt current." A third uses quantity meters entirely, on the ground that the losses are so small and that there is so little to get out of order. An interesting suggestion has been made by one prominent engineer, who writes: "For non-inductive loads we prefer the cheapest and simplest meter, assuming the load to be constant, and within the limits of accuracy of either type of meter, and when the range required entails a loss by using a current meter, we compare the loss with the cost of supplying energy for the shunt of a wattmeter and decide accordingly."

The most commercial method of attacking the problem undoubtedly is: which type brings in most net revenue? With the idea of attempting the solution of this question, the author made a number of experiments with a quantity and an energy meter in different premises, under varying conditions, with results as follows:

(1) Installation of about 100 lights, six to ten lights in use the whole 24 hours, 60 to 70 lights in use an average of 12 hours per day. Average voltage 102.

Energy meter	1,445 units.
Quantity	1,375 ,,

(2) Office lighting only; one or two lights in use eight hours per day, eight lights in use two hours per day. Voltage 101.

Energy meter	23 units.
Quantity	18 ,,

(3) Show-window lighting only; 10 lights in use about four hours per day. Voltage 101.

Energy meter	41 units.
Quantity ,,	40 ,,

At the same time the shunt losses to be debited to the energy meters for the periods under test amount to only 2·5, 1·5, and 1·5 units respectively.

Before leaving this subject, a brief description of an energy meter which the author has recently had an opportunity of testing may be of interest. This meter is made by the Westinghouse Company, and measures true watts on alternating circuits

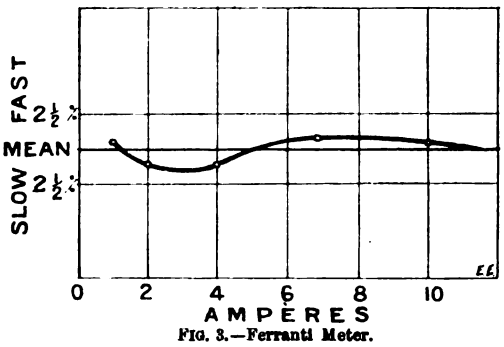

FIG. 3.—Ferranti Meter.

under almost all conditions met with in practice. The meter consists of a rotating disc of aluminium, on the upper side of which is placed the shunt coil. In series with this is an induction coil so adjusted as to produce a field lagging 90deg. behind the impressed E.M.F.; underneath the disc are placed the two main coils. These three coils are so placed that they each generate current in the disc, and the position of the fields produced by them is such that attraction and repulsion occur between them and the currents they generate in the disc. This causes the disc to revolve, and the tendency to revolve is at a maximum when the field produced by the series coils differs 90deg. in phase from that produced by the shunt coil, which is the case when the circuit to be measured is non-inductive. Should there be induction in the circuit, a lag will be produced in the series coils, causing the field produced by them to approach that produced by the shunt coil, which remains 90deg. behind the impressed E.M.F. This being so, the tendency to revolve will be reduced proportionately to the lag, and so on,

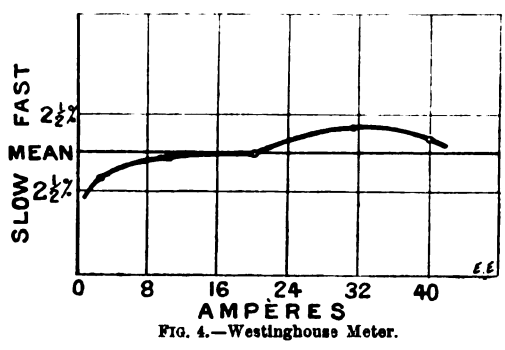

FIG. 4.—Westinghouse Meter.

until a lag of 90deg. is arrived at, when the field produced by the current coincides with that produced by the shunt coil, and the disc will then remain stationary.

The following figures show the performance of the meter under different conditions: 100-ampere capacity. Starts with ·25 ampere. Drop in main coil ·1 volt. Loss in shunt 1·3 watts.

Load.	Non-inductive.	Inductive.
10,000 watts	− 1·41 per cent.	
7,500 ,,	+ ·12 per cent.	
5,000 ,,	+ 1·58 per cent.	
2,500 ,,	+ 2·29 per cent.	
1,000 ,,	+ 1·16 per cent.	
6,656 ,,	Power factor ·84	+ ·33 per cent.
3,861 ,,	,, ·8	− 1·74 per cent.
1,355 ,,	,, ·81	+ ·58 per cent.

Briefly, therefore, the points of this meter are: great accuracy on any alternating circuit; impossibility of reversing due to presence of considerable induction; small losses; strong construction, cast-iron cover, and double sealing arrangement; no moving contacts; shunt running impossible.

(Continued on page 49.)

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MUNICIPAL ELECTRICAL ENGINEERS.

The second convention of this association is now a matter of history. Its meetings are ended, its papers have been read and discussed, its members have visited the various factories and central stations around Manchester, and have participated in those social functions characteristic of such meetings nccessary for the better knowing of one another and the due refreshment of the physical man. A calm and mindful examination of all the phases of the convention lead to one inevitable conclusion—that the meeting was a great success. The instant discussion of presidential addresses is neither customary nor convenient, but subsequently it is permissible to point some of the lessons to be learned from their weighty words. Mr. Wordingham is to be congratulated upon having given a highly thoughtful and instructive address, for having taken a high standard whereby to compare electrical engineers, and in advising his colleagues to aim at nothing below this high standard in their professional career. He hopes much for the future of municipal electrical engineers, as may be seen when he says: "I believe that the future of electrical engineering as a profession depends largely upon municipal engineers"; and a sentence or so further on in the address he says: "In my opinion, the class of consulting engineers will in the future be largely recruited from their ranks." To show that these views coincide with the views long advocated by this journal, we have only to quote a few sentences from a leading article of the date May 3, 1893, on "Municipal Electrical Engineers." We then said: "The future of electrical engineering will be largely in the hands of those who serve municipalities. . . . From their ranks, no doubt, in the long run, will the ranks of consulting engineers be recruited. . . ." In that article we suggested the formation of some such association as has since been formed and has, as we have said, just concluded its second convention. There is no doubt of the correctness of Mr. Wordingham's contention. The *élite* of the working members of all branches of engineering give the principal recruits to the consulting branch of the profession. We shall assume that there is general agreement on this question, and proceed to discuss the actions of the cheap-jack order referred to in the address. During the earlier stages of development of any branch of the engineering profession, a great many men obtain positions of trust and responsibility who would not obtain such positions in later stages of development. While, then, we deplore and regret many of the actions of these men, we do not think it necessary to condemn the whole profession for the peculiar methods of what may be termed the residuum. Playing to the gallery may answer for a while; it will not answer for ever. The getting of bold advertisement in a variety of ways has an immediate but not always a lasting effect. There are proper ways—recognised ways—of getting one's work and abilities known; and the engineer, consulting or otherwise, who goes outside these ways will ere long find his gains in one way more than equalised by

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his losses in other directions. In the olden days, when a man during his apprenticeship gained practical knowledge, and during a pupilage with a consulting engineer widened that knowledge, and had opportunities of applying it practically, he made acquaintances, and at length was entrusted with smaller works on his own responsibility. If he possessed ability he could thus show it, could make more easily, perhaps, than now that first step on his own account that is so difficult to make, and which often kills by lengthy waiting before coming. In the electrical profession there has been no chance of stepping into a business from pupilage, or becoming the partner of a man already in the busy ranks. The consultants have claimed that rank without previous training of the kind described. With the next generation things will be different, and with succeeding generations matters ought to stand very much as with, say, the highest class of consulting engineers in other branches at the present time. We hope to see a rigid code of professional etiquette holding good for electrical engineers as elsewhere, and if broken by individual men to see those men ostracised by their fellows. Mr. Wordingham deserves the thanks of every right-minded professional man for so ably touching this subject. We all know the difficulties of the question, and we all desire to see a higher standard ruling. Time is one of the factors to bring this about; the expressed views of such men as the president of the Association of Municipal Engineers is another; and the latter will considerably shorten the length of the former.

OBITUARY.

We regret to have again to notice a death amongst the staff of Messrs. Siemens Bros. and Co. Last week the firm received word that Mr. C. J. Roberts, one of the leading members of their staff, had died in Jamaica from acute peritonitis. The sudden and wholly unexpected news came as a severe blow to all who knew Mr. Roberts, and a few words as to his past career will not be out of place. After some year or so in a locomotive shop, Mr. Roberts was apprenticed to the firm of Messrs. Maudslay, Son, and Field, hence conforming with the best means of preparing himself for the profession of an electrical engineer. He then joined the firm of Messrs. Siemens Bros. and Co., with whom he has been for over 14 years. In the early days of the industry Mr. Roberts had charge of many important installations of isolated plant, such as that erected for the Earl of Durham at Lambton Castle. He was afterwards selected to go to Panama in 1891 to erect the electric tramway there. Two years in the bad climate of that part of the world, which has claimed many noted engineers as its victims, had its effect on Mr. Roberts, so that even this year he had attacks of ague at times. The tramways at Panama were completed under his supervision, and have since given every satisfaction. Returning to England, Mr. Roberts was placed in the estimating department at Woolwich, of which important branch of the firm he was second in command. He at different times was sent abroad to prepare schemes and to report on the prospects of undertakings submitted to the firm. One notable example was a trip to Spain to get details for a large transmission of power scheme. Finally, Mr. Roberts left England a few weeks ago to represent the firm on important and confidential business in Jamaica, but he only reached that country some four days before he died. Of his professional ability, and the loss the firm has sustained, it is useless to refer after the above *résumé*, but his absolute reliability from a business point of view was supplemented by a courteous bearing which won for him respect and good wishes from all. We are informed that no one on the staff would be missed by his colleagues more than Mr. Roberts, and that there are few but can remember gratefully his kindly help when they entered the works as novices. Hence his loss as a friend of the various members of the staff will be even more felt than his loss as an active member of the firm. We had once an opportunity of publishing an article written by Mr. Roberts which was of a somewhat humorous nature, although showing a grasp of the feelings of the times. It was entitled "Conference of Electrical Units," and is reproduced elsewhere in this issue.

MUNICIPAL ELECTRICAL ASSOCIATION.

(Continued from page 47.)

Testing.—Needless to say, all meters should be tested at the supply works before being sent out to a consumer's premises. That this is necessary is shown by Figs. 1 and 2*, which show the curve of meters as actually received from the makers. As might be expected, the meter, the curve of which is shown in Fig. 1, runs somewhat freely on the shunt. These cases are, of course, very exceptional, and as an antidote Figs. 3, 4, 5, and 6 show the degree of accuracy commonly obtained by the best-known meters at the present time. The works tests should include the following, and a record should be kept of all tests: (1) accuracy at tenth, half, and full load; (2) starting current; (3) running on shunt; (4) running on shunt with slight vibration; (5) running on shunt with slightly increased volts.

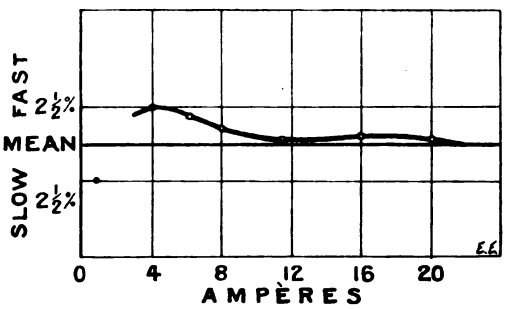

FIG 5.—Hookham Meter, Old Type.

Incidentally, it may be mentioned that where any meters are found running on the shunt, the defect may be often remedied by the simple expedient of fixing the meter about ¼in. out of level. This method has the advantage of not causing any sensible difference in its accuracy. (6) Watts lost in shunt (if any); (7) drop of volts in main coil at full load; (8) insulation of meter. In the case of quantity meters, they may be strung in a series, a large number being thus tested at once.

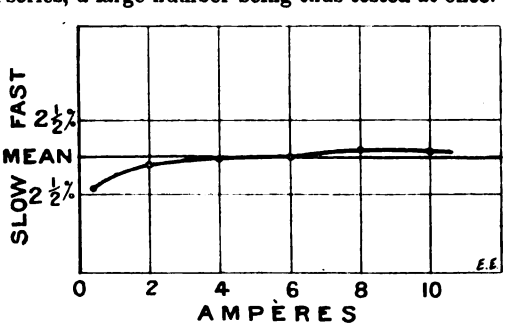

FIG. 6.—Thomson Meter.

In similarly testing energy meters, special precautions must be taken, by running a separate shunt return, back to the source of supply, otherwise two errors creep in—first, at heavy loads the pressure at the terminals of the shunts is less in each successive meter, and, second, the main coils of the meters nearest the source of supply receive more current than those at the lamp end. All meters should be tested, if possible, with the cover in position. Neglect of this may cause a serious error. In conclusion, the author wishes to express his indebtedness to Messrs. Ferranti, British Thomson-Houston, the Westinghouse Company, and Chamberlain and Hookham for the kind assistance they have given him in the preparation of his paper.

DISCUSSION.

The **Chairman** said it was almost impossible to over-rate the importance of the subject of meters, as these determined the

* For Figs. 1 to 4 see page 47.

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amount of revenue to be collected. Everybody must be struck with the extremely small advance that had been made of late years in the construction of meters. They were all looking out for a perfect meter, but it had not appeared yet. It would be remembered that at the last convention Sir Courtenay Boyle said he was anxious to get the experience of engineers on the various meters.

Mr. Gibbings (Bradford) said they almost ought to have the public in to discuss the question of meters, as he found they had a great deal to say about meters as a rule.

Mr. Wilson, in reply to the Chairman's call, thought the tests he made with the Thomson-Houston meter were satisfactory. That was all he had experience of. He might add he was not connected with it in any way now.

Mr. Venner (Messrs. Chamberlain and Hookham) in a similar way had only experience his own firm's meter. He was inclined to imagine that in the table given by the author in one of the papers, showing the shunt loss in the case of the Hookham and Thomson meters, the figures were taken from a number of meters, and in the case of the others from one only, or two, which were probably the best which could be sent out. There was a serious loss which was much neglected—namely, the drop in volts. It would have been interesting to have a similar table showing that meters had not arrived at absolute perfection yet. It must be remembered that the meter was the one part of the electrical plant which was liable to the constant criticism of the consumer. The consumer realised that it touched his pocket, and watched the meter as a cat watches a mousehole.

Mr. A. S. Giles (Blackburn) said an important point was the cost of a meter. The small consumer with four or six lamps would pay £4 or £5 for putting in the service, but when the meter cost £5 more the capital outlay was out of proportion high. He hoped for a time when they would be able to buy electricity meters at somewhere about the cost of gasmeters. Most people when they looked at a meter failed to see where the money went. He believed the fact that there were so few manufacturers had something to do with the high cost, and he was sorry to learn that there was little probability of more manufacturers taking it up. The $C^2 R$ loss was really important, and there was an appreciable drop in some cases across the terminals of the meter. He used the demand indicator, and if there was an 11 watts loss in the meter, with the addition of the drop in the demand indicator, it would be difficult to keep the consumers' pressure within the 2 per cent. limit. He had not been troubled by meters running on the shunt.

Mr. Evershed, as a manufacturer, would like to say a little. Mr. Wilmshurst had said that most engineers overlooked the waste of power in the current coils. It was not serious, because it only occurred when a large amount was being taken. But the drop in volts was very serious; a one-volt drop was quite common upon a continuous-current meter. On one occasion he was asked to construct a voltmeter to read to 2½ volts. This meter his customer put across the terminals of a certain 10 ampere meter, and the indicator went hard over. The customer sent back the instrument as faulty, as everyone does. He (Mr. Evershed) in the extreme case had found a five volts drop. He might remark that drops of that sort the engineer must find out; the makers would not try. He hoped to make a meter some day, and would not himself. He did not see why meters should run upon a shunt. The thing was to get over friction. He hoped before long to see motors from which the starting coil was absent. There was the question whether they should go in for energy meters or quantity meters. A quantity meter was cheap to make for the direct current, and therefore it was desirable for small consumers. A meter which cost a good deal less than £5 was wanted, but where it was to come from he did not know. There would always be a demand from large consumers for meters with a large range, but he thought a cheaper meter could be made, if it was only required to be correct over a small range which the small consumer would not go beyond. In such a case there was no need for the very finest workmanship. The best class of meters were not likely to be much cheaper than now. Workmen were certainly getting more skilled, but the rate of wages was advancing at a pace with which the use of labour-saving appliances could not cope. With the present general type of meter he did not see how it was possible to get down to the 50s. or 40s. that was talked of.

Mr. Talbot found that the Chamberlain and Hookham meter would not work well in a damp place. The Ferranti meter gave them trouble in the way of testing, and they had to return 10 per cent. as inaccurate. He had arranged that the manufacturers paid the freight both ways. He was surprised to hear that the Manchester Corporation did not test meters. [**Mr. Wordingham**: We do, though; we test them all.] The price of meters had come down within the last three years. They could be got for five guineas if ordered in quantity. He was afraid they would never get them for 30s.

Mr. Atkinson (Ferranti) said, as a matter of fact, a very small number of their meters came back, but some of the meters required a small amount of adjustment due to the effects of the railway journey. In supplying to London there was no difficulty. At Manchester they adjusted the meters after they had arrived.

Mr. Tonge (Preston) thought Mr. Talbot had had a very unfortunate experience. He had had every meter tested, and had not sent back 2 per cent. of the Ferranti's. He was in favour of quantity meters rather than wattmeters for direct current.

Mr. Elphinstone agreed with Mr. Evershed as to the price of labour and the small possibility of reducing electricity meters to the price of gasmeters. He would be glad if some of the engineers would tell him the practical points which wanted meeting. He had been unable to avoid seeing at various central stations meters which were obviously unfit for service.

Mr. Quin (Blackpool) said the continuous-current meters in their early days were very bad—in fact, they used to find 30 per cent. of them stopped every week. So he was prepared to maintain against some of the other speakers that there had been considerable advance made in the matter of meters. He had had many of his meters run on the shunt. In one particular type of meter nearly half had done it, and they had had to be removed. A difficulty would arise, and had arisen, when the station pressure was raised from 100 volts to 200 volts. That left them with the 100-volt meters on their hands. It was easy to alter the Thomson-Houston type, but they had a good many Shallenberger quantity meters. The starting current was high, and when the current supplied was halved the difficulty came in and they must lose a good many units in the year. It had been necessary to do what Mr. Evershed had condemned—namely, add a shunt coil. The meter so altered would not start on the shunt whatever you did to it, but would start on an 8 c.p. lamp.

Mr. Andrews (Hastings) had found that there was nothing which caused so much trouble as meters. He had tried quantity meters and energy meters. With the quantity meters, one lost units through it not registering on a light load. The Thomson-Houston was absolutely correct at first, but after a month or two the commutator sparked, and they lost current. The other type would go on any current or no current at all; and instead of losing current, one lost reputation.

Mr. Sutherland, speaking of the meters in London, said that with the Thomson-Houston meters at present the trouble was the commutators sparking. As to running upon shunt as a remedy, the makers recommended screwing up the jewel screw, which simply increased the friction and ought to impair the accuracy. Shallenberger meters were very good meters if they would only start sooner. He thought wattmeters paid for the extra loss by starting quicker. Chamberlain and Hookham meters had given trouble by running upon the shunt, but he believed that had been remedied. One thing he wanted to know was, why should the larger-size meter cost so much more than the smaller one? Apparently the only extra work was a few yards of extra wire, yet the price might be two or three times greater.

Mr. Bastin said in a meter it was not the materials, but the calibration, which cost the money, and the larger the meter the longer the range to calibrate. If meters sufficiently satisfactory for ordinary use could be made upon some simpler plan, there might be some hope of the cost being reduced.

The **Chairman** might mention again that they did test their meters at Manchester. The railway journey did upset the meters, and it was found necessary to allow the Ferranti people to make the final calibration at the Manchester works. This might account for Mr. Talbot's experience. They used at Manchester almost exclusively Ferranti, but had a few Thomson Houston and a few Aron meters. It was desirable, however, for the sake of uniformity to keep to one type, as there was nothing more exasperating than to have to remember which meter was installed on a consumer's premises. So if one got a fairly good type of meter it was best to stick to it. When he recommended the adoption of the Ferranti meter, he was afraid that with the lapse of time the starting current would be found to have increased. He was pleased to find that it was not so, and that the meter was satisfactory in this respect as in others. The meters never failed to start on one 16-c.p lamp, and the mercury seemed to remain perfectly clean for a long time. There was, however, one disadvantage which affected every meter with which there was a permanent magnet magnetised by the current. It might get over-magnetised, and so read too high at low loads. For such purposes he had fallen back on Thomson meters, but there was the tendency to run upon shunt, and they had to be watched. The extraordinary method recommended by the makers for remedying this had been referred to. They had told him to do something similar—namely, tighten the brushes, which was just as bad. In London he had known of an engineer who used to buy the small-size Aron meters and remove one of the coils, and so get large-size Aron meters which were really extremely cheap.

Mr. Wilmshurst, in replying, said the electricity meter had had to suffer for the sins of the gasmeter. To lie like a gasmeter was proverbial, and, as a result, in his town a consumer might speak of his electricity meter as the Ananias in the cellar. There was not much room for improvement in meters from full to half load, but it was needed as to starting and for light loads. He was the engineer referred to by Mr. Evershed who sent the voltmeter back. With the alternating current there was such a drop shown in the main coils that he had thought the voltmeter must be wrong. That particular meter he had left out of his paper, as he had not thoroughly gone into it, and though he thought he had detected the fault, he wished to be quite certain for fear of doing injustice to any maker. He looked upon the use of so-called permanent magnets with very moderate enthusiasm. With certain meters at certain rates there were actions tending to demagnetise the magnet. In the new type of Thomson meter two magnets were only used instead of three, to avoid the effects due to the obliquity of the magnets to the field coils. With the iron covers there might be consequent poles. He would like phosphor bronze, as he thought the zinc cover unmechanical.

Saturday.

On Saturday morning the business meeting of the Municipal Electrical Association was held at the Manchester electricity works. After considering the report of the sub-committees and the secretary's report and

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treasurer's statement, the meeting considered the constitution of the association, and resolved to form a new class, to be called "associate members," consisting of the chief assistant electrical engineers of large stations, such members to have equal rights with full members. The association also resolved to increase the council by adding two members, being chairmen of electric lighting committees. The place of meeting for the next convention was then discussed, and Glasgow was selected. Mr. W. Arnot, of Glasgow, was unanimously elected president. The two retiring members of committee—Mr. H. Faraday Proctor, of Bristol, and Mr. T. P. Wilmshurst, of Halifax—were elected vice-presidents. The following gentlemen were then elected members of the council for the ensuing year: Mr. E. T. Ruthven-Murray, Worcester; Mr. A. Bromley Holmes, Liverpool; Mr. Albert Gay, Islington; Alderman Lloyd Higginbottom, Manchester; Councillor George Pearson, Bristol. Mr. G. H. Cottam, the retiring hon. treasurer, was re-elected, and Mr. A. B. Mountain was also re-elected hon. secretary.

ELECTRICITY IN RAISING OIL.

An account is given in the *Canadian Engineer* of a successful experiment, carried out at Petrolia by Mr. W. H. Ashworth, manager and electrician of the electric light company of that town, in applying electricity to the pumping of oil. Out of the 8,000 oil-wells, which yielded about 800,000 barrels in Canada last year, there are nearly 6,000 in and around Petrolia. One would think that in a town like Petrolia, where they have "oil to burn," so to speak, they would use some kind of crude oil-engine, or at least use oil as fuel for the steam-engines that are required on the fields. But they do neither. They use steam-engines to work the pumps that lift the crude oil, and they use wood and coal for fuel for these engines. The wells are bored in all directions about the town, many of them in the back yards of the owners' houses, so that the visitor on approaching the town sees a forest of derricks, looking like the stumps of trees left after a fire has passed through a green forest. Under each derrick is a well, worked either by a "walking beam" or a "kicker"—that is, two arms joined at right angles, one arm slanting vertically, the other horizontally, the latter having the pump rod attached to its outer end. A group or "batch" of these wells are operated from one engine, rods and scantlings being connected from the engines to the kickers and walking beams. The wells run by one engine are at all kinds of angles to each other, this being easily accomplished by a crude horizontal wheel, making a quarter turn and back, and so pushing and pulling the rods of the pumps on its line. By putting a wheel whenever a well has to be reached at an angle, a dozen or even thirty wells may be reached from a single engine. Mr. Ashworth last year undertook to operate a "batch" of wells from the dynamo in the Petrolia Electric Light Company's power-house, and installed a six-kilowatt 500-volt Canadian General machine in a small building in the field beside one of the old engine-houses. The little shed required for the purpose was only half the size of the steam power-house, and no heavy foundation or boiler setting was required. The machine was placed on a frame consisting of two pieces of 10in. by 10in. timber on each side, one on top of the other, to give a clearance from the ground for the driving gear, which was a set of pulleys belted so as to reduce the motion imparted from a main shaft operating a crank at either end, the two cranks being placed so as to give an alternate motion to the two sets of pump rods. This simple apparatus was attached to 16 very heavy wells known as "water wells," and running at much higher than the usual speed, but they have been run most successfully by electricity ever since. No boy or man is required for firing, and the machine requires no attention after it is started each day. Last year in Ohio or Pennsylvania one or two wells were experimentally operated by electricity, there being a separate dynamo for each well, but this, we believe, is the first case on record when a "batch" of wells has been electrically operated.

VERBAND DEUTSCHER ELEKTROTECHNIKER.

EISENACH MEETING.

(BY OUR SPECIAL CORRESPONDENT.)

(Continued from page 810, Vol. XIX.)

On Saturday, June 12, the business of the Verband was resumed in the "Gewerbehaus" at 10 a.m. The first paper to be read was one by Dr. Ross, of Vienna, on a new type of boiler he had devised. This type combines the Dubiau system, described by Dr. Ross at Munich in 1895 (*Electrical Engineer*, vol. xvi., p. 91), with the water-tube type of boiler. The author showed a drawing of a Babcock-Wilcox boiler with this new attachment. Results were given to show that advantage had been gained by the addition. Dr. Ross explained that by the provision of a few extra tubes the mixture of hot water and steam from the tubes was discharged into the steam space without mixing with the somewhat cooler water in the drum. The arrangement is claimed to give a better circulation in the tube exposed to the hot gases from the furnace, and also drier steam. I hope to give a reproduction of the drawing and some more details of the invention at an early date.

The other two papers were by Mr. C. Arldt and Mr. A. Heyland respectively. The first of the two papers was a description of an ingenious device for transmitting signals to be read somewhat after the manner of the old A B C instrument. The revolving needle is used, but is controlled very differently. The principle of the apparatus is not unlike that of the three-phase motors. Three wires are used, and the current sent by each of the three wires is varied by the position of the dial of the sending apparatus. Three coils at the receiver end are then energised by the current, and produce a resultant magnetic field corresponding to the position of the dial of the sending apparatus. This gives what has long been wanted—*i.e.*, a means of control independent of clockwork synchronising gear, and without the use of many wires. The details are, of course, worthy of further notice, which will follow in due course.

Mr. Heyland's paper was on a new design of single-phase alternate-current motors. The author claimed a larger starting torque for his motor than had been obtained elsewhere. In the discussion which followed this fact was denied by many speakers, and the three-phase supporters waxed eloquent on the slight done to their system. Mr. Heyland had to admit that he was rather unfortunate in his selection of examples of motors with which to compare the results of his own type. One excellent single-phase motor was described, but, unfortunately, it obtained its good character by the use of a commutator when starting. Still, I do not think this to be an insuperable objection, and trust that a motor of the type described will soon be obtainable in England.

The next item of business was to elect certain members of the general council, as a given proportion have to retire annually. This year's president will continue to hold office, as it has been decided to change the holder of this supreme office but once in two years. In this way the fault of turning out a good man just when he begins to thoroughly understand his duties as president is avoided and better organisation is ensured; also the best men in the profession will not be so quickly passed through as presidents. We then adjourned, the business of the meeting being completely finished; and the rest of the time, Saturday afternoon and Sunday, was devoted to pleasure. Thus the members assembled at 3 p.m. on Saturday for a drive through the beautiful environs of Eisenach as a preliminary to a dance in the Tivoli at night. A number of open carriages were provided, and we divided up into parties of four. I had with me Dr. Aron, whose new meter is described in this issue; Dr. Roesler, whose experimental work on the efficiencies of transformers and motors is well known; and Mr. C. H. Biggs, the son of the editor and proprietor of the *Electrical Engineer*. The two nationalities, English and German, being equally represented, our conversation alternated between the two languages. The English idioms and stock phrases interested Dr. Aron very much. The phrase, "Every man for

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himself and the devil take the hindermost," had his special approval as far as veracity was concerned. Talking of his new meter, I was informed that the cost of the experimental department in the meter works has run to five figures in English pounds for several years past. We drove up the Marienthal to the entrance of a certain water-worn gorge. This gradually narrowed till we came to a series of sandstone rocks, through which the path wound. These rocks were often less than 2ft. apart, and fear was expressed lest Mr. Kapp should cause a block. The sides being overgrown with moss and ferns presented a most lovely aspect. Climbing the hill, we again took to our carriage and drove, *vid* a quaint old inn, called Hohe Sone, to a coign of 'vantage amid the forest called Hirschstein. There I found that some glee-singers were present, and, after enjoying the view, we had the benefit of their good singing. We then drove on to Wilhelmsthal, a little village by the side of a beautiful lake. There refreshments were provided, after which we drove home by a less mountainous road, which on approaching Eisenach commanded a fine view of the Wartburg towering over the tree-clad hill. On the way back our two German friends endeavoured to prompt us up in sweet things to repeat to the young ladies at the dance, but we found that the phrases arranged for us were not without deeper meaning than was desirable. The dance in the evening was, of course, very enjoyable. The system of waltzing was on the alternate-current principle. Each pair having completed one cycle by waltzing round and round the room, separated and selected new partners for the next cycle. We finally broke up the party some time after midnight.

THE NEW ARON METER.

The following is a *résumé* of Dr. Aron's paper describing his new meter, which we are able to illustrate from the blocks appearing in the *Elektrotechnische Zeitschrift*. The new instrument (Fig. 1) is essentially of the same principle

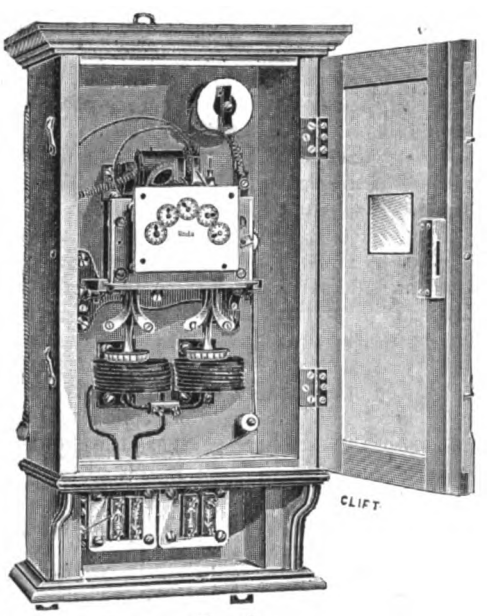

FIG. 1.

as all electricity meters of the Aron type—that is to say, the influence of the current on the swinging pendulum is recorded. For about 12 years these instruments have done good service to the electrical industry, but they had the disadvantage that too much clockwork was used in them and depended on for accuracy. By introducing the differential counter about 10 years ago, Dr. Aron eliminated many of the faults of the clockwork, such as the necessity of comparing the reading of the meter against the standard time. Nevertheless, the meter contained some other disadvantages of the clockwork, which for practical purposes were often rather inconvenient: the clocks had to be wound up periodically, they had to be regulated, the pendulums had to be put in motion to start the clocks. All these disadvantages are now entirely avoided, and in such a degree that the Austrian Board of Trade (Kaiserlich-koenigliche Normal-Aiclungs Commission) has passed this new type and declared these meters to be portable after they had been tested and sealed by the authorities.

The principal difference between the new Aron meter and the old type is, it is wound up electrically, it has very small pendulums, and therefore is portable, without the necessity of clamping the pendulums. It also starts itself when the necessary E.M.F. has been applied to the terminals. It has a synchronising arrangement, and measures correctly even when the two pendulums are not regulated and in absolute synchronism.

Theory.—The short and light pendulums used in this new meter are about 4in. long, and make about 12,000 single oscillations per hour. They are so sensitive under the influence of current that each of them at full load shows a difference of about 2,500 oscillations per hour.

With so large variations of the period of the pendulums the quadratic member of the formula developed in the theory of the instrument is objectionable, and the meter would not record correctly within the whole range.

Thus, if n be the normal number of oscillations, N the varied number, J the intensity of the current, C a constant, then

$$N = n\left(1 + \frac{J}{2C} - \frac{J^2}{8C^2} + \ldots\right)$$

To eliminate the quadratic member both pendulums are influenced in the reverse direction. Then we have the difference,

$$N_1 - N_2 = n\left(1 + \frac{J}{2C} - \frac{J^2}{8C^2}\right) - n\left(1 - \frac{J}{2C} - \frac{J^2}{8C^2}\right)$$

$$N_1 - N_2 = n\frac{J}{C},$$

therefore $N_1 - N_2$ is exactly proportional to J.

As each pendulum goes alternately forward or backward, the quadratic member of the formula is eliminated during the whole period of one reversal. This case is practically in use with three-wire, five-wire, and multiphase current meters, where each pendulum is used for each circuit. With the two-wire meters both pendulums are influenced by the same circuit, and so the sensibility is doubled.

Another advantage obtained by using two pendulums of nearly the same periodicity is this: that the shunt coils of the pendulums being provided with the same number of turns, and receiving the current in the same direction, are astatic against external influences. If any undue influence is being exercised—for instance, by terrestrial magnetism—it will act equally on both clockworks and make both of them equally deviate from the true time. No difference will accordingly be indicated on the differential dial.

Description of the Clockwork.—The movement (Figs. 2, 3, and 4) consists of two clockworks with escapement wheel and pendulum, which are connected to a third wheel train, the differential counter (q_1, v_1, v_2, b_1) giving the difference of their movements. A second stronger-built differential gear serves to transmit the common driving power to both wheel trains in such a manner as to allow to each of the two clockworks motion independent of each other. The motive power of the driving mechanism is transmitted to the axis, R, by a spiral spring in such a manner as to allow it to rotate only in one direction. This spiral spring at the same time serves to drive the clockwork during the small period in which the clock is being wound up.

The vertically-mounted shaft of axis, R, carries the loosely-mounted planet wheel, b_2, which is in gear with the two crown wheels, f_1 and f_2. As soon as the shaft is in rotation, the planet wheel, b_2, will turn and impart motion to the crown wheels, f_1 and f_2. As long as these two crown wheels continue running with equal speed, the planet wheel, b_2, will not turn on its own shaft. Now if the speed is varied, the planet wheel, b_2, will commence rolling along the cylindrical gear of that crown wheel which is running slower than the other. So both crown wheels are at any time under the influence of the same driving power without their various speeds being disturbed.

Each crown wheel is geared with a clock train and escapement, i_1, with two pendulums provided with palettes,

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etc., on levers of the Graham type. In order that the direction of rotation of the two trains may in spite of the

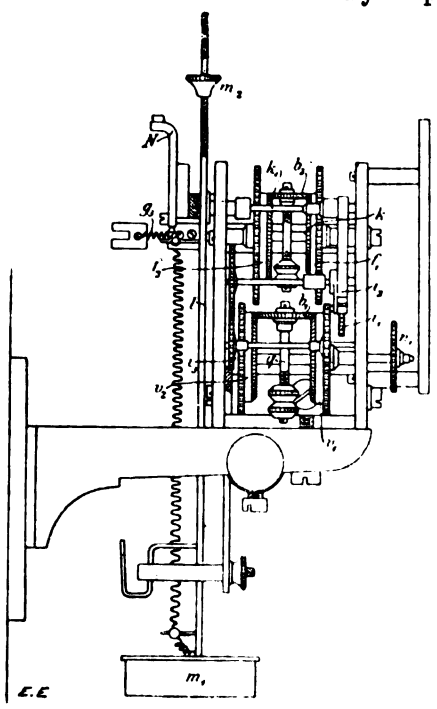

FIG. 2.

common driver be in opposite directions, the right train escapement is connected directly, while the left escapement

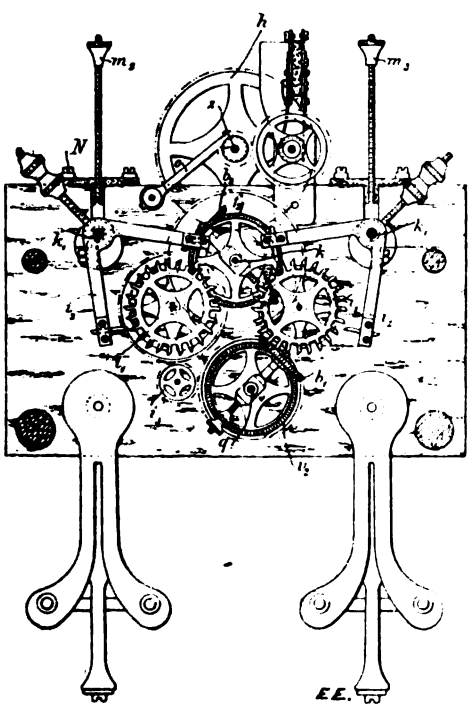

FIG. 3.

is driven through an idle axle, i_3, to change the direction of rotation. The rotation of the axle of the central bevel

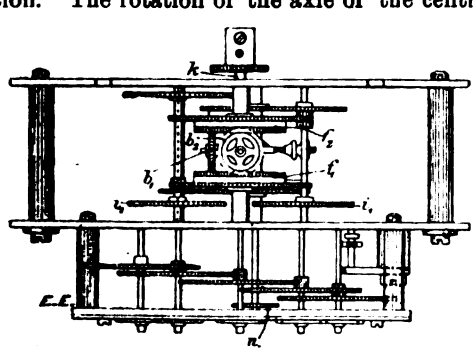

FIG. 4.

wheel, g_3, then gives, as is well known, the difference between the period of the two pendulums. Of the two sets of crown wheels, the axle of the upper sets, k, rotates in proportion to the sum of the oscillations of the two

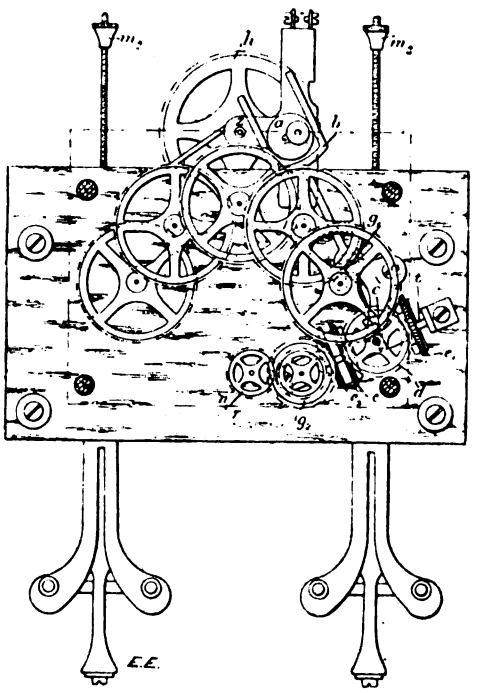

FIG. 5.

pendulums. On the other hand, the axle, g, of the lower set of crown wheels rotates in proportion to the difference of the number of oscillations of each pendulum. The lower axle drives the counting gear. The pendulums are rigidly fixed to the axle, k_1, of the two anchors carrying palettes. The pendulums are each provided with a shunt coil at their lower ends, which act as weights. Two connections to each of these coils are made by two loops of thin insulated copper wire from the contacts, N.

Two regulating weights, m_2, are shown, one on each pendulum, in the illustration (Fig. 3), but a single weight has been found to be sufficient.

Reversing Apparatus.—The next part of the apparatus to be described has for its object the correction of any fault due to small deviation of the natural period of either pendulum. To do this the direction of the shunt current in the pendulum coils is reversed at stated intervals, and at the same time the gear driving the counter is reversed so that the record may be continuous in direction. In this way a fault which is acting in one direction, say, to register too much in the first period, after reversal acts in the opposite direction and registers too little in the second period. The apparatus for effecting this change can be

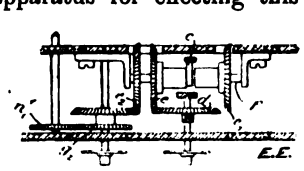

FIG 6.

seen in Figs. 5, 6, 7, and 8. The large wheel, h, is caused to rotate by the clockwork once in about 20 minutes. During its revolution it winds up the spring, l. At the end of the revolution the trigger, n, lifts the lever, v, which

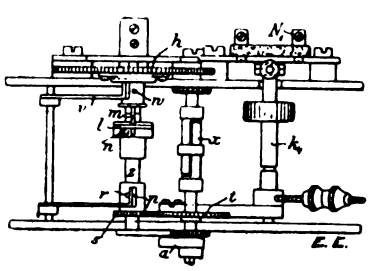

FIG. 7.

is on the same axis as the locking lever, r. This being lifted allows the axis, z, to fly round through 360deg. This axis

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being geared to the commutator, x, moves it round through 180deg., and reverses all the shunt connections. At the same time the eccentric, a, on the end of the commutator

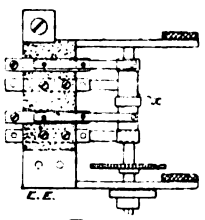

FIG. 8.

axle, acting on the lever, b, reverses the mechanical connection between the differential clockwork and the counting gear. The direction of rotation only is reversed, and this is done by means of the bevel wheels, e_1 e_2, which slide on a sleeve, so that one or other only of the wheels is in gear.

The Winding Gear.—The winding-up gear for the clockwork is shown in Figs. 9 and 10. It consists of a horseshoe magnet, a, with poles shaped so as to permit of the armature revolving within them. In this way a large range of motion can be easily given to the armature. Inside the armature, b, is placed a small watch-spring, g, which is wound up about once every 30 seconds. The arrangement

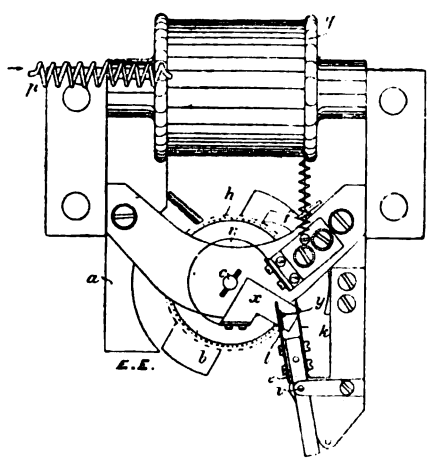

FIG. 9.

of pawls and clicks can be seen from the two illustrations. Attached to the armature is a contact, y, which connected through x by the spring, r, to the shunt coil on the magnet. The contact, y, engages with a little throw-over switch, e, which rotates round an axis, i. The position of this switch is partly controlled by a spiral spring, m, which makes it rest either one side or the other of a given centre line.

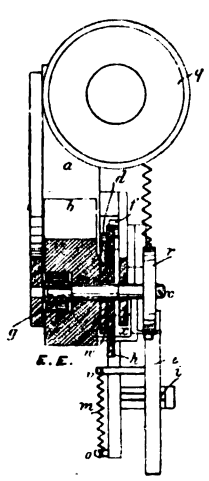

FIG. 10.

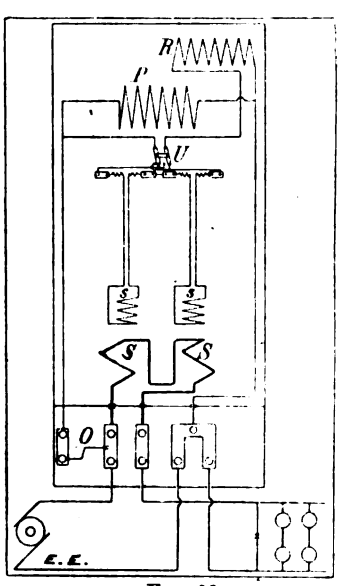

FIG. 11.

When the clock runs down, the armature, b, slowly revolves away from the poles, the contact, y, being against the insulated spring, k. At a certain point the spiral spring, m, gets over the centre and reverses the switch, and contact between y and l is then made. This energises the magnet coils, and the armature again winds up the clock. The contact is a rubbing one, tending to keep clear, and the breaking point is not at the same part where the circuit is made.

The ordinary connections of the meter are shown in Fig. 11, which is for a two-wire system. The two current coils, S S, are connected in series with the lamps to be supplied. The shunt coils, s s, are also in series, and a large external resistance, R, is also placed in this circuit, so that the energy taken by the meter is small. This is from one to two watts, according to the size of the meter. The connection, O, is removed when a number of these meters are to be tested, and the current coils then can all be connected in series and the shunts in parallel.

The meter is equally applicable to direct and alternate current working. The special advantage of the meter for the alternate-current circuit is that it is a wattmeter, and is

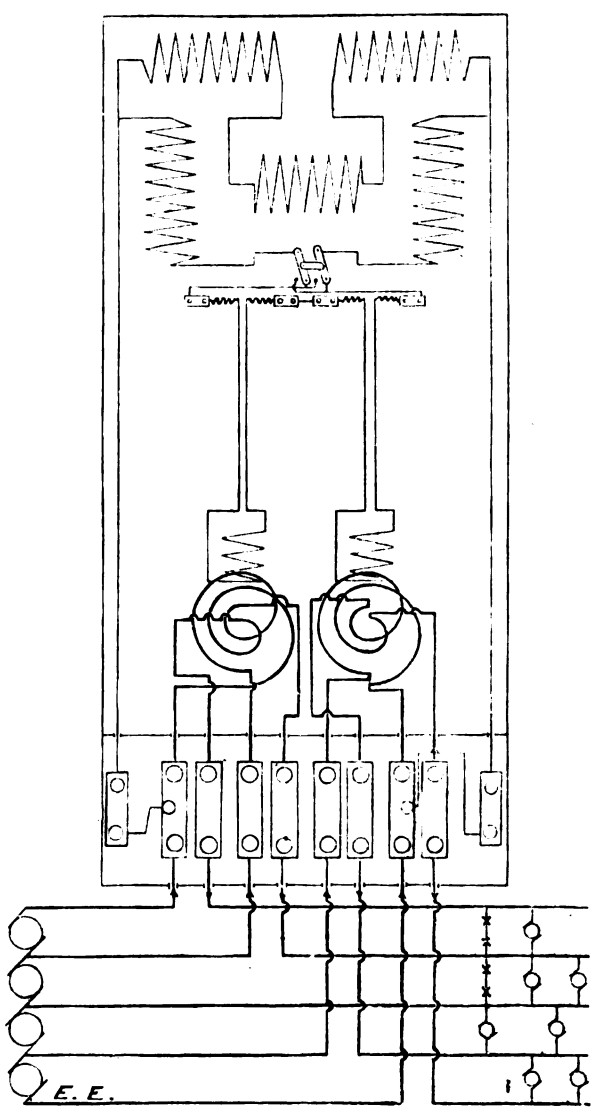

FIG. 12.

independent of the periodicity of the supply, and also of any difference of phase there may be between the current and the E.M.F. In other words, the meter measures true power. The magnet of the winding-up gear requires to be arranged to suit the frequency, but this is without any influence on the measuring parts of the meter. The meter is extremely sensitive, being affected by exceedingly small currents, and measures correctly within the whole range from zero to the full load. The meter has also the advantage over some other types of having no permanent magnets, and is independent of frictional losses such as are found in motor meters. The influence of a change in temperature is also corrected, and is found to be inappreciable. Dr. Aron concluded with saying he thought he had now arrived at the best meter possible employing the clockwork on his old principle, and he hoped it would ensure a permanent position for such meters in the industry.

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Through the kindness of Dr. J. Juttke, who superintends for Dr. Aron the manufacture and supply of these meters in England, we are able to give the diagram (Fig. 12) showing the connection of the meter to a five-wire system. In conclusion, we must say that it seems to us to be a good direct-reading meter, available for use on any system of distribution, and we are glad to note that they are being made in England.

CONFERENCE OF ELECTRICAL UNITS.*

[AUTHORISED ABSTRACT.]

An ordinary meeting of electrical units was held last night in the new extension of the polar area.

The chair was taken at 7.46 by B. A. Volt, Esq., and the proceedings commenced with the singing of a hymn specially composed for the occasion by one of the Watts (D.Sc.):

How doth the little busy volt
Increase the ampere-hours,
By exercising all the day
His mighty storage powers.

How cheerfully he fills each cell,
How neat he spreads the charge,
And labours hard in changing well
Di-oxide to litharge. AMPERE.

The president then opened the meeting in the following speech: "Fellow units and constants,—It is with the most sincere pleasure that I look back on the great progress we have made in the last few years, partly, no doubt, owing to the enthusiasm of our younger members, but chiefly, I think, to the high example of truthfulness and accuracy given us by my honourable friends the *established standards*, whom I now see gathered around me." [The committee was composed chiefly of standards, who were seated round the president in a Gramme ring] After some further remarks, addressed chiefly to the younger members, the right honourable president proceeded: "Before I close this perhaps tedious address, I feel bound to pay a humble tribute of respect to my venerable and esteemed contemporary the Siemens unit, little known, perhaps, to the new generation since he has retired from active service; but let me tell you, gentlemen, that but for him we might still be running along naked conductors in a helpless state of uncontrolled barbarity, scarce knowing whether we were quantities or differences of potential, instead of which we see everywhere, or nearly everywhere" (here the president looked pointedly at some young alternate volts who were sitting in series near the back of the hall), "order and law. I even hear with pleasure to-night that some of our most prominent members have organised a society for the conversion of foot-pounds. The first meeting will be held to-morrow night. Subscriptions are earnestly invited, and I am requested to add that contributions of cast-off insulation or disused lines of force will be thankfully received. I will now detain you no longer, but call upon my honourable friend the Siemens unit for a few remarks, by which all of us are sure to profit."

The Siemens unit, in a voice choked by self-induction, thanked the chairman for his kind references to him, and said: "I am now an old unit who have borne the current and heat of the day (the latter proportional to the square of the former), my insulation is getting thin and grey, and I now look forward to that quiet and peaceful ohm, 'where potentials cease from troubling and the amperes are at rest.' I would erg(e) you, then, to direct your energy along legitimate channels, eschewing the by-paths of modern Ferrantic enthusiasm. I am sure that my old and respected friend the continuous-current dynamo would never have so far lowered his efficiency as to consent to supply current to a tubular conductor for the base and vibrating purposes of high tension and homicidal transformers. I would beg the younger members to take pattern by him, and not to be led astray by the brilliant but erratic results obtained by that erg-destroying invention of the evil one, the alternate-current dynamo. My earnest prayer for each member present is that in times of trial and trouble, when short-circuits and earths gather round your devoted heads, you may be sustained and comforted by self-regulation, and that your observed characteristics may approach nearer and nearer to the ideal which has been plotted for your guidance and direction. I trust that the young alternate volts whom I see around me will forgive me if I have in any way hurt their feelings, but I feel strongly that a volt who has persuaded himself that the path of duty is a sine curve is cherishing a most fatal delusion, which must inevitably lead to the destruction of all that a unit holds dear in this system and in the next."

Here a young volt was led out by an elderly Ruhmkorff coil in a violent fit of hysteresis.

Scarcely had the honourable gentleman tottered to his seat when an alternate volt sprang to his feet and poured out his indignation in a torrent of words: "I wish to speak with the utmost deference of the honourable standard who has just sat down, but I cannot be calm. My potential rises when I think of the insults heaped upon me and my family by an antediluvian unit, however respectable. Why, I say, does he wish to hint that we are upstarts? The first dynamos who ever lived gave alternate currents. The natural condition of a volt is to alternate, and yet we are despised and cried down, simply because we refuse to outrage nature by the artificial aid of a meretricious commutator. There is a violent prejudice against us; coiled resistances refuse us passage; many established instruments decline to measure us; there is even a base conspiracy amongst motors, who have united to lock us out, but I have no fear; Nature will triumph over foolish and malicious oppositions alike, and the glorious time will come at last, when potential will be infinite, conductors attenuated to a geometrical line, and amperes a thing of the past."

The next speaker was the ohm, who said she "could not but deprecate the tone of violent and high-tension personality which had been introduced into the discussion by the last speaker. His accusation was that the ohms were wanting in permittance and conductivity. She ventured to state that it had been demonstrated times without number that their coy resistance could be overcome by the steady attentions of a constant current, but she considered that the fickle and false attentions, or rather persecutions, of an alternating current, whose value at the best was but a mean one, were but justly requited when they met with impedance." The speaker wound up an indignantly eloquent peroration with these noble words: "The manly and respectful attentions of a constant current we will receive with that courtesy which is their due, but the erratic, dishonourable, and dishonouring seductions of a wobbling alternator we will never permit. No, sir, we have too much self-induction."

At this point the proceedings were interrupted by a violent disturbance created by an aged and respectable ohm who, amidst some confusion, screamed out that an ampere was crawling up her. He presently appeared at the top, and was then seen to be in a state of inebriation. The scandalised president just mustered sufficient potential to gasp out an enquiry as to how he got there, to which the ampere coolly replied that a volt had given him a "leg up," and there the matter had to rest; the refractory ampere could by no means be got down, as the back E.M.F. had just left the room.

After this it was found impossible to proceed, as all the ohms were tucking their skirts round their legs and screaming violently. Accordingly the president, after one or two fruitless attempts to restore order, switched out the meeting. U. C.

* Reprinted from the *Electrical Engineer*, April 25, 1890.

JOHANNESBURG ELECTRIC LIGHTING.

The following is an abstract of the report prepared by the engineer of Johannesburg on the electric lighting undertaking of the town during the past year:

"During the year the overhead wires have been increased by about 20 miles (360 poles erected), making the total length of wires at the end of the year about 42 miles. At the end of 1895 the customers of the department numbered

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117. During the year they have been increased by 120, making the number 237 at present. At present about 14,000 lamps, equivalent to 8 c.p. each, are connected with the mains, and about 8,500 are awaiting connection. During the year the public lighting has been increased by 100 incandescent electric lamps, making a total of 123 at present, equal to 300 8-c.p. lamps, and by 21 arc lamps of 2,000 c.p. nominal. The total number of units generated during the year was 400,978, and they were distributed as follows:

Sold to private consumers	282,304
Used for public lighting	12,878
Used at work	22,736
Unaccounted for	83,060
Total	400,978

The average price obtained per unit sold was 1s. 5¾d.

"The following additional plant, etc., has been put down during the year: two 100-h.p. nominal boilers erected with chimney, etc.; five Willans engines and alternators complete, 45 kilowatts capacity each; two direct-driven exciters, with Chandler's engines, being in duplicate; one independent steam-driven condenser and Worthington feed pump; two arc lighting dynamos; one enlargement of switchboard and conduit to arrester-house; one enlargement of arrester-house and about 70 Wurt's patent arresters fixed.

"Plans and specifications were prepared for the following works, which have been completed: new general offices, at a cost of £2,543. 17s. 8d.; new Kaffir compound for 120 boys, at a cost of £554. 3s.; new drying-shed for lime, at a cost of £525."

SOUTHAMPTON ELECTRICITY WORKS.

We give herewith the revenue account, balance-sheet, and statement of electricity generated, sold, etc., from the accounts of the Southampton Corporation for the year ending March 31, 1897, which have just been issued:

REVENUE ACCOUNT.

	£ s. d.	£ s. d.
Coal	638 10 9	
Oil, waste, water, and engine-room stores	75 1 1	
Wages	262 10 3	
Repairs and maintenance—buildings, 19s. 3d.; engines and boilers, £102. 4s. 6d.; other machinery, £5. 9s. 5d.; accumulators, £48. 8s. 5d.	157 1 7	
		1,133 3 8
Wages	102 4 7	
Repairs, maintenance, and renewals of mains	3 5 10	
Repairs, maintenance, and renewals of meters	2 15 3	
Clothing	8 16 6	
		117 2 2
Rents	73 0 3	
Rates and taxes	57 9 3	
		130 9 6
Salaries—Engineers' department	293 13 9	
Accountant and collector	40 8 0	
Commission of collector	14 7 0	
Stationery and printing	59 6 10	
General establishment charges	18 11 8	
Management expenses of Southampton Electric Light and Power Company, Limited	137 10 0	
		563 17 3
Insurances		71 4 2
Bad debt		2 15 9
		2,018 12 6
Amount carried to net revenue account		1,472 9 6
		£3,491 2 0
	£ s. d.	
Sale of current per meter	3,405 6 11	
Sale under contracts	3 12 2	
		3,408 19 1
Rental of meters, £67. 15s. 9d.; sale and repairs of lamps, 9d.; hire of lamps, £1		68 16 6
Rents receivable, £8. 15s.; discount, £4. 10s. 11d.; sale of regulations, 6d.		13 6 5
		£3,491 2 0

GENERAL BALANCE-SHEET.

Liabilities.	£ s. d.
Capital account—amount received	56,064 0 0
Sundry creditors	1,019 16 2
Net revenue account—balance at credit thereof	21 2 5
Sinking fund account	508 12 3
	£57,613 10 10

Assets.	£ s. d.	£ s. d.
Capital account—amount expended		28,424 14 9
Stores on hand at March 31, 1897: coal, £6. 0s. 9d.; oil, waste, etc., £17. 17s. 3d.; general, £11. 12s.		35 10 0
Sundry debtors for current supplied to March 31, 1897		1,135 10 1
Other debtors		179 14 5
Cash—at bank:		
On deposit	£25,000 0 0	
Capital account, £2 920. 14s. 11d.; less revenue account, £84. 18s. 7d.	2,835 16 4	
In hand	2 5 3	
		27,838 1
		£57,613 10 10

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		157,550
Quantity sold	By contract 129; By meter 131,714	131,843
Quantity used on works		3,495
Total quantity accounted for		135,338
Quantity used in distribution and batteries		22,212
Total maximum supply demanded, kilowatts		187

COMPANIES' MEETINGS AND REPORTS.

THOMAS PARKER, LIMITED.

The annual meeting of the shareholders in the above Company, the report of the directors of which appeared in our issue of last week, was held at the works, Wolverhampton, on Tuesday afternoon. Mr. C. T. Mander, chairman of the directors, presided.

The **Chairman** moved the adoption of the report, and stated they were a trading concern, and that they did not want much to go forth to the public except that they were in a prosperous condition. A large sum per annum was being turned over, and it had been found necessary to increase the shopping and tools by 50 per cent. They could have accomplished more work but for the shopping being unfinished and the tools not being in positions as they ought to have been some four or five months ago, due to the congestion of trade. Nevertheless, gradually they were being put in place. They could have paid more than a 7 per cent. dividend, but as they paid only 5 per cent. last year, he thought 7 per cent. was a fair increase; and it was just as well they should increase the dividends gradually rather than pay large dividends one year and have, perhaps, a nasty jar the following year and be obliged to pay a less one. There would be carried forward to next year £1,167 odd. In addition to that they had "knocked off" somewhere about £3,000 in one way or another—patterns, machinery, plant, and other things. The directors considered that an ample sum, and felt fully justified in paying the dividend. The Chairman also added that they had written off the whole of their preliminary expenses.

Mr. Thomas Parker seconded the adoption of the report, and stated that they had as many orders in hand as the whole turnover of last year, and would soon be equipped in order to turn them out in half that time.

The motion was agreed to, and the dividend declared.

Mr. C. T. Mander was re-elected director, and the auditors, Messrs. Allen, Edwards, and Smith, were also re-elected.

The **Chairman** stated that the directors had decided to call up the remaining portion of the shares. When they first started he thought they would do well to leave a certain amount of uncalled capital in hand, which would make their credit better. Since then he had been advised differently, and their credit might be judged by the shares in the market. People did not care to pay above par if there was uncalled capital. Possibly in the course of another year they would have to rearrange their capital so as to deal with the orders coming in.

A vote of thanks to the chairman concluded the proceedings.

UNITED RIVER PLATE TELEPHONE COMPANY, LIMITED.

The ordinary general meeting was held on Tuesday at Winchester House, Mr. J. Irving Courtenay presiding.

In moving the adoption of the report, the **Chairman** reminded them that two years ago, after a considerable interval, during which no distribution was made to the shareholders, they paid 3 per cent., last year they paid 4 per cent., and this year they had the satisfaction of recommending 5 per cent. Whatever might be the fluctuations in other business in the Argentine Republic, they had themselves to record a steady all-round improvement in their telephone business. The gross receipts were £60,325, as against £48,744 in the previous year, and after deducting the working expenses—£30,294—debenture interest, etc., they had a net

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balance of £20,552, making an available balance, with the amount brought forward, of £25,076. After paying the dividend proposed £7,576 would remain to carry forward. The reduction in the gold premium to an average of 192, as against 235 of last year, although increasing the sterling value of wages paid, had also substantially increased the sterling value of their receipts and of their profits. Storms had been frequent, and much damage had been done to properties. On account of their claim against the Municipality of Buenos Ayres for the return of taxes they had received since the closing of the books to the period under review 110,000dol. in 6 per cent. municipal bonds. There had been some exceptionally heavy work in connection with the Buenos Ayres plant. A number of important changes and improvements had been made, involving much trouble and anxiety, but the results of the work had given great satisfaction. During the year negotiations were pending for the acquisition of a permanent central office site, and the negotiations had resulted in their acquiring a valuable and centrally located site, with frontages upon the Avenida de Mayo and the Calle Rivadavia, They had every reason to believe that in due time they would possess a building thoroughly adapted to permanent requirements and with an increasing value as an investment. The Province of Buenos Ayres Telephone Company, in which they were largely interested, continued to progress gradually and surely. Taking a general survey of the position of the Company, they would agree that, on the whole, the past year had been marked by an evident improvement throughout; and as to the current year, although certain portions of the Argentine Republic might suffer from a variety of causes, there seemed no reason why the business of the Company should not continue to improve.

Mr. Frederick Green seconded the motion, which was carried unanimously.

ELECTRIC AND GENERAL INVESTMENT COMPANY, LIMITED.

The eighth ordinary general meeting was held on Friday at Winchester House.

Mr. George Herring, who presided, in calling attention to the principal items in the accounts, stated that the investments were taken at cost price, as usual, the directors believing that this was a better way of dealing with them than to value them at the end of each year. If there were any loss they would provide for it in another shape, but they found that this was the best manner of keeping the investments, which he might state were well worth the money appearing against them in the balance-sheet. He did not think any shareholder could be dissatisfied with the profit and loss account, for to make a gross profit of £15,000—reduced by the general charges to £13,000—on a paid-up capital of £20,000 must be considered very good. They had carried to contingencies fund £5,000, and they distributed in dividends £8,000. When provision was made for contingencies it was generally thought that it was done in anticipation of some probable loss, but that was not so in the case of this Company. Theirs was not a regular business. They might have some good business offered to them this year or they might not, and as they paid the handsome dividend of 25 per cent. they thought they were justified in placing a certain amount to contingencies fund, so that their dividend next year might not fall from 25 per cent. to nothing. They were now in receipt from various sources of sufficient money to pay their outgoings, but if they undertook no new business next year there would be no dividend. He hoped they would therefore understand that the transfer made to the contingencies fund had been taken solely in the interest of the shareholders. He then referred to the action taken by the Company in connection with the placing of the City of London Electric Lighting Company, the County of London and Brush Provincial Company, and the Pioneer British Electric Traction Company, and to the assistance which they had rendered to the Electric Construction Company, and said he thought that the public were all very much richer for the Company's action, while they had contributed a great impulse to the electrical industry. He concluded by moving the adoption of the report.

This was seconded by **Mr. J. B. Braithwaite, jun.**, and carried.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Paris.—The French Telegraphic Authorities will receive tenders at Paris, Rue de Grenelle, 103, on July 13 for 755 kilometres of paper-insulated cable.

Madrid.—The Spanish Government Post and Telegraph Departmental Authorities will receive tenders at Madrid on July 12 for 20,000 battery zincs for telegraph work.

Herve (Belgium).—Offers will be received up to October 1 by the Municipal Authorities of Hervé, in the Province of Liège, for an installation of town lighting. No information is given as to the system (electrical or otherwise) which would be preferred.

Wigan.—The Gas and Electric Lighting Committee require tenders for the supply of gas coal. Particulars and form of tender may be obtained on application to Mr. Jos. Timmins, engineer. Tenders, sealed and endorsed "Tenders for Coal," to be delivered to Mr. J. J. Charnock, town clerk, Town Hall, on or before 20th inst.

Madrid.—Tenders will be received by the Spanish Government for the supply of 14 tons of sulphate of copper for the Spanish telegraphs. Delivery at Bilbao or Huelva. Tenders, on stamped paper, and with a security of 10 per cent., and particulars on application to the Direccion-General de Cerros y Telegrafos, Madrid.

Huddersfield. — The Electric Lighting Committee of the Huddersfield Corporation have for disposal a 100-h.p. compound vertical Brush engine and a 50-unit Mordey alternator (2,000 volts 25 amperes). Sealed tenders, endorsed "Tender for Purchase of Plant," must be delivered free of charge, addressed in the handwriting of the tenderer or his agent, to the Town Clerk, Town Hall, Huddersfield not later than July 14.

Halifax.—Tenders are required by the Tramways Committee of the Corporation for the supply of 91 side and centre poles for electric wires. Plans and specifications may be seen, and forms of tender obtained, on application to Mr. Edward R. S. Escott, C.E., borough engineer, Town Hall, Halifax. Tenders, endorsed "Tender for Tramway Poles," must be sent to Mr. Keighley Walton, town clerk, on or before 14th inst.

Dundee.—The Gas Commissioners require tenders for a supply of small coal for electrical purposes, in quantities as required, up to April 30, 1898, also for supplies of copper strip. Specifications and forms of tender may be had on application to the Electrical Engineer, Electric Light Station, Dudhope-crescent-road, Dundee. Tenders to be lodged with Mr. Thos. Thornton, clerk of the Commissioners, City Chambers, Dundee, by 13th inst.

Jassy (Roumania).—Tenders will be received on September 6-18 at 4 p.m., in the hall of the Communal Council of the Mairie of the Commune of Jassy, for the concession for a term of 40 years of the contract for gas or electric lighting, or gas and electric lighting, of the public thoroughfares and communal buildings. Every applicant, before being entitled to tender, will be required to deposit a provisional security of 70,000fr. in cash or Roumanian public bonds. All tenders must be sealed and lodged at the Mairie by the day and hour named. Conditions of tender and specification respecting this concession will be forwarded on application to Mr. C. Gall, secretary.

Egypt.—The Secretary of State for Foreign Affairs has received a despatch from her Majesty's Agent and Consul-General at Cairo, drawing attention to a notice published in the *Official Journal* of the Egyptian Government of 23rd ult., in which it is stated that tenders are invited by the Egyptian Government for Welsh coal for the use of the Administration of Railways and the Port of Alexandria. Tenders should be sent under cover by registered post, and should reach the President of the Administrative Council by October 15 next. Such further particulars as have been received may be seen at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 6 p.m.

Birkenhead.—Tenders are invited by the Corporation for the wiring and lighting by electricity of Woodside Ferry. Plans can be seen, and a copy of the general conditions and specification with form of tender obtained, on payment of the sum of £1. 1s. (to be returned on receipt by the Corporation of a bona fide tender), at the Town Clerk's Office, Town Hall, Birkenhead, or at the office of Mr. James N. Shoolbred, M.I.C.E., 47, Victoria-street, London, S W. Tenders, which must be on the prescribed form, sealed and endorsed "Tender for Electrical Wiring and Lighting of Woodside Ferry," must reach Mr. Alfred Gill, town clerk, Town Hall, Birkenhead, by 12 noon on 20th inst.

Jassy (Roumania).—Tenders will be received on and after September 6-18 at 3 p.m., in the hall of the Communal Council of the Mairie of the Commune of Jassy, for the concession for a term of 40 years of a line of tramways to serve the Commune of Jassy, the said concession to include the construction, maintenance, and working of the line. Every applicant, before being entitled to tender, will be required to deposit a provisional security of 50,000fr. in cash or Roumanian public bonds. All tenders must be sealed and lodged at the Mairie until the day and hour above named. Conditions of tender and specification respecting this concession will be forwarded on application. Tenders will be subject to articles 68-79 of the Public Accounts Act. Mr. C. Gall, secretary.

Sofia (Bulgaria).—The Municipality of Sofia will receive offers up to September 22 for the concession of the public and private lighting of the city, for power, and also for electric tramways. The duration of the concession is for 50 years. Such further information as has reached this country can be seen at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 6 p.m., and particulars, in French or Bulgarian, can be obtained for 5f. from the Mairie at Sofia. The mayor is Mr. D. M. Yablanski, and the engineer Mr. Chr. Taneff. NOTE.—In accordance with a custom prevalent in the Balkan States, when the tenders have been opened, it will be admissible for anyone to underbid the lowest one up to October 2. In the language of the notice, "tenders will be received for either or both of the undertakings at the offices of the Municipality of Sofia up to September 22 next, and will then be examined, but a final adjudication will be held on October 2, if in the interval a reduction of 5 per cent. is offered on the tenders containing the most favourable terms."

St. Helens (Lancs.).—The Electric Lighting Committee of the Corporation are prepared to receive tenders for the supply and erection of the following plant for the extension of the municipal electricity works: (Section A) boiler-house plant—Lancashire boiler and fittings, forced-draught apparatus, feed pump, economiser, etc.; (B) engine-house plant—steam alternator and exciter, etc., steam exhaust, feed, blow-off, and sundry pipes, valves, etc.;

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(C) switchboard and instruments; (D) underground work—culverts and cables; (E) transformer sub-stations. Tenderers are at liberty to tender for any section or sections, or for the whole of the sections, but not for part of a section. The plans of plant and specification, with terms and conditions of tender and contract, may be obtained at the office of Mr. Robert Hammond, M.I.E.E., consulting engineer to the Corporation, Ormond House, Great Trinity-lane, London, E.C., on payment of £2. 2s. for each copy, which sum will be refunded on the return of the specification, fiilled up with a bona fide tender. Tenders (sealed, and marked "Tender for Electric Lighting") must be addressed to Mr. W. J. Jeeves, town clerk, Town Hall, St. Helens, and delivered by July 20.

Lincoln.—The Corporation require tenders for the supply, delivery, and erection, according to specifications, of the following plant: (Section A) two dry-back marine-type boilers; (B) high-speed engines, continuous-current dynamos, steam and other pipes, pumps, motors, and travelling crane; (C) a fuel economiser; (D) storage batteries; (E) a main switchboard and instruments; (F) armoured concentric and triple-concentric cables, and pilot wire cables. Specifications, general conditions of contract, and plans for all or any of above sections may be obtained at the office of Mr. C. S. Vesey Brown, city electrical engineer, Corporation Offices, Silver-street, Lincoln, on payment of a deposit of £1. 1s. for each section; the deposit will be refunded on the return of the specification, etc., with a bona fide tender. If a tender is accepted, such acceptance will be subject to the sanction of the Local Government Board being obtained to the borrowing by the Corporation of the moneys required for the carrying out of the works comprised in the above contracts. Sealed tenders, addressed to the Electric Lighting Committee of the Lincoln Corporation, endorsed with the words "Tender for Section A, B, C, D, E, or F (as the case may be) Electricity Works," must be delivered to the office of Mr. H. K. Hebb, deputy town clerk, St. Peter's Churchyard, Silver-street, Lincoln, by noon on July 14.

RESULTS OF TENDERS.

Ponders End.—The following tender has been accepted for supplying and erecting iron buildings for the Edison and Swan United Electric Light Company, Limited: Humphreys, Limited, Knightsbridge, London, S.W., £475.

Aberdeen.—At a meeting of the Gas and Electric Lighting Committee the furnishing of the new offices at the electric station was under consideration. It was agreed to accept the offer of Mr. Joseph Ellicock, Aberdeen, amounting to £168. 4s.—£91. 14s. 9d. for the gasworks office, and £76. 9s. 3d. for the electric station.

BUSINESS NOTES.

Electric Construction Company.—The transfer books for the ordinary and preference shares will be closed as from July 8 to 22 inclusive.

Edison and Swan Company.—We are authoritatively informed that the £90,000 4 per cent. debenture stock just offered has been fully subscribed.

City of London Electric Lighting Company.—The warrants for interest due on June 30 on the £400,000 5 per cent. debenture stock have been duly posted.

Portsmouth.—The new electric shop in the dockyard was opened for work on Monday, but all the plant will not be in position until about the end of the week.

North British Electricity Supply Company, Limited.—This Company has been registered, with offices at 82, West Nile-street, Glasgow. The capital is £1,000 in £1 shares.

City and South London Railway.—The returns for the week ended July 4 were £1,031 compared with £881 for the corresponding period of last year, being an increase of £150.

Colne.—The Town Council have resolved to strongly oppose the application to Parliament of the Electric Supply Corporation, Limited, London, for statutory powers in the borough of Colne.

Mile End.—The Guardians have affixed their seal to a contract with the Thames Ironworks Company, Limited, for the provision of electric lighting plant, etc., on the Guardians' premises, Bancroft-road.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended July 4 amounted to £1,416, as compared with £1,286 in the corresponding week of the previous year, being an increase of £130.

Western and Brazilian Telegraph Company.—The traffic receipts for the week ending July 2, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, were £2,013.

London, E.—The St. George's (East) Vestry have received notice from the County of London and Brush Electric Lighting Company of their intention to apply next session for a provisional order to light the district by electricity.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended July 2 were £2,461. 3s. 9d., compared with £2,403. 6s. for the corresponding period of last year, being an increase of £57. 17s. 9d.

Eastbourne.—The Eastbourne Electric Light Company, Limited, have received permission from the Town Council to extend the mains in Granville-road and Chesterfield-road and Devonshire-place, subject to the roadways and footpaths being properly restored.

Penarth Electric Lighting Company, Limited.—This Company has been registered, with a capital of £2,000 in £1 shares, to carry on the business of electricians, engineers, suppliers of electricity, and the general business of an electric lighting company.

Erratum.—Messrs. A. and S. Barker write us as follows: "Our attention having been called to an article in your issue of June 4, under the heading of 'Corporation Enterprise,' we notice you call the gas-engine Cripto. It should be 'Crypto' dynamo and 'B' gas-engine."

Dissolution of Partnership.—Mr. Alfred Bottomley informs us that the partnership between Messrs. Swete and Baker, electrical engineers, of Johannesburg, has been dissolved by mutual consent, and that the business will be carried on by Mr. Basil Baker at the same address.

Machine Belting.—Messrs. J. and A. Hillman, manufacturers of stretched leather machine belting, etc., of Dudley, inform us that they have made arrangements with Messrs. J. C. Mackinlay and Co., 27, Walbrook, E.C., to represent them as their sole London agents.

Safety Motor Syndicate, Limited.—This Company has been registered, with a capital of £1,500 in £1 shares, to manufacture, sell, and deal in motors, steam, oil, gas, water, air, electrical, and other engines, dynamos, and machines. Registered office: 49A, Lincoln's-inn-fields, W.C.

The Blackwall Tunnel.—At the London County Council meeting, Mr. Bull (chairman of the Bridges Committee) said, in answer to questions, that the committee had carefully considered the question of the lighting of Blackwall Tunnel, and had decided to use only electric light.

Enfield.—The Urban District Council have informed the Imperial Electric Light and Power Company that before they can consent to their proposed application for a provisional order to light Enfield by electricity they must be informed as to the details of the company's proposals.

Worthing.—The Electric Light Committee recommended the Council to make application to the Board of Trade for an extension of the time within which certain works are to be constructed under the electric light provisional order. The Town Council have adopted the recommendation.

Ryde Electric Light and Power Company, Limited.—This Company has been registered, with a capital of £10,000 in £5 shares, to carry on the business of electrical engineers, electricians, practical engineers and contractors, electrical apparatus manufacturers, and suppliers of electricity.

The Fire at Harris's Timber Mills.—Messrs. J. F. and G. Harris write to inform us that the fire which occurred at their mills last Friday morning has destroyed a portion only of their machinery and buildings, and has in no way interfered with the stock. The business will be carried on as usual.

Phaeton Electrical Company, Limited.—This Company has been registered, with a capital of £1,000 in £5 shares, to act as agent for the United Kingdom of the Electriciteits Maatschappij Phaeton, of Nijmegen, Holland, and to manufacture, sell, and deal in lamps, bells, and other apparatus.

The Demand Indicator.—The County of London and Brush Provincial Electric Lighting Company announce that they have adopted the demand indicator system of charging for energy, and that a reduced scale of prices has come into effect, particulars of which may be obtained at the company's office.

Aberdeen.—At a meeting of the Gas and Electricity Committee leave was granted to the electrical engineer to draw up specifications and schedules for the lighting of the new police workshops with electricity. The meeting approved of the action taken by the engineer in connection with the regulations for electric wiring.

Darlington.—At the Town Council meeting, the Gasworks Committee reported that an enquiry from Crompton and Co., Limited, with reference to allowing them to have the power to work the provisional order, now the property of the Corporation, within the borough for the supply of electricity, had been considered and adjourned.

Edisonia, Limited.—This Company has been registered, with a capital of £40,000 in £5 shares (4,000 preference), to acquire the license granted to J. E. Hough, by the Edison-Bell Phonograph Corporation, Limited, and to manufacture, sell, and deal in phonographs, graphophones, cylinders, Röntgen machines, and other instruments.

O'Brien-Lennard Electrical Installation Company, Limited.—This Company has been registered, with a capital of £5,000 in £1 shares, to acquire the business carried on by the Electrical Installation Company, Limited, and that carried on as late Russell and Lennard, and to carry on the business of electrical, mechanical, and hydraulic engineers.

Llandaff.—At the meeting of the Rural District Council, notice by Messrs. Downing and Handcock was received that it was the intention of the Penarth Electric Lighting Company to apply for a provisional order on or before December 21 to supply electricity to Llandaff, Llanishen, and Lisvane. A committee was appointed to go into the matter and report at the next meeting.

Ramsgate.—At the meeting of the Corporation, the Mayor enquired if anything further had been done in regard to the electric railway scheme. The Town Clerk said he had sent a copy of the resolution passed at the last Council meeting to the Secretary of the Light Railway Commission and they had acknowledged the receipt. He had not seen the promoters or anyone else since.

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Melton Mowbray.—A letter was read at the District Council meeting from Mr. W. H. Julian, on behalf of the Melton Mowbray Electric Lighting Company, expressing their intention to apply for a provisional order for supplying the town with electric light. A similar application was received from the Melton Gas, Coke, and Lighting Company, and the matter was referred to a committee of the whole Council.

Blackburn.—The plans of loops and passing places required in connection with the new electric traction scheme were approved at the Town Council meeting, subject to the tramway company agreeing with the Corporation as to the cost of alterations of certain levels. A resolution was passed authorising the borrowing of £14,000 for electric lighting purposes at from 2½ to 3 per cent. interest per annum.

Ilfracombe.—At the Town Council meeting an application was received from the Imperial Electric Light and Power Company for the sanction of the Council to a provisional order for supplying electricity at Ilfracombe. Mr. Kelly thought that if the Council did not intend to provide the electric light, they should not prevent a company coming in. He moved that the consent be given, but the motion was rejected.

Darlaston.—At the Urban District Council meeting, letters were received from the Midland Electric and Power Distribution Company, Limited, and the South Staffordshire Blast Furnaces Power Syndicate, giving notice of their intention to apply for powers to supply electricity for public and private purposes within the limits of the Council's district. The matter was referred to the General Purposes Committee.

Great Fire in Hamburg.—A great fire occurred last week at the electric works, the damage done being enormous. Owing to the numerous steam hoses which were brought to bear on the burning building, the fire was brought under control before it could spread to the adjacent houses. The valuable electric machinery, however, was completely destroyed by fire and sulphuric acid. No loss of life is announced.

Blackpool.—The electric lighting of the Winter Gardens is proving very successful. The whole of the installation has been carried out by Messrs. Veritys, Limited, from their Manchester offices, 29. Princess-street, under the personal supervision of Mr. Charles S. Northcote, the company's manager for Manchester and the North of England. The Winter Gardens Company have appointed Mr. A. R. Sillar to be their resident electrical engineer.

Marylebone Electric Supply Company, Limited. — This Company has been registered, with a capital of £100,000 in £5 shares, to carry on business as electrical engineers and contractors, suppliers of electricity, manufacturers of electrical apparatus, etc., and to buy, manufacture, and turn to account plant, machinery, and products capable of being used in connection with the operations of ore required by workmen or others employed by the Company.

Lewisham.—At a meeting of the District Board letters were read from the County of London and Brush Provincial Electric Light Company and the Great Western Electric Light and Power Company, giving notice of their intention to apply for provisional orders to supply electric lighting in the district. The Chairman said the Board must do all it could to protect its rights in those matters, and the letters were referred to the Works Committee.

Presentation.—We recently announced the retirement of Mr. W. Geipel from his position as superintending engineer to the Brush Electrical Engineering Company. On the 30th ult. a number of his colleagues and associates presented him with two handsome clocks, accompanied by a cordial expression of the good feeling and respect which he has inspired among his co-workers during his long term of service, in various responsible positions, with the Brush Company.

Wolverhampton.—A further meeting has been held for the purpose of organising the workers of both sexes engaged in the electrical trades of Wolverhampton. During the week the local officers of the Electrical Trades Union had the assistance of Mr. F. G. Lewis (general secretary) and Miss Marian Barry (organiser Womens' Trade Union League), and conferences had been held with special reference to the introduction of women workers into branches of the electrical industry.

Cheltenham.—At the Town Council meeting a letter was read from Mr. W. H. Wray, on behalf of the Cheltenham branch of the Amalgamated Society of House Decorators and Painters, calling attention to the fact that the contractor for the painting of the electric light standards in the Promenade was not paying the standard rate of wages. It was resolved to send a copy of the letter to the contractor, with a request that he will inform the Lighting Committee if he has any explanation to offer.

Personal.—Mr. H. J. Spencer informs us that he has resigned his appointment as engineer-in-charge to the Council of Leyton, and has rejoined the staff of Mr. Warden-Stevens, consulting engineer, Victoria-street, Westminster (whom he was with before taking up his position at Leyton). Mr. Warden-Stevens has some important work coming on hand in Australia, and Mr. Spencer has had considerable experience in electric lighting matters there, having been in charge of the works at Redfern and Perth, etc.

Wednesbury.—It was reported at the Town Council meeting that notices had been received from the Midland Electric Corporation for Power Distribution, Limited, and the South Staffordshire Blast Furnaces Powers Syndicate of their intention to apply for powers to supply electricity in the town. It was also reported that the Board of Trade had given the South Staffordshire Tramways Company a further extension of time for the use of steam trams from June 25 last. The communications were referred to committees.

The Fatal Accident at Bournemouth.—An inquest has been held with respect to the death of Joseph Morris, a labourer, who was employed drilling holes in iron columns at the Bournemouth Electric Supply Company's works, when, accidentally leaning his head against a synchronising switch, he received a 2,000-volt current through his body. His head was badly burnt, and death was instantaneous. The jury returned a verdict of "Accidental death," but considered that the current should be turned off when the men were working under such circumstances, or the switches covered.

Copper.—The consumption of copper was well maintained in June, the deliveries amounting to 19,031 tons, or 1,051 tons in excess of the supplies; so that the visible stock has fallen to that extent. The arrivals were 1,360 tons less than in May, the decrease in the North American supplies being 954 tons; but there is still ample room for further diminution in the quantities of copper dumped on this market by the United States. Though the statistical position is not quite so favourable as in the middle of June, the price has recovered from the decline of the earlier part of the month, and now stands virtually as it did at the close of May.

Cardiff.—The *Western Mail* says: "Since the Cardiff Market has been fixed up with electric light the cost of lighting has increased enormously, and the matter came up for consideration before the Property and Markets Committee on Wednesday. In 1894, when gas was the only illuminant, the lighting expenses for the year were £206 13s. 2d., but in 1896, when electricity was tried, the cost jumped up to £491. 6s. 1d. for the electric light, with £68. 0s. 7d. extra for gas—a total increase of £357. 13s. 6d. Of course, the electric light did not prove altogether satisfactory at the start, and frequent tests had to be made in the daytime, but the difference in the prices is surprisingly large."

Rochdale.—On the minutes of the Gas Committee, at the Town Council meeting, Councillor Cryer asked what progress was being made with the electric lighting scheme. Alderman Petrie replied that the committee were making what progress they could under the circumstances. At present they were treading along the sinuous path which was mapped out for them by Act of Parliament. They could not make rapid progress, as a certain amount of time had to be taken up with preliminaries. When they got the provisional order they would be free from the fetters of red-tape, and would be able to advance rapidly along the path of progress, as this committee was always known to do.

London Provincial Electrical Company, Limited.—This Company has been registered, with a capital of £60,000 in £1 shares, to adopt and carry into effect an agreement for the purchase of the business, property, and liabilities of Messrs. W. R. Ridings, L. B. Codd, and Thomas Evans (trading as Ridings, Codd, and Co.), of Birmingham, electrical engineers, contractors, etc., to develop and extend the same, and to carry on business as manufacturers of and dealers in arc lamps, or any part or parts thereof, as wire-drawers, metal tube manufacturers, ironfounders, metallurgists, electricians, and producers of metals and alloys of all descriptions in crude or manufactured forms, etc.

Bexhill.—At the Urban District Council meeting Mr. Young wanted to know when the Council might expect to receive a report from the Electric Lighting Committee, and proceeded to discuss the matter, but Earl De la Warr reminded him that there was no motion before the meeting, and that it was out of order. Mr. Young said he objected to things being done *in camera*. Earl De la Warr: I can't allow you to discuss the matter now. Mr. Young: I know your lordship's weakness for electricity, which I have not. It's all very well to run into £2,000 preliminaries, but I want to know what is being done. Earl De la Warr: Very well; you must have a motion. Mr. Young then gave notice of motion.

Rotherham.—At a meeting of the Gas Committee a letter was read from Messrs. Crompton and Co., Limited, of London, stating that they proposed to apply for a provisional order for an electric lighting supply for the town of Rotherham, and asked whether the Council would favourably receive this action on their part. The committee recommend that the town clerk inform Messrs. Crompton and Co. that the Corporation have taken up the question of electric lighting, and will therefore oppose the proposed application. The committee recommend that the town clerk take immediate steps to obtain a provisional order for the Corporation to supply electric light for public and private purposes within the borough. This has been adopted by the Town Council.

Midland Electric Corporation for Power Distribution, Limited.—This Company has been registered, with a capital of £200,000 in £5 shares, to carry on in the United Kingdom and elsewhere the business of an electric light and power company in all its branches; to construct, lay down, establish, fix, and carry out all necessary buildings, works, machinery, mains, cables, wires, lines, accumulators, lamps, and appliances, and to generate, accumulate, and supply electricity, whether for public or private purposes; to acquire or construct, and equip, work, and manage railways and tramways; as electricians, mechanical engineers, iron, brass, and other metal founders and fitters, colliery owners, shipbuilders, and shipowners; to acquire, work, deal with, and turn to account any patents, patent rights, etc.

Eccles.—In the minutes of the Town Hall and Electric Lighting Committee, at the Council meeting, there was a resolution that the Council be recommended to apply to the Local Government Board to sanction the borrowing of £1,565. 12s. 6d. to defray the expenses incurred by the late Local Board and the Council in the

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matter of the electric lighting of the borough. The expense was incurred in respect of the provisional orders, the advice received from consulting engineers, the chief rent upon the plots of land purchased, the information obtained by deputations of the Council from other places, and the information which has been supplied to the burgesses. Mr. Oldfield (chairman of the committee) and the town clerk analysed the sum, and explained it in detail, after which the minutes, with the resolution, were adopted.

Leicester.—We are informed by Messrs. Hick, Hargreaves, and Co., Limited, of Bolton, that they have recently received from the Leicester Corporation an order for another engine for their electric light station, similar in all respects to the three large engines originally supplied by the same firm. We take the opportunity of correcting a statement which recently appeared in our pages, from which it might appear that the engines above referred to had proved unsatisfactory, whereas the opposite is really the case, as may be gathered from the repeat order. The Mayor of Leicester, who was reported as having made a statement in a recent speech which might be thus interpreted, has explained, in reply to Messrs. Hick, Hargreaves, and Co.'s enquiry, that he had been wrongly reported, and that his remarks were not intended to apply to the engines in question.

Sofia.—The Secretary of State for Foreign Affairs has received a despatch from the acting British Consul-General at Sofia, stating that the Municipality of that town invite tenders for (1) the supply of electric currents to light the streets as well as public and private buildings in the town, and the supply of electric power; and (2) the construction and working of electric tramways in the town and suburbs. Tenders will be received for either or both of these undertakings at the offices of the Municipality of Sofia up to September 22 next, and will then be examined, but a final adjudication will be held on October 2 if in the interval a reduction of 5 per cent. is offered on the tenders containing the most favourable terms. Such further particulars as have been received may be seen at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 6 p.m.

Bolton.—The borough electrical engineer, Mr. A. Ellis, M.I.E.E., reports that for the month ending June there were 260 consumers whose premises were connected with the electricity mains, with an equivalent of 21,964 8-c.p. lamps, against 133 consumers with an equivalent of 10,106 8-c.p. for the corresponding period last year. The heaviest load in the station since its inauguration was during Jubilee week, when on Saturday, 26th ult., there were 178 amperes at 2,100 volts, or equivalent to 12,406 8-c.p. lamps burning simultaneously. During the month 428 yards of main cable had been laid in Blackburn-road and 662 yards in St. Helen's-road. With regard to the works costs for the year ending March 31, excellent results had been obtained, and which, when taking into consideration the number of units sold, would compare with any other station in the kingdom, the total costs working out at 2·82d. per unit sold.

Central Electric Supply Company, Limited.—This Company has been registered, with a capital of £100,000 in £5 shares, to carry on the business of electrical engineers and contractors, suppliers of electricity, manufacturers of electrical apparatus and mechanical and chemical engineers, and the producing, generating, accumulating, and supplying light, heat, sound, and power, or any of them, by electricity, galvanism, magnetism, or otherwise, and other business or businesses convenient to be carried on with such business or businesses or any of them, or any branch thereof, and for the purposes aforesaid to acquire lands, works, property, and premises wherever convenient, machinery, patent rights, and other property, and to acquire and establish other businesses and property; to acquire and turn to account any patents, patent rights and inventions, etc. Registered office: Broadway House, Westminster.

Airdrie.—At the Town Council meeting a letter was read from the Imperial Electric Light and Power Company stating that they were giving notice that it was their intention to apply to the Board of Trade for a provisional order for electric lighting within the Council's district, and would be pleased to have the support of the Council in doing so. The Provost: We had that before us a number of years ago, and we unanimously objected to any company getting a provisional order. We opposed it, and they did not get it. The Council formerly thought that anything of the kind should be promoted by the Council and not by a private company. Councillor Neilson: Have the Council any idea of promoting such a scheme? The Provost: At that time they had. Councillor Harvie: But we lost our power. It was resolved that the same action should again be taken now as previously in preventing an outside company from obtaining the monopoly.

Aston.—At the Urban District Council meeting, the Highways and Buildings Committee reported that they had received a formal notification that the South Staffordshire Blast Furnace Power Syndicate intended applying for a provisional order to supply for all public and private purposes electricity within the limits of the district. A similar notice was received from the Imperial Electric Light and Power Company, who also asked for the consent of the Council to the company's application. The consent was refused; and as the Clerk said he had within the last day or so been informed that another company was contemplating applying for a similar provisional order, it was suggested whether it would not be advisable for the Council itself to consider the expediency of applying for a provisional order on its own behalf. It was understood that the Highways Committee would consider the matter and report.

Glasgow.—The Sub-Committee on Electric Traction had submitted, at a meeting held on 10th ult., the proposal that, in the equipment of the Springburn route for electric traction, the Tramway Department should purchase the current from the Electric Lighting Department. Having carefully considered the suggestion, and a memorandum by the general manager on the subject, the sub-committee were of opinion that the power for the experimental installation should be generated in the department's depôt at Springburn, where there is suitable and inexpensive accommodation both for the generating machinery and the motorcars. A deputation from the Tramways Committee intimated this decision to the Electricity Committee at a conference held on June 23. Councillor Paterson afterwards moved that the Electricity Committee recommend to the Corporation at their meeting to be held on the first Thursday of July that the supply of electricity required for tramway traction should be taken from the Electricity Department of the Corporation. Councillor Gray having seconded the motion, it was agreed to, Councillor Paton dissenting on the ground that the motion was incompetent.

Tipton.—At the meeting of the Urban District Council a letter was received from the Board of Trade, enclosing a copy of the application made by the South Staffordshire Tramways Company for a renewal of authority to use steam power on their lines, and stating that the Board of Trade had given their consent for a further period of three months from the 25th inst. The letter from the tramway company embraced the conditions of agreement between them and the Electrical Construction Company, ratified by the special meeting of shareholders in London. Councillor Doughty said the time had arrived when Tipton should demand what was to be definitely done for them. They had been badgered about for years, and from the newspaper report of the meeting of the shareholders of the tramway company, the latter appeared to be in a bad way. The Council should seriously consider whether they should take over the lines into their own hands and work them themselves or let them to another party. They had been trying to get an alteration for years, and nothing satisfactory had been done. The matter dropped. The Midland Electrical Corporation wrote stating that they intended to apply to the Board of Trade for a provisional order to supply electricity for public and private purposes in an area including the urban district of Tipton.

Electric Power for Surface Pumping.—Mr. Edmund Howl, general manager of the South Staffordshire Main Drainage Commissioners, in a report to the Commissioners offers an important suggestion bearing on the use of electric power. He states that he has, along with Mr. Marten, the engineer, gone fully into the question of using electric power for surface pumping for low-lying ground, and has fixed on 33 places in the drainage area where small electric stations could be placed to advantage. The cost of pumping on the surface, he states, is not more than 5 per cent. of the cost of pumping from below, as surface water would not have to be raised more than 15ft. into the streams as against an average of 400ft. when pumped from the mines. If surface pumping could be established, which would prevent three to four million gallons per day from getting below during the winter months, it would save the cost of working the auxiliary engines and also pushing the main engines to an uneconomical extent, and would effect a saving on revenue account in a wet season similar to last of about £3,000 per annum. He called special attention to the subject now, as an electric power distribution company have deposited statutory notices with a view to supplying electricity for power purpoees over an area which embraces the whole of the Tipton Mines drainage area.

Cork.—The following letter was read at the meeting of the Harbour Board, relating to the proposed tramway extensions: "Dear Sir,—I am in receipt of your letter of the 24th inst. herein, and regret to learn that the Board have decided to adjourn the matter until July 21. This involves delaying the whole scheme of extensions until November next, as after the date mentioned it will be impossible to have the application put before the Privy Council before the long vacation. Seeing that the portion of the scheme in which the Harbour Board is interested is comparatively small, it is somewhat hard that their action should have the effect of postponing so inordinately an undertaking like the extension to Ballintemple, with which the Board have no concern. The experience of the previous scheme, too, shows that the local delays are certain to be followed by even greater dilatoriness when the application goes before the Privy Council. I would, therefore, pray that the requisite statutory meeting of the Board should be summoned to consider the application forthwith. The resolution of the Board can have annexed to it a condition that their approval is subject to conditions which are to be agreed on between the promoters and the Board, and these conditions can be discussed at your proposed meeting on July 21, but this need not prevent the statutory meeting being meanwhile held. I think Mr. Ronan will advise you that there is no objection to this.—Yours faithfully, MAURICE HEALY." It was decided to hold the statutory meeting as soon as possible, and pass a resolution approving of the tramway, subject to clauses to be inserted afterwards.

Electric Light for the Embankment.—There will shortly come before the London County Council a proposal made by the Highways Committee for providing the electric light on the Victoria-embankment and Westminster and Waterloo Bridges. It is recommended that the Council shall establish its own building and plant for producing the light, and that lamp standards shall be placed at the sides of the carriageways, the committee thinking that the Council would object to the standards being placed, as is done in some other parts of London, in the centre of the carriageways. It is proposed that there should be provided in all 90 arc lamps of the Jandus pattern, and that of these 54 should be placed

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on the Victoria-embankment, 27 on each side, 10 on Waterloo Bridge, 11 on Westminster Bridge and its approaches, and the remainder at Northumberland-avenue approach and other points, eight being placed on the piers adjacent to the Embankment. The proposed site for the generating station is a piece of ground adjacent to the Charing Cross Station of the District Railway, power having been obtained in the Act to use the ground for that purpose. It is not intended under the present scheme that the lamps on the river wall shall be lighted by electricity, but should this be decided on later, the generating plant provided will be sufficient to supply the additional energy required. The committee do not think it advisable that the ornamental gardens on the Embankment should be lighted by electricity, as they are doubtful whether any public advantage would be gained thereby. The first cost of the installation is estimated at £22,000, and the cost of maintenance will be about £1,900 a year. The present annual average charge for lighting the Embankment and bridges is about £1,300.

Audenshaw.—At the District Council meeting Councillor Brierley asked how they stood about lighting the township by electricity. Were they preparing for it? The Chairman said it had never been resolved upon. Councillor Brierley thought it would be a wise course to pursue. The Chairman said it had been mentioned, but there was a general feeling that it was indesirable to move at present. Councillor Brierley said it was the light of the future, and if Ashton and Manchester obtained powers to extend their lighting they would have to go to one or the other. The Chairman said it was suggested that they should get power and have their own plant. Councillor Brierley thought it would be wise if they obtained power, even if they did not put it in force at present. They would be in a better position to supply the light when required. Councillor Davies said it was a matter that had been several times mentioned, but it did not meet with much favour up to the present. The suggestions made for postponement were that if powers were applied for they would have to give a guarantee to take up those powers in a given time. It had also been suggested that if any other authority or company or society should apply for powers, the Council should oppose, and it had been thought they would be successful in their opposition, and obtain an order over the company or authority. It would, perhaps, be as well if the Council considered whether it was not advisable, and the time ripe, for obtaining power, and be in with this forward movement or system of lighting. The Chairman said they would have to obtain power to borrow the money. The Clerk said they would be strongly opposed by the Ashton Gas Company. They had already laid down for the Council a considerable extent of mains, and recently they had increased their lighting capacity for gas. Councillor Hamer said they were out of order. This did not arise on the minutes. It was a proper matter for consideration in the proper place, and no doubt there could be given reasons for and against.

Leith.—At the Town Council meeting Mr. Baxter moved the following motion: "That the Magistrates and Council, considering the apparent impracticability of having the cable system of tramways introduced throughout the whole of Leith, thereby necessitating change of carriages at some places in the burgh, and the opinion of the Corporation that a change of carriages at the foot of Leith-walk (to which point alone the company has stated they will cable) would cause greater inconvenience and danger to the public than such a change at the mutual boundary at Pilrig, and considering, also, the fresh light which has been obtained against the superiority of the cable system, now resolve to abandon their negotiations towards cabling, and resolve to proceed on the footing of the whole of the Leith tramways being worked by electricity, thus also assisting the Council's scheme for the supply of electric energy within the burgh." He said he was prepared to turn round from cabling to favour a scheme that he thought would meet with most favour from the Council. The Council had practically agreed that to make a change of passengers at the foot of Leith-walk was a thing they would not tolerate. Then the next best thing was to do away with cables altogether and go in for a system that would lend itself to the whole of Leith, and electricity, he considered, was the best for that. By combining their proposed electric lighting system and electric tramways they would be able to supply electric light as cheap as any burgh in the United Kingdom. Bailie Robertson seconded Bailie Waldie moved as an amendment that they decline to decide on the motion until they had received the report of the special committee on tramways at the end of the month. Mr. Mackie seconded, and said the matter was premature. Several other members expressed a similar opinion, and ultimately Mr. Baxter withdrew his motion in favour of the amendment, which became the finding of the meeting.

Leeds.—It is considered probable that the new electric tram service from Kirkstall to Roundhay will come into operation very soon. The machinery is in a very forward state. The lofty engine-room has been roofed in, and one engine has been placed in position and is working—has been working, in fact, for more than a week. The second engine is in a fairly advanced state. The present engine-house will accommodate two engines and a double dynamo—ample power for the Kirkstall to Roundhay service. The second engine, when absolutely fixed, will be worked, like the first one, almost continually until actual business commences. In this way good working order will be ensured. The boiler-house adjoining lacks a roof yet, and the upper floor arrangement for coaling has, of course, to be provided, but both the big Lancashire boilers by Claytons are in position, and are supplying steam to the working engine. From the upper floor, when all is complete, the fuel will be conveyed by means of mechanical feeders to the furnaces. A kind of trolley-way will run out from this part of the building over the river close by, and receive coal direct from the barges. The economiser in the storehouse next to the boiler-house is also in a forward condition, and the chimney shaft is finished. Room is being left for the erection of six more engines and four more boilers when the time comes to extend the electric tram service in other parts of Leeds. At a meeting of the Tramways Committee a resolution was passed recommending the Council to appoint Mr. J. Kidd to the position of chief engineer at the electrical generating station, Crown Point, at a salary of £2. 10s. per week. At the meeting of the Council Mr. Hannam moved the appointment of Mr. J. Burbridge as chief electrical engineer in the Tramways Department, at a salary of £300 per annum. Mr. Burbridge is clerk of works in connection with the construction of the Kirkstall and Roundhay Corporation electrical tramways. He formerly acted as manager of the Roundhay tramways under the Thomson-Houston Company.

Manchester.—At a meeting of the Parliamentary Sub-Committee on June 3 the following report of the Special Sub-Committee on the Manchester Corporation Bill was read: "The sub-committee appointed in reference to the Rochdale-road and tramways portions of the Bill, consisting of the Lord Mayor, the Chairman of the Improvement Committee (Councillor Vaudrey), the Deputy-Chairman of the Improvement Committee (Alderman Griffin), the Chairman of the Paving, etc., Committee (Alderman Milling), and the Deputy-Chairman of the Special Joint Committee *re* Tramways (Councillor Richards), report that they have had several meetings, and have considered the necessary modifications to be made in the Bill with a view of meeting the observations and suggestions of the Lord Chairman and the Government Departments. In view of the Bill coming before the Police and Sanitary Committee at an early date, it is suggested that they be authorised by the Parliamentary Sub-Committee to deal with all matters in connection with the improvement and tramways portions of the Bill. The sub-committee farther recommend that the chairman of the Electricity Committee be added to this sub committee, and that the electric portion of the Bill be also referred to this sub-committee." It was resolved, "That the report of the sub-committee now read be approved, and that, as recommended thereby, the chairman of the Electricity Committee (Alderman Higginbottom) be added to the sub committee, and that the electric portion of the Bill be also referred to them, and that such sub-committee be authorised to deal with all matters in connection with the improvement, tramways, and electric portions of the Bill." These proceedings were approved at the last meeting of the City Council. The annual report of the Corporation Gas and Electricity Committee was presented at the meeting of the City Council. The profits on the electric lighting, after deducting every charge, amounted to nearly £17,000, and although over 30,000 additional lamps have been erected during the past year, the demand is still rapidly increasing. The gas receipts for the 12 months also show an increase of £42 000.

Crompton and Co.—We have received from the above firm a pamphlet concerning some new departures in arc lamp compensating coils and in the arrangement of transformers for single arc lamps. The system of working alternating arc lamps, up to any number in series, by means of special compensating coils placed in parallel, has been previously described in our columns, but we are glad to see an English firm taking the matter up practically. The compensating coil in such a system performs the treble functions of regulating the length of the arc, of an automatic cut-out, and also as an equivalent resistance to take the place of the lamp when cut out. Messrs. Crompton and Co. strongly recommend the use of these coils for working three lamps in series on a 100-volt circuit. It not infrequently happens that in such a case the carbons in one of the lamps are allowed to turn out, and thus seriously overheat or burn the shunt solenoid of the lamp, owing to the full pressure of 100 volts acting upon it, The other device, which is very useful in many cases, is the special arrangement of a transformer for arc lighting off the low-pressure mains which has only a single winding. The two ends of the winding are coupled across the mains at 100 or 110 volts, or even at 200 or 220 volts. Two other terminals are provided at proper points midway between the two ends on this winding, and to these terminals the arc lamp is connected. The result is that the energy taken from the mains is approximately only that required to work the one lamp. This is a matter of great importance, as it is often found that a consumer requires only one lamp, but finds himself forced to take two, as the meter he has to use does not measure the energy he consumes, but the current only. In some instances also one lamp only is fitted; the energy which might well drive another is absorbed in a resistance coil. Hence the apparatus is extremely valuable to the consumer, and is one which will therefore be much in demand. We are glad to see that the despised alternate-current arc is receiving more attention, and are sure that with a careful selection of carbon good results can be obtained, and a cost not disproportionate to that of arc lighting by direct currents.

Colwyn Bay.—The new promenade at Colwyn Bay, North Wales, which is fast approaching completion, will, when finished, be one of the finest in the United Kingdom. It will cost about £13,000, and is being constructed by Mr. Jacob Biggs, Farm-street, Birmingham, a contractor who has successfully carried out many important undertakings in North Wales, amongst other works being the new system of sewerage for Rhyl at a cost of £30,000. In 1896 the Colwyn Bay Urban Council acquired the foreshore from the Office of Woods and Forests for £1,200, and they at once set to work to carry out this important improvement, and which will be finished in the Jubilee year. The esplanade and roadway (20ft. wide) extends from the railway station eastward for about a mile, forming an inward curve below

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the embankment of the London and North-Western Railway, to the passengers of which line no doubt it will be a source of attraction. The surface of the promenade varies in width from 40ft. to 90ft., and is asphalted; it is also provided with cart crossings, kiosks, lavatories, etc. It is also anticipated that it will eventually be lighted by means of electricity, the Council having obtained the necessary powers. A noteworthy feature of the work is the outer wall, which is being constructed flush with the surface, so that at high spring tides the waves will reach the promenade proper. The approach of the new work is obtained by means of a subway constructed beneath the railway line at the east end, which was made at great expense, by the local authority, and who now are making a new roadway about a quarter of a mile lower down the beach, thereby securing a circular route for vehicular traffic. It is expected that eventually the promenade will be extended another half mile so as to reach Old Colwyn, where rapid developments are being carried out. The whole of the work is under the supervision of the town surveyor, Mr. Wm. Jones, A.M.I.C.E In addition to the chief contractor, Mr. Jacob Biggs, the asphalting is in the hands of the Val de Travers Company The growth of Colwyn Bay has warranted the proposal being made for the construction of a pier 900 yards in length, with a uniform width of 40ft. The project has been approved by the Council, and the promoters are moving with all possible speed in the matter.

Brighton.—Mr. Rienzi Walton, M.I.C.E., has held a Local Government Board enquiry with reference to the Town Council's application for sanction to their borrowing £43,300 for purposes of electric lighting. No opposition was offered, and the proceedings were purely formal. The Mayor (Sir John Blaker) was the only member of the Corporation present, the town clerk (Mr. F. J. Tillstone), the borough engineer and surveyor (Mr. F. J. C. May), and the borough accountant (Mr. H. M. Stevens), being in attendance officially. The Town Clerk said he was sorry he should be unable to call the manager of the Corporation electricity undertaking, Mr. Wright having left for America to read a paper to some institution before notice of the date of the enquiry was received from the Local Government Board. The Inspector asked if any portion of the loan was to be used towards the payment of excesses on previous loans. The Town Clerk replied in the negative. Some of the contracts in previous loans were not quite closed, but taking into account the estimated extras the previous loans would be just about equal with the amount spent. Up to the present time there was a balance of £197 to the good. The Inspector: What has been the total amount of electric light loans up to the present? The Town Clerk: £191,281. 6s. 2d. is the total amount sanctioned. The Inspector: What occasions the application for the new loan? The Town Clerk said it was for an extension of the undertaking in consequence of the rapid increase in the demand for electricity. The Inspector: How many lamps have you at present? The Town Clerk said the total number of 8-c.p. lamps was 74,350. That total included 255 public arc lamps, 686 public lamps lighted by incandescent lamps, and 1,503 private houses connected with the service. The Inspector: What additional number of lamps will this loan enable you to have? The Town Clerk said it would enable them to supply 28,000 additional 8-c.p. lamps. At the Town Council meeting the Lighting Committee reported that they had received a letter from Councillor Miller requesting that additional lighting may be provided in Wellington-villas. The letter was referred to the borough surveyor. It was resolved to grant a day's holiday without loss of pay to all the employés in commemoration of her Majesty's Diamond Jubilee. The report was adopted.

The Kennington-road Baths.—The following description of the electric lighting of the above, which are to be opened by H.R.H the Prince of Wales to-day, will be of interest. The supply is obtainable either from the generating plant, which is placed in the basement of the building, or, so far as concerns the incandescent lamps, from the mains of the London Electric Supply Corporation. Steam for the engines will be taken from the boilers which are used for heating the baths, the pressure being 90lb., there being three Lancashire boilers at present installed. There are two sets of engines and dynamos, one being of a direct-coupled plant, consisting of a Peach engine and Parker dynamo, good for 300 amperes at 110 volts; the other a belt driven plant, comprising a Marshall horizontal engine and Parker dynamo, good for 70 amperes at 110 volts. A battery of 60 accumulators serve to supply the day load; these are charged from either of the two dynamos They are divided into sections of 20, and the switchboard is arranged so that any two sections may be charged at one time. In discharging, the three sections are in series. Thus the cells can be charged in parallel with the lamps without the use of the usual back E.M.F. cells or external resistance. The switchboard is provided with Weston ammeters and a Kelvin voltmeter, while in addition to the usual switches there is provided a main change-over switch for connecting to the street supply mains. The lighting is effected by two five ampere arc lamps of the enclosed type placed outside of the building, whilst about 480 incandescent lamps, varying from 8 c.p. to 32 c.p., are used for the internal lighting. For ventilating there are to be used seven electrically-driven air-propellers by Matthews and Yates, each having its own separate circuit. The whole of the wiring is enclosed in iron pipes which have been specially treated inside to protect the wires and to obviate the rusting to which the damp atmosphere of baths renders ordinary pipes particularly liable. Special draw-in and joint boxes of cast iron have been adopted throughout, so that any circuit may be withdrawn and replaced when so required, a special point having been made of keeping all joints at these boxes to facilitate inspection. The electrical part of the installation has been carried out by Messrs. Geipel and Lange, successors to Messrs. Paterson and Cooper, of 68, Victoria-street, Westminster, under the superintendence of Mr. A. Hessell Tiltman, F.R.I.B.A.

Foreign Telegraphic Rates.—The following reductions in the rates for foreign telegrams on and from July 1 are announced in a memorandum issued from the General Post Office:

	A word. From s.	d.	To s.	d.
European system:				
Azores	0	10	0	9
Canary Islands	0	10	0	9
Gibraltar	0	4½	0	3½
Greece & Greek Islands	0	7	0	6½
Morocco—				
Tangier	0	6	0	5
Other places	0	4	0	3½
Portugal	0	4½	0	3½
Senegal	1	6	1	5
Spain	0	4	0	3½
Tripoli	1	1	0	8½
Extra European system:				
China—				
All places except Macao (including HongKong)	7	0	5	6
Macao	7	6	5	9
Formosa	8	0	6	6
Japan—				
Vid Great NorthernCo	8	0	6	2
Vid Eastern Co.	10	8	7	9
Vid Indo-European Co.	10	8	7	9

	A word. From s.	d.	To s.	d.
Extra-European system (continued):				
Malay Peninsula(Penang, Singapore, Malacca, and Native States)	5	0	4	6
Persia(Bushire)	2	5	1	9
Philippine Islands	9	0	8	7
RussiainAsia—				
1st Region.	1	8	1	0
2nd Region.	2	7	1	3
Siam, *vid* Moulmein	4	6	3	10
West Coast of Africa—				
Bathurst	5	11	4	7
Bonny	9	8	8	3
Brass	9	8	7	10
Gold Coast—				
Accra	8	0	6	3
Other places	8	2	6	5
Lagos	8	10	7	1
Sierra Leone	6	9	5	5
Cameroons	9	10	8	5
Togoland	8	4	6	6

At the same time the number of letters allowed to a word in plain language in extra-European telegrams will be increased from 10 to 15, and the number of figures from 3 to 5.

London Lighting Extensions.—The Highways Committee reported at the London County Council meeting as follows: "We have to report the receipt of two notices dated respectively May 5 and June 26, 1897 (registered Nos. 1,021 and 1,052), from Messrs. Kincaid, Waller, and Manville, on behalf of the South London Electric Supply Corporation, under the provisions of the Lambeth Electric Lighting Order, 1892, of intention to lay mains (*a*) in and across Lambeth Palace-road, Church-street, and Pratt-street, and along Juxon-street to Lambeth-walk, and (*b*) high and low tension mains in Kennington-road (east side), Lambeth-road (south side), Kennington Park road and Clapham-road (north-east side), and low-tension mains in Kennington-road (west side), Lambeth-walk (both sides), Kennington-road and Clapham-road (parts of north-west side), Lower Kennington-lane (north side), Kennington-lane (south side), Upper Kennington-lane (parts of both sides), and Albert-embankment from Lambeth-road to Kennington-lane; and to construct drawing-in boxes and 10 transformer boxes, and various crossings in places shown on the eight maps submitted with the notice. Under this order which, originally granted to the Vestry, has been transferred to the company under an agreement confirmed by the Board of Trade, the Council has no power of approval or disapproval of works. We called the attention of the Board to the exceptional position of this company under the transferred order as compared with other companies to which orders have been granted direct; and a letter has been received stating that the Board will adopt the suggestion made by us on behalf of the Council that each provisional order granted in future to a local authority in London shall contain a provision that notice of a proposed transfer of the powers, etc., conferred by the order, shall be given to the Council, so that it may have an opportunity of making any representation which it may deem desirable with respect to the transfer, and proposes to take the necessary steps to obtain the insertion of the first-named provision in the Fulham and Newington electric lighting orders of this session; and that the Board, without finally coming to any determination upon the point, is in favour of the insertion, in future deeds transferring to companies powers conferred on local authorities, of provisions giving to the Council the same power in regard to the approval of works which it possesses under orders granted directly to companies in the first instance."

Torquay.—At the Town Council meeting the Mayor reported the result of the public meeting held last Friday to consider the tramway scheme. Messrs. Foster and Kite, solicitors to the tramway promoters, wrote that they were instructed by the directors of the tramway company to advise the Council that after carefully considering the report of the public meeting held on Friday they did not feel justified in accepting the resolution passed at the meeting as representative of the opinion of the majority of the burgesses. The directors requested, in consequence of the short notice of the meeting given, that a poll of the burgesses be taken, and that the Council postpone their decision until they had the result of the poll before them. If the Council considered the expense of the poll should be borne by the company the directors would pay them. Alderman Mortimer said he did not attend the public meeting because he thought the burgesses were to be asked to advise the Council. But he noticed that the chief speakers were members of the Corporation. Vested interests

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were abundantly represented at the meeting, and he doubted whether the meeting was a true index of the feeling of the majority of the burgesses. He moved that as the promoters offered to pay for it that a poll be taken. Mr. T. H. Wills seconded. The Mayor pointed out that there was no request for a poll at the public meeting. Dr. Richardson asked the Council to take the means necessary to oppose the scheme. Mr. Glanfield asserted that the public meeting was packed. Mr. Beavis maintained that it was too late to ask for a poll. Alderman Harris held that after the emphatic protest of the meeting on Friday it would be almost an insult to the burgesses to vote again. This was only a side wind to get the case reheard. Mr. Butland said the promoters of the scheme could take an independent poll of the town if they wished it done. Alderman Callard remarked that they had received their instructions from the public meeting, and moved that the Council refuse to approve of the scheme. This amendment was adopted by Dr. Richardson, and was carried by 12 votes to 7. Members protested that the refusal of consent to the order was not an amendment to the motion to take a poll, but the Mayor ruled otherwise. But the question that a poll be taken was put to the meeting, and was supported by 10 votes. Nine voted against it. The names were then taken, whereupon 10 appeared on each side. The Mayor refused to give his casting vote, leaving the matter undecided.

Sheffield.—We understand that the Sheffield Electric Light and Power Company, Limited, is extremely busy in preparing and fitting premises for the electric light. The parish church is to be provided with nearly 600 lamps in various parts of the edifice. Other places of worship are also being electrically lighted; and the Lyceum Theatre will be brilliantly illuminated by means of over 1,000 lamps. Numerous business establishments are following the example of their neighbours and are having the current laid on, whilst the demand for domestic lighting from the residential districts is increasingly urgent. The electric light is greatly appreciated in the homes of suburban residents, and enquiries for a supply of current are so numerous that the company will forthwith proceed to lay additional underground supply mains in the outlying thoroughfares. The largely increased call for current which will be made upon the machinery of the company during the coming autumn and winter was anticipated and provided for last year, by the placing of orders for additional huge engines, dynamos, and boilers, and great preparations are being made at the electric lighting station for the reception of 2,000 h.p. of machinery, which is due for delivery in September.—*Sheffield Daily Telegraph.* The *Leeds Daily Mercury* says: "There is every prospect of a contest between the Sheffield Corporation and the Sheffield Electric Light and Power Company over the possession of the undertaking. The order putting the company in sole possession of the field contained a stipulation that the Corporation may at any time call upon the company to hand over their undertaking to them on payment of 5 per cent. Corporation stock for every £100 of capital property expended by the company, and the payment of a sum sufficient to make up an average dividend of 5 per cent. on the capital of the company since its formation. Three months ago the Corporation gave notice to the company to treat, and subsequently offered either in 2½ per cent. Corporation stock or in cash £200 for every £100 of capital properly expended by the company. With the view of putting themselves in a proper position, the Corporation also commenced an action to compel the company to give up possession of their undertaking. In the negotiations that have since taken place, the directors have practically declined the offer of the Corporation, as they do not think it sufficient. A meeting of the Parliamentary Committee, who have the matter in hand, was held this week, when they passed the following resolution: 'That further negotiations with the Sheffield Electric Light Company be suspended until it is ascertained by legal decision, upon the action already commenced, what really is the position of the Corporation in the matter.' The situation is somewhat complicated by the fact that three of the directors of the company are prominent members of the Corporation and several others are shareholders in it. In the meantime, the company are increasing their capital and extending their works."

Perth.—At the monthly meeting of the Town Council a communication was read from the Imperial Electric Light and Power Company, London, intimating their intention to apply to the Board of Trade for permission to introduce the electric light into the Perth district, and asking the Town Council to support their application. Lord Provost Dewar said the Council had always been inclined towards the introduction of electric light, but that was no reason why an outside company should have the power to introduce it. He moved that the request of the London company be not granted, and this motion was seconded by Councillor Wotherspoon. Ex-Bailie M'Nicoll failed to see why they should stand in the way of the people getting this light, which was undoubtedly going to be the light of the future for all communities. The Lord Provost said he quite agreed with Bailie M'Nicoll, but he thought it would be very stupid to allow a company to introduce the electric light into Perth. He was sure that the Town Council would not stand in the way of electric light being introduced by the local authority if there was a demand for it. Bailie Wright pointed out that Mr. Wilson, gas manager, and himself had been appointed to make enquiries into the advisability of electric lighting being introduced, and in the interval he thought no definite steps should be taken. Councillor Anderson said the Town Council had spent £40,000 which was quite unnecessary, in view of the fact that electric lighting would in the near future become universal. It was a great mistake on the part of the Town Council to have gone into that extravagant expenditure, and it showed that Perth was very far behind the times. While he had no intention of giving the benefit to be derived from the introduction of electric lighting to an outside body, he hoped that the matter would be thoroughly investigated by a committee of the Council at the very earliest opportunity. Councillor Dempster said he did not quite agree with Councillor Anderson, for, although electric light was introduced into the city, it would not decrease the consumption of gas. The Lord Provost said that, far from the Town Council having overlooked the advantages to be derived from electric lighing, they had some time ago secured an elaborate report from Prof. Kennedy and Mr. Forbes, electrician of Messrs. Pullar's works. Councillor Anderson then rose. The Lord Provost: You must not interrupt me unless you are to speak to a point of order. Councillor Anderson: I am merely following your own bad example. The Lord Provost: Unless I have said anything out of order you had no right to rise, and you must sit down Councillor Anderson continued on his feet, but amid the hubbub it was impossible to catch what he said. Ultimately, on comparative quietness being restored, the Lord Provost remarked—Your conduct is not at all clever, and it is extremely rude. If I had said anything requiring an explanation I would have allowed you to make it, but I cannot allow you to interrupt me in the way you have done when I am addressing the Council. The Lord Provost went on to state that electric light had recently been in great demand, and on his suggestion it was agreed to bring up the matter later on, meanwhile declining the application from London.

The Middlesbrough Trams.—At a meeting of the Streets (Tramways) Committee of the Corporation last Friday, the Town Clerk said he had received a letter from the Corporation agents stating that Tuesday was the first day the case could be called, but they did not expect it would be reached before Wednesday or possibly Thursday. They ought to brief counsel on Monday. They had not yet discovered what the committee had in view in opposing the confirming Bill, but they inferred that they wished to force the promoters to obtain at the earliest moment powers to make the tramway. They had seen the solicitor and agent to the company again with a view to get them to make some better offer to stop the opposition. They, however, stood firm in their refusal to bind the company to promote a Bill if the Light Railway Commissioners decline to make an order. They said the utmost they would recommend their Board to entertain was a condition to insert powers for the purposes in any Bill they may promote in Parliament (if the Commissioners refused to make an order) in relation to their Middlesbrough undertaking, and if (failing the company) the Corporation should obtain powers to make the line, the company are to work the same on terms to be settled by an arbitrator to be appointed by the Board of Trade. The agents also enclosed the following letter from the tramway company's solicitor: "At a Board meeting this afternoon (July 2) I submitted the suggestion which you made this morning for getting rid of the opposition of the Corporation, and I am instructed to say that if the petition is withdrawn to-morrow my clients will have no objection to agree to work the line in the event of its being hereafter constructed by the Corporation. If, however, there is any delay in the withdrawal of the petition, and my clients are put to any expense in connection therewith, they will decline to enter into any agreement whatever." The suggested draft agreement was as follows: "2A. If the Light Railway Commissioners refuse to make such order, the company will, in the next provisional order or Bill in Parliament promoted by them after such refusal whereby powers are sought in relation to their Middlesbrough undertaking, include powers to authorise the making, maintaining, and working of the said tramway. (2B) The said tramway, when constructed, shall be deemed for the purpose by the local authorities or local authority under the Tramways Act, 1870, or the said order of 1897, and for all other purposes, part of the undertaking authorised by the said order of 1897. (2C) If the Corporation (failing the company) obtain powers to make the said tramway the company will work the same on terms, failing agreement, to be settled by an arbitrator to be appointed by the Board of Trade." The Chairman said it might be 20 years, or 50 years, before they went in for any further provisional order. Alderman Hinton said they would have a better chance of getting the line under the Light Railways Act than under the Tramways Act. After a lengthy discussion it was decided to appoint witnesses to give evidence against the Bill. At a special meeting of the Council called to consider the recommendation of the Streets Committee that the Bill in Parliament promoted by the tramways company should be opposed by Alderman Hinton and Councillor Duncan on behalf of the Corporation, a lively discussion took place. On a vote being taken to confirm the recommendation the division was equal, and the ex-Mayor declared in favour of opposing the Bill. Councillor Burrows and Councillor Ward protested that the proposition had been rushed through without an opportunity being afforded to discuss the question.

PROVISIONAL PATENTS, 1897.

JUNE 28.

11594a. Application of electricity to the working of artillery. Guilio Martinez, 52, Chancery-lane, London. (Date claimed under Patents Rule 19, May 10, 1897.)

15379. Improvements in the construction of electric rail and tramways. William Henry Burkitt, Sycamore Cottage, Ocker-hill-road, Tipton, Staffs.

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15396. Improvements in or relating to carbons for electric welding, brazing, and the like purposes. George William de Tunzelmann, 27, Martin's lane, Cannon-street, London.

15411. Improved electric igniter for gas-engines. Robert Bosch, 322, High Holborn, London. (Complete specification.)

JUNE 29.

15419. Improvements in or connected with electrical distribution fuse-boards. Veritys, Limited, and Morton Blencowe Cotterell, Plume Works, Aston, Birmingham.

15472. Improvement in electric furnaces. George Dexter Burton, 144, Lincoln-street, Boston, Mass., U.S.A. (Complete specification.)

15484. Improvements in means for electrically transmitting indication and alarms. James Joseph Hicks and Gilès Henry Zeal, 23, Southampton-buildings, Chancery-lane, London.

15488. Improvements in means or apparatus for charging accumulators. Harry Barringer Cox and the Cox Thermo-Electric Company, Limited, 46, Lincoln's-inn-fields, London. (Complete specification.)

15490. Improvements in electric heaters. George Brinton Fraley, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

15491. Improvements in electric heating apparatus. George Brinton Fraley, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

15495. Improvements in contact-boxes for electric railways. William Milton Brown, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

15503. Improvements in electric arc lamps. Oliver Imray, 28, Southampton-buildings, Chancery-lane, London. (The General Incandescent Arc Light Company, Limited, United States.) (Complete specification.)

15510. Improvements in secondary or storage batteries or accumulators and in the manufacture of the same. James Yate Johnson, 47, Lincoln's-inn fields, London. (James Phillip Clare, George Elwyn Hatch, and John Henry Taylor, United States.) (Complete specification.)

15513. Process for producing peat charcoal by means of an electrical current. Christian Albert Jensen, 77, Chancery-lane, London. (Peter Jebsen, Norway.) (Complete specification.)

15524. Improvements relating to electric bell-pushes, switches, and the like. Clement de Cirellas and Agostino Silvestri, 45, Southampton-buildings, Chancery-lane, London.

JUNE 30.

15558. Improved incandescent lamp. Frederick Crabb and Edmund William Hampton, 15, Caer-street, Swansea.

15560. Improvements in and relating to electrical bell-pushes. Maunsell Mercier, 61, Barton-arcade, Manchester.

15607. A method of effecting multiplex telegraphic and telephonic communication and apparatus for that purpose. John Imray, 28, Southampton-buildings, Chancery-lane, London. (La Société Anonyme pour la transmission de la force par L'electricité, France.)

15609. Improvements in electrical switches. Joseph Wilson Swan, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

JULY 1.

15656. Improvements in screens used in connection with electric chronographs and other apparatus for ascertaining velocities. Harry Denham Wedlake and Henry Merrick Fletcher, Connor Downs, Hayle, Cornwall.

15712. Improvements in electrical igniting gear for gas and oil engines. William Baines and William Norris, 18, Southampton-buildings, Chancery-lane, London.

15719. Improvements in electric road cars. Carl Adolph Hollstein, 18, Buckingham-street, Strand, London.

15721. Improvements in electric arc lamps. Reginald Haddan, 18, Buckingham-street, Strand, London. (The Patent Verwerthungs Gesellschaft, Germany.)

JULY 2.

15762. The electric stage wedge. William Henry Whiteside, Grand Theatre, Leeds.

15771. Improvements in or relating to the feed mechanism of arc lamps. Charles Oliver, 31, Southampton-buildings, Chancery-lane, London.

15785. Improvements in the form of the solid ends of stranded or other flexible electrical conductors. Frederick Herbert Somerville 2, Rail villas, Fairfield, Chelmsford.

15815. Improvements in enclosed arc lamps. Gilbert Howard Terrell, 93, Chancery-lane, London.

JULY 3.

15830. Fluids dynamo-motor. Michele Patrono, 9, rue Vineuse, Paris.

15838. Improvements in or pertaining to multiplex printing telegraph systems. Philip Middleton Justice, 55, Chancery-lane, London. (Henry Augustus Rowland, United States.)

15859. Improvements in certain apparatus to be employed in connection with the electro-deposition of metals. John Boultbee Brooks and John Holt, 24, Temple-row, Birmingham.

15870. Improvements in the electrical propulsion of carriages and other vehicles, boats, and the like. Adolph Müller and Henri Tudor, 4, South-street, Finsbury, London.

15876. Improvements in writing telegraphs. Philip Arthur Newton, 6, Bream's-buildings, Chancery-lane, London. (Leon O. McPherson, United States.) (Complete specification.)

15877. Improved system for feeding electricity to moter cars. Luigi Cerebotani and Carl Moradelli, 111, Hatton-garden, London. (Complete specification.)

15878. Improvements in or relating to apparatus for making observations by means of Rontgen or X rays. Jacques Wertheimer, 111, Hatton-garden, London. (Complete specification.)

15879. Improvements in and relating to plates for secondary batteries. William Joseph Starkey Barber-Starkey, 322, High Holborn, London.

15903. Improvements in or connected with electric batteries. Alexander David Seton and John Laskey Dobell, 57, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1896.

16657. Electricity meters or means or apparatus for the measurement of electric energy. Telge.

17395. Magnetic cut-outs. Andrews.

17563. Electric traction. Meacock.

17577. Electrical measuring instruments. Elphinstone.

17832 Arrangement for lowering the globes of arc and other lamps. Cotsworth.

17879. Electric batteries. Cornely and Dautel.

17906. Crossings of electric conductors for electric railways and tramways. Snell, Grove, and Hills.

22326. Electric apparatus for lighting and extinguishing gas-jets. Krieger.

1897.

2996. Apparatus for automatically starting electric fire-pumps and other electrical machinery. Rungay.

6743. Electric accumulator plates. Mayes.

11337 Sockets or holders for incandescent electric lamps and the attachment of lamps thereto. Boult. (Worringen.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	9½-9¾
Brush Company, Ordinary	3	1½ 1⅝
—— Non. Cum., 6 per cent. Pref.	2	1½-1⅝
—— 4½ per cent. Debenture Stock	100	105-109
—— 4½ per cent. 2nd Debenture Stock	100	93 97 xd
Callender's Cable Company, Debentures	100	108-113 xd
Central London Railway, Ordinary	10	9¾-10¼ xd
——	6	5¾-6½ xd
Charing Cross and Strand	5	13-14
Chelsea Electricity Company	5	9¾-10½ xd
—— 4½ per cent. Debentures	100	110-113 xd
City of London, Ordinary	10	23½-24½
—— 6 per cent. Cumulative Pref.	10	17-18
—— 5 per cent. Debenture Stock	100	129-134
City and South London Railway, Consolidated Ordinary	100	59 61
—— 4 per cent. Debenture Stock	100	137-139
—— 5 per cent. Pref. Shares	10	15½-16
County of London and Brush Provincial Co., Ordinary	10	12¾-13½
—— 6 per cent. Cum. Pref.	10	15-15½
—— 4½ per cent. 2nd Debenture Stock	10	14½-15½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1¾-2½
—— 5 per cent. Debentures	—	88 93
Edison and Swan United Ordinary	3	2½-2¾
—— 5 per cent. Debentures	5	3½-4½
—— 4½ per cent. Debentures	100	103-1⅛ xd
Electric Construction, Limited	2	1¾ 2⅛
—— 7 per cent. Cumulative Pref.	2	2¾-3¼
Elmore's Copper Depositing	1	¾-1
Elmore's Wire Company	2	⅛ ¼
W. T. Henley's Telegraph Works, Ordinary	10	18½-19½
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	105-113
House-to-House Company, Ordinary	5	8½-9
—— 7 per cent. Preference	5	10-10½
India Rubber and Gutta Percha Works	10	20½-21½
—— 4½ per cent. Debentures	100	105-108
Kensington and Knightsbridge Ordinary	5	12¾-13½
—— 6 per cent. Pref.	5	8-8⅝
London Electric Supply	5	1⅞-2⅛
Metropolitan Electric Supply	10	16½-17½
—— 4½ per cent. First Mortgage Debenture Stock	100	118-122 xd
National Telephone, Ordinary	5	6⅜ 6⅝
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	15-17
—— 5 per cent. Non. Cum. Third Pref.	5	6-6½
—— 3½ per cent. Deb. Stock	100	103-107 xd
Notting Hill Company	10	15-16
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8½-8¾
—— £4½ shares	4½	7½-7¾
Oriental Telephone and Electric Company	1	⅜-½
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	102-104
St. James's and Pall Mall, Ordinary	5	15½-16½
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	37-40
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	8	10⅜-11½ xd
Westminster Electric Supply, Ordinary	5	15½-16½
Yorkshire House-to-House	5	8½-8¾

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NOTES.

Obituary.—The death has been recorded of C. R. Fresenius, the chemist.

Personal.—It is understood that the following appointments have been made at Shoreditch: as electrician-in-charge, Mr. George Kemp, A.I.E.E., of Wolverhampton; and as superintendent of mains, Mr. H. J. Roscoe, of Birmingham.

Thomson Lecturer.—From the *Glasgow Herald* it appears that Prof. J. A. Ewing, M.A., of Trinity College, Cambridge, has been appointed Thomson lecturer in Aberdeen Free Church College for session 1897-98. Mr. Ewing is, of course, the professor of mechanics in the University of Cambridge. The subject of his lectures is to be "Magnetism."

Royal Institution.—At the last monthly meeting of the members of the Royal Institution, Sir James Crichton-Browne, M.D., F.R.S., treasurer and vice-president, presiding, several new members were elected. The special thanks of the institution were returned to Sir Andrew Noble for his donation of £100 to the fund for the promotion of experimental research at low temperatures.

Magnetic Rigidity.—In the *American Journal of Science* there has been a paper on "The Magnetic Increment of Rigidity in Strong Fields" by Mr. H. D. Day. Very long after magnetic saturation has been reached the increase of rigidity due to increase of field intensity goes on, and the limit of the latter was not reached even with the highest intensities attainable. As the field becomes stronger, the increment of rigidity varies more and more regularly with the twist.

Refining Whisky by Electricity.—No week without the Dalziel novelty. From Newhaven, Connecticut, it is telegraphed that the officials of the Revenue department have completed a number of tests for the refinement of whisky by a new electrical process. A large percentage of fusel oil and other impurities was removed, "and the whisky was mellowed as if by age. The liquor was sprayed in a glass retort, and a current of 200 volts was passed through the mist." Simple, isn't it?

New Biography. — Messrs. Archibald Constable and Co. propose to publish shortly a life of Sir Charles Tilston Bright, the distinguished engineer and pioneer of electric telegraphy, who was knighted when but 26 years of age for laying the first Atlantic cable. The work, compiled by a brother and son, is based largely on the diaries kept by Sir Charles Bright, and will read almost like an auto-biographical narrative. It will be issued by subscription in two volumes, and the number printed will be strictly limited.

Condensers on Alternating Arcs.—A correspondent writes to us: "I notice in your paragraph on 'Condensers in Alternating Arcs' [in the *Electrical Engineer* of July 2] that Mr. Claude secures a specially diminutive condenser by causing the capacity to diminish in proportion to the inverse square of the dielectric thickness. This is a special and important law—probably a misprint." We did not quite say that. What Mr. Claude really meant we do not pretend to know, but probably his notion was that while by diminishing the distance between the plates the capacity was increased (in proportion to the inverse of the dielectric thickness), it became at the same time possible to pack a greater number of plates into the same space, and therefore increase the effective surface. Even if the tinfoil were infinitely thin, of course it would not come out quite right. There was, however, a misprint in the paragraph. "Construction," in the last line of it, ought to have been "constructors."

Electrolytic Condenser and Rectifier.—Something of the nature of an electrolytic condenser of large capacity, and also an electrolytic current rectifier, has been proposed by Mr. Ch. Pollak. By passing firstly an alternating current and then a continuous current between aluminium electrodes in an alkaline solution, the plates become coated with an extremely thin crystalline deposit of oxide, which is practically non-conducting. A condenser is thus obtained in which the oxide film acts as the dielectric, and the extreme thinness of this film is the cause of its very high capacity. Further, it is stated that on substituting another metal—*e.g.*, lead for aluminium at one of the electrodes, it is found that the current will pass one way, but not the other, the effect being the same as a rectifier. The economy of these devices is another matter.

Calcium Carbide.—In view of the manufacture and use of carbide of calcium, it was considered desirable to issue regulations with regard to its sale and storage which were formally specified in an order in Council dated February of this year. The regulations appear to be founded largely upon the Petroleum Acts. As the regulations might be considered as not sufficiently explicit without further definition, the Acetylene Illuminating Company, manufacturers of carbide of calcium at the Falls of Foyers, have issued a pamphlet which contains an abstract of both the Petroleum Acts and the regulations of the London County Council applicable to the storage of carbide of calcium. It is optional for all local authorities to modify the suggestions made by the London County Council in any manner they may think desirable.

Heat Transfer.—According to a note in the *Engineer*, an experimental investigation undertaken by Mr. T. E. Stanton to determine the rate of transmission of heat from the walls of a heated metal pipe to colder water flowing through it, has given results in accordance with Prof. Osborne Reynolds's theory of the convection of heat from a hot surface to water flowing over it, this theory being that the motion of heat in the pipe follows the same law as the motion of momentum, as far as convection and conduction are concerned; so that, from Prof. Reynolds's equation for the fall of pressure in a pipe, the value of the slope of temperature may be expressed, the constants in which may be determined by experiment. In this theoretical expression for the slope of temperature it is seen that the effect of the velocity of the water is very small, which is the most remarkable fact brought out by the experimental research.

The Central London Railway.—We appreciate the fact that there is no nation like the Americans for getting matters forward after our experience with respect to the above line. Thus we called at the offices of the British Thomson-Houston Company last week to get more details of the scheme, and were courteously informed that the contracts were not yet signed, neither were the details fixed. We were therefore surprised to see that two American papers, dated June 30, have the details we ask for. We notice that the articles in question even speak of the tunnelling work as finished, and of the shields, etc., as things of the past. Thus "the shield 'was' pushed forward by 22 rams," etc. We trust that the electrical work will not be completed quite so quickly, and that there will be intervals during which the English agents of the American firm will be able to acquire information about the important work they have in hand.

The Jungfrau Mountain Railway.—A Zürich correspondent of the *Times* says that the Swiss Scientific

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Commission, which has been appointed to examine into the projected construction of the Jungfrau Mountain Railway, has been confronted by the initial problem of settling in what State or corporation property in the mountain is vested. The Corporation of the Bernese Oberland lays claim to it in virtue of certain existing titles in opposition to the State of Berne, which asserts its own right of property over all the mountains in its own canton; while a third claimant has appeared in the Conseil d'Etat of the Valais, as one of the projected stations (the Mönchjoch) will be on Valaisian territory. Property in the upper mountains is claimed in Berne as belonging to the State, while in Valais it is vested in the communes, and the question there will probably have finally to be referred to cantonal land tribunals. It is not to be supposed that the intricacies of the Swiss law as to real estate will prove a practical hindrance.

Nickel and Iron.—Before the Royal Society at Edinburgh, Prof. C. G. Knott has given the conclusion of his investigations of magnetic strains, for which the society has awarded him the Keith prize. For all iron and steel tubes the longitudinal dilatation in a longitudinal magnetic field, in moderate fields is positive, but it is negative in higher fields. The maximum depends on the thickness. The transverse dilatations must be of such a value as to be in some cases less than half the longitudinal dilatation, and sometimes greater. The behaviour of nickel is much simpler than that of iron. The cubical dilatation is determined by the longitudinal dilatation, both being negative and more nearly alike in order of magnitude than in the case of iron. Nickel turnings behave quite differently. Dr. Charles Guillaume, of Neufchatel, reported to the International Committee of Weights and Measures, which held its biennial meeting at Sevres, in the spring, that a new nickel-iron alloy had an expansion and contraction under the influence of temperature smaller than with all other alloys produced so far. The alloy was 36 parts of nickel and 64 parts of iron. For measuring apparatus and machines exposed to abrupt changes of temperature this metal might be of importance, and it would be interesting to know how it behaved magnetically.

The Late Sir John Pender.—Lord Kelvin has written to the *Times* in reference to his speech at the Pender memorial meeting in University College on the 2nd inst., the substance of which was reproduced here. It has been brought to Lord Kelvin's notice that, in speaking of the services of the late Sir John Pender in bringing to a successful issue the enterprise for telegraphic communication with America, he inadvertently did serious injustice to the late Sir Curtis Lampson when he said that it was owing to Mr. Pender alone that the Atlantic Telegraph Company was kept afloat from 1858 to 1864. In fact, a large part of the heavy burden of keeping the original Atlantic Telegraph Company alive in the disheartening circumstances of the failure of the 1858 cable, after the short time of its successful working, was voluntarily undertaken by Mr. Lampson when he and Mr. Pender continued to act as directors, and nearly all the others, including Lord Kelvin, resigned. Mr. Lampson was deputy-chairman of the Atlantic Telegraph Company during the cable-laying operations of the "Great Eastern" in 1865; and when the final success was achieved by the Anglo-American Company in 1866, the honour of baronetcy was conferred upon him by her Majesty in recognition of the services by which he contributed so largely towards this result.

Manchester Literary and Philosophical Society.—The Wilde medals for 1896 and 1897 have been presented, the first to Sir George G. Stokes, F.R.S., and the second to Sir W. Huggins, K.C.B., F.R.S. Some time ago Mr. H. Wilde, a distinguished member of the society, endowed it with a fund, the income of which was to be devoted to the advancement of literature, science, and philosophy, and the recognition of meritorious work in these departments. A gold medal, to be called the Wilde medal, was to be awarded annually by the council of the society to the author or originator of any discovery in natural science, or of any valuable invention in applied science, or to the author of an original paper or essay on a literary, scientific, or philosophical subject. In the second place, a sum of 15 guineas and a silver or bronze medal, to be called the Dalton medal, was to be awarded annually to the author of an original paper on a literary, scientific, or philosophical subject accepted by the council for publication in the *Proceedings* of the society. For many years past the society seems to have aspired to the bestowal of medals in recognition of merit in literature and science, and long ago a die for a Dalton medal was actually prepared; but for some reason, probably the want of the necessary funds, the scheme remained nothing more than an idea, until, owing to the generosity of Mr. Henry Wilde, however, its realisation was made possible about two years ago.

Measuring Specific Capacity.—Starke's method of measuring the specific inductive capacities of solid bodies has been described in *Wiedemann's Annalen*, and is abstracted in the current number of the *Journal* of the Institution of Electrical Engineers. The principle of the method is the same as that of the Schwerbe method of determining the specific gravity of solid bodies. The pondero-motive or electromotive properties of an electric field filled with a non-conducting fluid remain unaltered in direction and magnitude by the introduction therein of a solid insulator, only when the fluid and solid substances have the same specific inductive capacity or dielectric constant. This condition can be easily obtained if the dielectric constant of the fluid can be varied within a sufficiently wide range by mixing therewith a second fluid having a different dielectric constant. If now the point at which equality of the dielectric constants of the fluid and solid media is attained can be determined with sufficient sharpness, the dielectric constant of the solid body can be easily determined by measuring that of the fluid. The author employed Nernst's method for determining the dielectric constants of the fluid mixtures. The mixtures were composed of benzol, xylol, benzine, and many other substances; and for dielectric constants above 4·2 a mixture of benzol and ethylene chloride was employed, pure ethylene chloride, at 0deg., having a dielectric constant = 11·31. The standard or calibrating fluids for the condenser vessels were purified benzol and ether.

Water-Tube Boilers.—At the recent congress of Naval Architects a paper was read on "Water-Tube Boilers," by Mr. P. Sigaudy, who said that within the last two years water-tube boilers of the small-tube type had been used to such an extent and with such success that the time had come to examine whether they could be applied to ocean steamers, and whether the legitimate suspicion in which they were held by shipowners and marine engineers was still justified. Locomotive type boilers had proved troublesome from tube leakages in torpedo boats. From the day the tubulous boilers were adopted these accidents had nearly totally disappeared, and the speed has kept on increasing till it had reached, and even surpassed, the incredible 30 knots, and that, too, without any trouble with the boilers. The same thing was certainly going on in large steamers. They attained 20 knots with great difficulties of construction, such as large size, etc.; but if it was wanted to go ahead, they must accept the tubulous boilers. The history of ocean steam

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navigation might be divided into several periods, each of which marked an advance on the preceding one. Up to this day the greatest improvements had been: (1) the substitution of the screws for the paddle wheels; (2) the adoption of compound engines; (3) the triple and quadruple compounding. The next step would be the adoption of the water-tube boiler, and it would prove to be an advance of still greater importance than any of the former ones.

The Junior Engineers.—On Saturday, July 3, a large party of the members of the Institution of Junior Engineers availed themselves of Prof. Ewing's invitation to visit the engineering laboratory at Cambridge. Every preparation had been made to render the visit pleasant and interesting. All the apparatus were displayed in the various rooms. The engines, etc., were running; experiments were conducted on the testing machines, and on the elasticity and other instruments. After the reception by Prof. and Mrs. Ewing, the members were shown over the whole building. The laboratory was only opened in 1893, but the advantages offered are so greatly appreciated that last term the number of students attending was no less than 107. The teaching is carried on by the professor and five demonstrators, with workshop instructors in carpentry, patternmaking, fitting, and forging. Lectures are given on the subjects of the mechanical sciences tripos—viz., mathematics, mechanics, strength of materials and theory of structures, principles of mechanism, heat and heat engines, applied electricity, along with practical work in mechanics and elasticity, heat, surveying, drawing, and electricity. In the teaching of these subjects a variety of machines and apparatus are employed, most of which have been made in the university workshop. For the kind reception which had been extended to them, the acknowledgements of the visitors were expressed by the chairman of the institution (Mr. H. Bloomfield Vorley). On leaving the laboratory special visits were made to Peterhouse, King's, and Trinity Colleges, and also to the electric light station, where the engineer (Mr. John H. Barker) showed the members round.

Sensitive Galvanometers. — A summary of an article in the *Beiblätter* by A. Raps and A. Franke has been published as an abstract in the *Journal* of the Institution of Electrical Engineers. It relates to rendering galvanometers of high sensibility independent of external magnetic fields. In order to prevent the perturbations which act with equal strength on both magnets in all directions—such as earth currents—and to obviate the inconveniences incidental to the use of the iron ring suggested by Du Bois and Rubens, two different methods are proposed. In the first method one or two bundles of thin iron wires are brought near to the weaker magnets in a horizontal direction outside the galvanometer casing, so that the component lying along the axis of the bundles is strengthened. The distance of the bundles from the magnets, and their direction relatively thereto, must be chosen according to the relation between the moments and the difference in the directions of the two magnets. In this manner matters can be so arranged that perturbations taking place in one direction have scarcely any effect on the instrument, while those occurring in a direction at right angles thereto affect the sensibility, but not the position of rest. In order to compensate for the component which is produced by reason of the magnets not being turned exactly through 180deg., two small auxiliary magnets are also mounted on the moving system externally to the two principal magnets; these magnets being much lighter and weaker than the principal magnets, and not appreciably increasing the moment of inertia. These auxiliary magnets are so magnetised that the sum of their moments is only slightly greater than the component of the two principal magnets. By turning the auxiliary magnets the combination can be made perfectly astatic.

Spectroscopy.—High-potential coils and high vacua have not been without their influence on spectroscopy. Sir William and Lady Huggins have, in a paper read before the Royal Society, described a set of experiments showing simply and conclusively that calcium vapour, when sufficiently attenuated, radiates under electrical stimulation, H and K lines alone without any of the other lines of its usual spectrum. The final stage, at which the metal remained present only as a bare trace, was reached by successive approximations, the attendant spectral variations being photographically recorded. They form a connected sequence, obviously dependent upon the thinning-out of the emitting substance. Every other cause of change was indeed carefully excluded, and a spark of small intensity was employed throughout so as to keep the temperature uniform and moderate. This corresponds with what is found to take place in the atmosphere of the sun, and was used by Sir J. Norman Lockyer as an argument to prove that under those circumstances the element was broken up. There never seemed any theoretical reason why the spectrum should not get simpler as the molecules were less hampered by mutual action, and it may be very safely presumed that the argument will be abandoned. As the *Times* says: "Thus the solar prominence spectrum of calcium has at last been artifically produced; and the condition *sine quâ non* of its production is unmistakably the extreme rarefaction of the emitting material—a condition amply fulfilled in the sun. No dissociation hypothesis is accordingly needed to explain spectral phenomena which have hitherto supplied the strongest argument in its favour. The difficulty, nevertheless, remains of accounting for the agility, so to speak, of the calcium molecule."

The Mechanical Engineers.—We may remind our readers that the meeting of the Institution of Mechanical Engineers takes place at Birmingham the week after next. The sittings will be held in the Municipal Technical School, and will begin on Tuesday, July 27. On the morning of that day there will be a reception of the president, Mr. E. Windsor Richards, the council, and members of the institution in the examination hall of the school by the Lord Mayor and the chairman and members of the local reception committee. The president will then deliver an address, which will be followed by the reading and discussion of papers. The afternoon will be occupied by visits to works in Birmingham, of which 25 will be thrown open to the members for inspection. The annual dinner of the institution will take place in the Grand Hotel in the evening. On July 28 the reading and discussion of papers will be resumed in the examination hall and will be concluded. The afternoon will be devoted to the inspection of local works, besides which there will be alternative excursions to Wolverhampton and to Oldbury or Tipton, where a number of the leading engineering and electric lighting establishments will be visited. In the evening there will be a conversazione in the Botanical Gardens at Edgbaston by invitation of the local reception committee. On July 29 there will be two excursions, one to Stratford-on-Avon and the other to Walsall, at which latter place a number of interesting industrial establishments will be inspected. Each of the excursions will occupy the day. The meeting will terminate on July 30. In 1847 the Institution of Mechanical Engineers was founded in Birmingham, which city continued for many years its headquarters. In course of time, however, the institution moved to London. Like some other professional bodies, the members of the institution

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meet only at infrequent intervals, in the present instance four times a year. Three out of the four meetings are usually held in London, the summer meeting taking place in the provinces. This being the jubilee year of the institution it has been decided that it shall revisit its old home, and this year's summer meeting will therefore be held in Birmingham. Preparations are being made by an influential local committee to do honour to the occasion.

A Claim of Priority.—In reference to the various plans for wireless telegraphy proposed by Dr. Lodge, Mr. Preece, Mr. Marconi, and others, it has been claimed from Paris, in the *Daily Telegraph*, that they were all anticipated as long ago as 1870—of course, by a Frenchman. "In 1870, when the French capital was invested by the German army, a chemist employed at the Sorbonne, M. Bourbouzé, who closely studied electric currents, succeeded in preparing an apparatus by which he telegraphed over short distances without conducting wires. Having communicated with the Academy of Sciences, he was directed to make further experiments along the river between bridges, as he saw that water was a better conductor of electricity than land. The experiments were a success, and it was then considered that M. Bourbouzé's arrangement could be utilised at the Auteuil viaduct for communicating along the Seine with a point at Poissy beyond the German investing lines. A balloonist accordingly started for Poissy in his aerostat, with instructions how to act for the reception of messages despatched from Auteuil by M. Bourbouzé. The aeronaut, however, came to grief. His balloon was swept far away from its destination by the wind, and the proposed experiments had to be abandoned." Our contemporary continues: "It is not considered in scientific circles here that the practical application of the principle of telegraphing without wires would be of much use, owing to the numerous restrictions in connection with the working of the system. The French scientists manifest little interest in the alleged invention of the Italian [*i.e.*, Mr. Marconi] nor do they expect anything from it." It is needless to say that induction telegraphy was impossible in 1870 because the telephone had yet to be invented, and as for Hertz-wave signals, the Hertz wave existed only in the form of a possible deduction from Clerk Maxwell's equations. There was theory enough in existence, but few understood it, and no one used it. It is, however, quite true that during the siege of Paris attempts were made to get telegraphic signals between Paris and outside by using the Seine as a conductor, which is quite a different thing to anything of Mr. Marconi's or the others. The only result was that a tale got about, and duly reached the Germans, that the French had a secret cable in the bed of the river. As a matter of fact, the area of the country round Paris occupied by the invaders increased so rapidly, that even now with our present knowledge of what can be done with sensitive receiving devices and heavy currents (which there was then no means of producing) it would be very difficult to succeed in what was attempted.

Mr. Appleyard's Experiments.—The important and interesting experiments of Mr. Rollo Appleyard on the formation of mercury films by an electrical process have been referred to in connection with the Physical Society. A short contribution, published in the *Philosophical Magazine*, gives some further details which are of interest. A sheet of filter paper, damped with distilled water, is folded upon itself four or five times. It is then laid flat upon a conducting surface. An indiarubber ring is pressed down on the folded paper and mercury is poured in to fill the ring. A battery of 200 volts is then connected for about three minutes between the mercury and the lower conducting plate, the mercury being positive After stopping the current the ring is removed from the filter paper and superfluous mercury is poured off, leaving a circular film upon the upper surface of the paper. On unfolding the sheet, a blackish substance is found distributed through it, graduated from the positive towards the negative pole. In a second experiment, if a sheet of tinfoil is included within the folds of filter paper, while the battery is applied, the tinfoil becomes perforated with pinholes. This, however, must not be taken *per se* as a proof of any direct transition of metallic mercury through the diaphragm; for if, instead of the mercury contained in the ring, a sheet of metal is used as the upper electrode, pinholes still appear in a sheet of tinfoil included in the folds of damp filter paper. Moreover, if a sheet of tinfoil is used as the upper electrode, this also becomes perforated. Again, if the sheets of tinfoil are removed, and a gold coin is used for the upper (positive) electrode, upon the top of the damp filter paper, the current produces a gold discoloration which penetrates the folds. This result may throw some light upon the formation of metallic lodes and veins; and although the discolouration is the effect of a steady current, and not sparks, it may help to explain the "inductoscripts" of Mr. F. J. Smith. Mr. Rollo Appleyard, in reference to his films, makes the following suggestive remarks: "It will be remembered that in some experiments I recently described to the Physical Society a globule of mercury, electrified in a partially conducting liquid, sent forth a tentacle in a direction towards the positive electrode. It is perhaps significant that in the present experiments the film is always on the positive surface. In the case of liquid coherers it is possible to conceive that, under the influence of steady or transitory currents, mobile conductors attempt to creep in this fashion through the dielectric films. And again, though the effect is probably very slight and entirely masked by electrolytic disturbances, sea-water may thus penetrate the dielectric at a fault in a cable. The film-forming process may be of practical utility where large surfaces are required to be coated with mercury, as in gold extraction, and possibly in the preparation of plates for primary or secondary batteries."

Rontgen Radiations.—While the Municipal Electrical Engineers were discussing practical questions of electrical work at Manchester, Sir George Gabriel Stokes was expounding high theory to the Manchester Literary and Philosophical Society. The occasion was the Wilde lecture, the subject of which was the Röntgen rays. Sir George said everything tended to show that the Röntgen rays were something propagated in the ether. What then was the nature of the process going on in the ether? Some of the properties of the rays were very surprising. One of the most surprising was the facility with which they went through bodies which were utterly opaque to light. But if that stood alone it would not constitute a very important difference between them and light. There were other properties which were far more difficult to reconcile with any idea of the rays being of the nature of light. For one thing, there was the almost complete absence of refraction. Another remarkable property was the extreme sharpness of the shadows which they cast. In the face of these striking differences, those who speculated with regard to the nature of the rays were naturally disposed to look in a direction having some distinct difference from the process supposed to go on in the production and propagation of ordinary rays of light. But the evidence seemed to him pretty conclusive that the Röntgen rays, like rays of ordinary light, were due to transversal vibrations. The so-called cathode rays might be described as the parents of the Röntgen rays. Rejecting the German view, Sir George Stokes adopted that held by all physicists in this

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country, that the cathode rays might be described as a rain of molecules coming from the electrically-charged cathode, like raindrops in a shower. The molecules struck successively on the wall of the tube, each molecule on striking producing a pulse, as it might be called, in the ether. There was a succession of these pulses coming from various points of the tube, and that explained the almost complete absence of diffraction, and had led him to form a new theory of diffraction. With a constant succession of pulses independent of one another there was no opportunity, as in the case of light, to get up interference in the vibrations of the ether. Sir George Stokes is not an experimentalist, and is therefore more or less at the mercy of any unverified results in *Comptes Rendus* or *Berichte*. But he is a mathematician of great eminence, and it would be a kindness if he would explain a little more clearly to those who have not his great knowledge of the wave theory why solitary waves such as he postulates should never be reflected (there is a possible reason, but the analogy of other transverse undulations is against it), and how the irregular pulsations can possibly be prevented from spreading sideways, so as to give even sharper shadows than the regular light waves. Perhaps this is included in the new theory of diffraction. Other apparently difficult points in Sir George's theory have been indicated before in these notes.

The Price of Electricity in the City of London.—The Commissioners of Sewers are naturally desirous to reduce the price of electricity at as an early a date as possible. They had before them on Tuesday last a clause recommending that the City of London Electric Lighting Company be informed that, failing any permission to the contrary, the Commissioners will insist in future on the due observance of the terms of Clause 33 of the agreements in regard to the amounts to be debited for depreciation in the accounts of receipts and expenditure. The clause in question is as follows: "The contractors shall keep a separate account of the capital expended and to be expended by them in respect to this agreement for public lighting, and also in respect of private lighting. The contractors shall also keep separate annual accounts of the receipts and expenditure in respect of this agreement, debiting each such account with 7½ per cent. on the capital aforesaid (less the amount from time to time written off under this provision for depreciation) and 5 per cent. per annum on the net profits shown by such account for reserve fund until such reserve fund reaches a sum equivalent to one-quarter of the capital aforesaid. If and when in any year during this agreement the balance of receipts over expenditure on the said annual account exceeds a cumulative profit of 10 per cent. per annum on the amount of the said capital, the price hereinbefore fixed for the supply of electricity to private consumers shall be reduced ½d. per unit for each 1 per cent. over 10 per cent., which shall be shown on the said accounts. The said accounts shall at all times be open to the inspection of any person who may be appointed for that purpose by the Commissioners, to whom all necessary information and vouchers shall be supplied on request, and any difference arising between the Commissioners and the contractors shall be referred to arbitration in the manner provided by Clause 16." We have looked into the matter, and find that there is a reasonable prospect of the profits this year warranting a reduction in the price per unit. The accounts for the past year do not, under the above clause, call for a reduction, and the amount transferred to reserve and depreciation, although in excess of the above limit, is all in favour of the consumer. On the report of the committee containing the recommendation that the City of London Company should be informed that the Commissioners would insist in future on the due observance of the terms of Clause 33 coming up for adoption on Tuesday, according to the *City Press*, Mr. Deputy Sayer said they were told that they had been deceived. He should like to know whether the private consumers were going to get a reduction. He hoped the public would not give any orders until the company reduced their prices. Mr. Morton said he hoped they would make use of the sliding scale for the reduction of the price. If they could have succeeded in keeping out the speculators, they might have succeeded in reducing the price. The Clerk said he had written to the company, but they had informed him that it was impossible to do as desired. The recommendation was then agreed to.

The American Association.—From advanced sheets forwarded us of the preliminary programme of the Detroit meeting of the American Association for the Advancement of Science, it appears that papers are to be presented from the University of Michigan, Johns Hopkins University, Massachusetts Institute of Technology, Cornell University, Princeton University, Lehigh University, and from many of the most important laboratories in the United States. Many distinguished physicists and electricians have expressed their intention to attend the meeting. The British Association meets on August 18 at Toronto, and a number of its members have already signified their intention of being also present at Detroit. The programme of the physics section will be particularly strong in electrical papers, and contains the names of Mr. Steinmetz and Mr. Brush, in addition to those who occupy university or college positions. Among the list of 29 papers to be read, the following have an immediate bearing on electrical problems: "The Screening Effect of Induced Currents in Solid Magnetic Bodies in an Alternating Field," by Mr. Charles P. Steinmetz, General Electric Company, Schenectady, N.Y.; "The Design, Construction, and Test of a 1,250-Watt Transformer," by Prof. Henry S. Carhart, University of Michigan, Ann Arbor, Michigan; "Electrolytic Action in a Condenser," by Dr. K. E. Guthe, instructor in physics, University of Michigan, Ann Arbor, Michigan; "On the Velocity of Light in a Magnetic Field," by Prof. E. W. Morley, Cleveland, Ohio; Prof. H. T. Eddy, Minneapolis, Minn., and Prof. D. C. Miller, Cleveland, Ohio; "The Magnetic Survey of Maryland," by Dr. L. A. Baner. University of Cincinnati, Cincinnati, Ohio; "The Effect of Heat on the Elastic Limit and Ultimate Strength of Copper Wire," by Prof. Frank P. Whitman, Adelbert College, Cleveland, Ohio, and Mary C. Noyes, Ph.D., Lake Erie Seminary, Painesville, Ohio; "The Electric Conductivity of Certain Specimens of Sheet Glass, with Reference to their Fitness for Use in Static Generators," by Prof. Dayton C. Miller, Case School of Applied Science, Cleveland, Ohio; "Graphical Treatment of Alternating Currents in Branch Circuits in Case of Variable Frequency," by Prof. H. T. Eddy, Minneapolis, Minn.; "On Simple Non-Alternating Currents," by Prof. Alexander Macfarlane, Lehigh University, South Bethlehem, Pa.; "Instruments for Determining the Frequency of an Alternating Current," by Prof. George S. Moler, Ithaca, N.Y., and Dr. Frederick Bedell, Cornell University, Ithaca, N.Y.; "The Predetermination of Transformer Regulation," by Dr. F. Bedell, Cornell University, Ithaca, N.Y., Prof. R. E. Chandler, Salem, Va., and Mr. R. H. Sherwood, Brooklyn, N.Y. There will also be a paper on "The Effect of Pressure on the Wave-lengths of the Lines of the Emission Spectra of the Elements," by Dr. W. T. Humphreys, Johns Hopkins University, Baltimore, Md.; and Dr. C. D. Child, of Cornell, will have a paper on "The Discharge of Electrified Bodies by the Röntgen Radiations."

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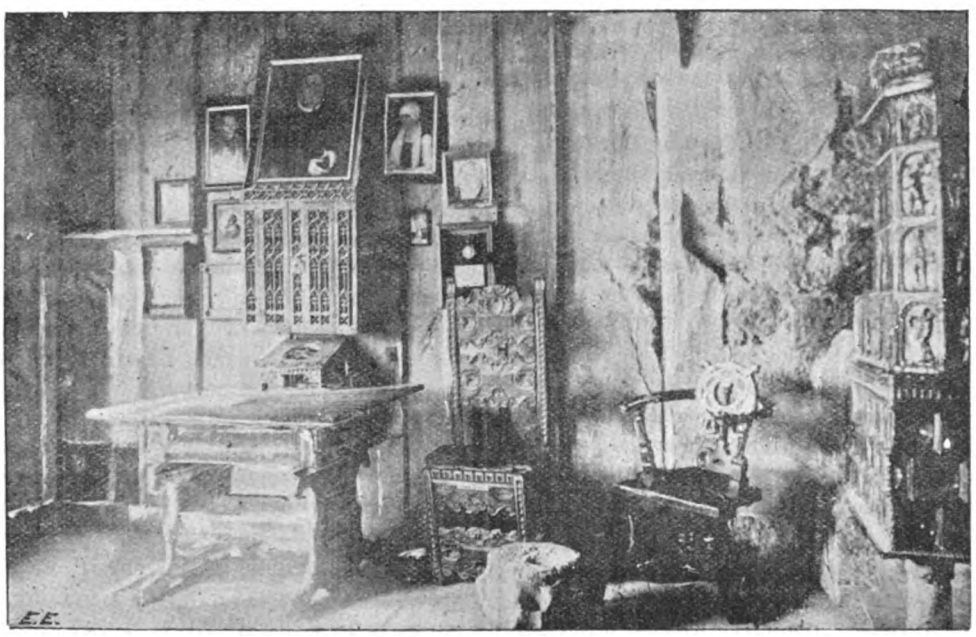
VERBAND DEUTSCHER ELEKTROTECHNIKER.

EISENACH MEETING.

(BY OUR SPECIAL CORRESPONDENT.)

(Continued from page 55.)

The last official act of the 1897 meeting of the Verband was a visit on Sunday morning, June 13, to the Wartburg. This old fortress has only recently been made accessible by vehicles, and on a hot day, as this Sunday was, a ride up the well-graded and winding road was preferable to a climb up one of the numerous footways. There is at present no electric lighting outfit for the castle and fortress, which is still inhabited by a small military force. Hence the visit was purely a social function. The noted room in which Martin Luther slung the inkpot at the devil was on view, and for the benefit of my readers a photograph of this room is given with this article. After a specially-conducted tour round the fortress we severally made our way back to the house and commenced preparations for a general departure. A large number of the members proceeded to Leipzig to inspect the exhibition there, on the invitation of a local committee. This function was attended by Mr. C. H. Biggs, to whom the following account of the work there must be credited.



Martin Luther's Room in the Wartburg.

THE LEIPZIG EXHIBITION.

Germany seems, indeed, to have a craze for exhibitions just now, having no less than three in full swing to my knowledge — viz., at Leipzig, Dresden, and Hamburg respectively. It is to the first-mentioned of these that I would now refer, not exactly to detail the many hundreds of interesting exhibits, but rather to give a few particulars with regard to the lighting and power arrangements of the exhibition, which are on no small scale. Although the exhibition is solely restricted to the productions of Saxony and Thuringen, yet it is singularly comprehensive, containing many examples of industry and art of which Germany may well be proud. The exhibits which have for the electrical engineer a more than passing interest, however, are, perhaps, with regard to numbers, somewhat disappointing; but the splendid and extensive contribution of a single firm—*i.e.*, Messrs. Schuckert and Co., of Nuremberg—goes a long way to compensate one for any lack in mere numbers. Besides many disconnected motors, transformers, etc., the exhibits of this firm comprise the whole of the electrical machinery and apparatus supplying the exhibition with light and power. Whatever other exhibits of electrical apparatus there may be are comparatively unimportant; in fact, that of Messrs. Schuckert and Co. not only holds a central position in the great machinery hall, but also provides the centre of attraction so far as the electrical engineer is concerned. To give some idea of the size of the installation, I need only mention that its capacity is equivalent to about 1,700 h.p., while the maximum load is 1,300 h.p. This power is developed by no less than 15 units, 12 of which are continuous-current machines and the remaining three alternators, their individual capacities being as follows—viz.:

Continuous-Current Machines.

Four	of	115	kilowatt	capacity,	supplying	at	110	volts pressure.
One	,,	100	,,	,,	,,	,,	240	,, ,,
Four	,,	53	,,	,,	,,	,,	110	,, ,,
Two	,,	40	,,	,,	,,	,,	110	,, ,,
One	,,	260	,,	,,	,,	,,	500	,, ,,

Alternating-Current Machines.

One	of	120	kilowatt	capacity,	supplying	at	2,300	volts pressure.
One	,,	80	,,	,,	,,	,,	240	,, ,,
One	,,	40	,,	,,	,,	,,	110	,, ,,

Besides the plant enumerated above, there are also two batteries of accumulators, each containing 63 cells. These, connected in series, give 150 amperes at 220 volts. One battery consists of the well-known Tudor type of cells, while those in the other are of Pollak make.

Perhaps the most interesting of the electrical generators is the last on our list of alternators. This is a two-phase machine coupled direct to a 150-h.p. vertical engine of marine type. The armature coils are stationary, while the field revolves; the iron core of the latter, together with its interleaving (claw) pole-pieces, being cast in two cylindrical pieces and bolted together. Between these two castings (concentric with and about midway between the axis of rotation and the pole-pieces) is wound the field coil, which is therefore practically enclosed. Pegs are inserted into this coil to prevent any motion independent of the core, to which, by the action of centrifugal force, it would otherwise be subject. The necessary excitation is obtained from a dynamo, generating at 80 volts pressure, fixed on the common shaft. This exciter, it may be mentioned, is provided with a Mordey shunt. Notwithstanding that precautions have been taken to prevent the field winding from slipping, it cannot be denied but that the design affords scope for considerable adverse criticism from a mechanical point of view With regard to the other generators, little more of special interest remains to be said, as they are all well-known examples of Messrs. Schuckert and Co.'s manufacture. It may be mentioned, however, that the alternators are direct coupled to vertical engines of marine type, while the direct-current machines are mostly driven in pairs by means of belts or ropes, each engine driving two dynamos. The machines generating at 110 volts are, moreover, connected two in series. In case of necessity, four can be so connected from the switchboard.

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All pipes conveying steam to the engines are snugly hidden from the public gaze beneath the flooring, while the boilers supplying the steam are situated in a building of substantial structure some little distance away. These latter are 10 in number, in two batteries, and of various makes and sizes, but are all of the water-tube type, and burn the common brown coal of Germany in their furnaces. This coal yields 4,000 calories of heat per pound (German), I believe. One boiler is provided with a special furnace for burning the waste or dust of the stokehole. All are mechanically stoked. When I recently visited the exhibition, provision was being made whereby the labours of the human stokers in attendance will be considerably lightened. Hitherto the coal has been elevated into the hoppers of the mechanical stokers by hand-power; but by the new arrangement it will be conveyed in buckets from the floor-level to an elevated platform, and from thence shot through funnels into the hoppers as required, the buckets being linked to an endless chain and driven by mechanical power in a similar manner to the buckets in a steam bucket dredger. The boilers supply their steam to a common main on the ring principle, valves, etc., being provided to enable any section to be isolated for repairs. Like the boiler-house, the chimney shaft adjacent is also of substantial brick build, and is 65 metres (over 200ft.) high. An economiser is placed in the main flue. The provision made with regard to the supply of water to the boilers and for condensing purposes is decidedly interesting. It must not be forgotten to state that all the engines are condensing. This being the case, and the available supply of water limited, special provision has accordingly been made to economise. The water for condensing and likewise for the boilers is drawn from a pond and wells situated near the boiler-house. It is not of sufficient purity to be conveyed to the boilers direct, so first undergoes a cleaning and softening process. For this purpose two large combination filters and softeners have been installed. These are situated in a building adjoining the boiler-house, and the pond water is forced into them by Worthington pumps. The cleansed and softened water is conveyed again by Worthington pumps to the boilers, each feed pipe being quite independent, so that the quantity of water in gallons or pounds supplied during a given time to any one of the boilers can be readily ascertained.

For the purpose of economising the condensing water, two great wooden towers have been erected outside the engine-room; they stand over an open tank or reservoir. On a level near the summits of these towers perforated channels bridge across and across the interiors, while beneath are situated extensive frameworks of wood, with rough boards (forming huge slightly slanting screens or partitions) attached. These partitions reach almost to the surface of the water in the reservoir, and provide an immense cooling surface. After circulating through the condensers, the water, which has, of course, absorbed a certain amount of heat, is elevated by Worthington pumps to the channels above mentioned, and from these percolates through to the rough wooden partitions, and so trickles over them until it finds a temporary resting place in the reservoir beneath. During the process, the water parts with its superfluous heat. It is then ready to be forced again direct from the reservoir through the condensers. And so the process is repeated; the same water, in fact, being used and reused, except that lost by evaporation. The system of distributing the current generated by the electrical plant cannot be concisely stated, since no general method has been adopted—many of the circuits being independent, besides which they are supplied at different voltages.

A portion of the low-pressure distribution is arranged on the three-wire system, with a tension of 230 volts across the two outer wires, and 115 volts between the neutral and outers. There are also circuits with a 240-volt continuous-current supply for lighting and power, and again with a 500-volt supply for arc lighting, while there is also a 500-volt circuit for power purposes. Altogether there are 11 circuits for continuous-current supply, though they are, of course, not all supplied by separate machines. The alternating-current supply is at 110 and 240 volts for lighting and power, while there is also a special circuit for a three-phase motor of 100 h.p. running with a pressure of 2,300 volts between any pair of its terminals. This motor may be seen driving some of the looms, etc., in the textile hall. There are 300 arc lamps distributed over the exhibition grounds and buildings, of which number 250 are placed in series of 10 lamps across the 500-volt arc lighting mains. The remaining 50 are distributed amongst the various other circuits. Where the 240-volt mains occur four arcs are placed in series across them, and two in series are put across the outers and neutral of the three-wire distribution. Not many alternating-current arcs are fixed, but a few have been used in the machinery hall.

Included in the lighting arrangements of the grounds are 22 searchlights for illuminating the lakes and fountains. They are situated in batteries on the shore, the different-coloured glasses provided being turned by an electric motor. All are on one circuit, and absorb 150 h.p. of the load. There is also a searchlight which takes 90 amperes, its rays penetrating some 45 miles, while the diameter of its lens is 90 centimetres (35½in.). Some of the incandescent lamps in the garden restaurants and grounds are fixed in a very temporary fashion. I noticed wires being secured to branches of trees or any other convenient support. And in many instances the lamps are held in suspension by these tree-supported wires, the wires (insulated) where the lamps occur being twisted round porcelain insulators secured to metal arms. On the 240-volt circuits the rule has been to put 120-volt lamps two in series, but a few 240-volt lamps are also fixed. A single-track electric tramway encircling a greater part of the exhibition grounds has been constructed. This was intended to be a novelty in the way of electric traction, but has been transformed from its original guise to that of the simple and thoroughly tested overhead wire system, with the rails as a return. The line is equipped with five self-contained cars, besides open cars, which trail behind. It was first attempted to work the line by means of the electric current conveyed along an insulated conductor placed between double rails at one side of the track. Connection was made with this conductor through push contacts of carbon placed at frequent intervals. These contacts had a copper crown, and depended upon the efficiency of a spiral spring for their break action. Each car was provided with a collecting shoe, bevelled at either end, of sufficient length to bridge two contacts at any one time. As a car proceeded its collector bridged and depressed successively, the pushes offering resistance to its path, thereby making contact between conductor and motor through the carbon-copper cap, and, lastly, the metal shoe. This system was actually tried at the exhibition, but was abandoned, I understand, owing to the frequency of short-circuits. Failure on this account might have been predicted from an inspection of the arrangements without going to the trouble of experimenting on a large scale. Another fatal drawback with the system as arranged at Leipzig was that anyone might have made contact with the conductor by depressing one of the pushes with a stick or umbrella. However, it is not likely that the experiment will be repeated unless on greatly modified lines.

Current is also supplied to no less than 250 motors of various types and powers. Twelve of these are designed for alternating currents, including the large three-phase motor already alluded to. Of the others included in the 12, two run with a 240-volt supply and the rest with 120 volts, while the periodicity is 50 in each case. It is interesting to observe that out of the collective total of 250 motors, 130 have been supplied by Messrs. Schuckert and Co.

The switchboard controlling the numerous machines and circuits mentioned above presents quite a study, especially behind the scenes, where a veritable labyrinth of terminals and connections—albeit exceedingly neat and orderly in arrangement—greets one's gaze. The board is of polished marble, supported on an iron framework. The individual units of the generating plant being of divers patterns, and supplying, moreover, at different voltages, are consequently not all connected up to common 'bus bars, but are arranged in sets, or run separately, according to requirements, in the case of the continuous-current machines, while the alternators, so greatly differing in types and voltages, are, of course, run separately. It will be seen that the prevailing idea with the designer has been to guard

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against the possibility of a serious breakdown; and as the distribution has been arranged from the switchboard, any breakdown of plant is only local in its effects, and in no way interfering with the efficient working of the other machinery. The connections on the board also facilitate any necessary rearrangement of the units should a partial breakdown occur. For instance, should anything go wrong with the dynamo generating at 500 volts, then a suitable combination of the other machines can be arranged in series, with the assistance of the accumulators, to make up the desired voltage. As a matter of fact, the accumulators have only been provided as a stand-by in the eventuality of a breakdown. With the provision for running certain machines in series it will be readily understood, without my giving further examples, that many other combinations which may be desirable are rendered possible. Continuous-current machines could also, it will be seen, be connected to some of the mains supplied by the alternators, and *vice versâ*. This would, of course, be impossible did transformers bar the way, but such is not the case, all transformation of current being done in close proximity to the generators, so that only low-tension leads proceed from the switchboard, with the single exception of the motor circuit, to which reference has already been made. By this happy arrangement of the switchboard not only is the possibility of a serious breakdown greatly minimised, but Messrs. Schuckert and Co. are enabled to include in their working exhibit machines of greatly varying designs and voltages. A motor-transformer, or booster, enables the accumulators to be charged with only one of the smaller low-voltage machines generating. Where a pair of 110-volt dynamos are driven together, one may, therefore, be run light, the other charging the accumulators through the booster. The accumulators are also provided with two multi-contact self-adjusting voltage switches for regulating the pressure when charging or discharging. These, together with the other numerous instruments with which the switchboard is provided, are of Messrs. Schuckert and Co.'s manufacture.

Coming to the cables used for the installation, it is interesting to note that 25 miles have been supplied, of diameters varying between 2·5 and 40 millimetres. One cable is of special manufacture. It consists of three wires stranded together, each insulated to withstand a working pressure of 2,300 volts, being for the three-phase motor. Paper insulation is used, and the whole is armoured with iron, which is again protected by a jute covering. This cable, when tested for insulation resistance, successfully withstood a pressure of 60,000 volts. All of the cables are armoured and laid direct in the ground. Exclusive of the mains, 75 miles of overhead wires have been used in the installation, which, together with the cables, were supplied by Messrs. Felten and Guilleaume, Muhlheim-am-Rhine.

I felt proud of the old country upon finding that the whole of the installation above described, from the dynamos to the lamps, had been designed on behalf of Messrs. Schuckert and Co. by an Englishman—Mr. Charles Mendelson by name—and this, too, when there is so much native talent in Germany. Mr. Mendelson not only devised the installation throughout, but also personally supervised the carrying out of the work, and is still in charge. I am indebted to him for the information given above, which I was able to glean during the short time at my disposal whilst on a flying visit to the exhibition. The exhibit of Messrs. Schuckert and Co. also includes an extensive assortment of transformers, including two of 110-kilowatt capacity, each transforming from 2,300 to 110 volts, and one of 53-kilowatt capacity, transforming from 2,300 to 240 volts. These are in use for the installation purposes, but many others of smaller size are shown, including some laminated cores without winding, which may be ordered and wound to suit any requirements. A novelty in the shape of a 3-h.p. single-phase motor with a hydraulic coupling, is also shown. The novelty lies in the coupling arrangements, by which the motor is allowed to run up to full speed before the load is taken on, thus obviating the trouble which is frequently experienced when a single-phase motor is put directly on to a load. To attain this object a cylinder is provided, partitioned into two halves and fixed on the motor shaft. Situated in that side of the cylinder adjacent to the motor is a closely-fitting but movable brass disc in connection with friction coupling, while the outer half is filled with glycerine having access to the brass disc through perforations in the partition near its rim. When the motor is started light, this glycerine naturally tries to escape through the perforations provided, and in so doing, with the rapidly-increasing revolutions of the motor, presses with greater and greater force against the brass plate, moving it forward and so bringing the connected friction gearing gradually into play. In this way the load is taken up after the motor has attained a high speed, the friction gearing accommodating itself to the action by slipping until the brass disc has been moved sufficiently forward to make the clutch firm. Messrs. Schuckert and Co. use compressed leather, to a large extent, for toothed-wheel gearing—a leather wheel in contact with one of iron giving greater flexibility and less noise than two of iron. Carbon brushes are also employed with all motors of the above firm's make. In conclusion, I may add that Messrs. Schuckert and Co. have carried out the whole of the electrical work described, with the exception of the tramway encircling the exhibition grounds, which, however, is supplied with energy from their plant.

ELECTRICAL EQUIPMENT OF THE "FUJI."

BY CHAS. E. GROVE.

The following article, with blocks, we have been allowed to reprint from the *Thames Ironworks Gazette* by the courtesy of the Thames Ironworks and Shipbuilding Company. The *Gazette* is a most excellent quarterly, which gives a good idea of the large number of interests and departments of the firm in question. The Japanese warship "Fuji" is the latest production of this firm, and the present number of the *Gazette* contains much information as to the equipment and performance of this last triumph of marine engineering and shipbuilding skill. The matter is all worthy of reproduction, but we have necessarily to confine ourselves to the electrical equipment. The ship, as completed, is shown in Fig. 1. It will be noticed that the author concludes that the majority of his readers will not be electricians, and we must apologise to him if we here upset his calculations by giving our readers the benefit of his work

"If I were writing a paper under this heading to be read by electricians only, I might content myself by saying that 'the electrical equipment of the "Fuji" is carried out on British Admiralty lines, with such and such exceptions and additions'; but as I take it that the majority of people who will read this paper are not electricians, I wish to try to explain the work in a rather more complete and popular way, so as to give a general idea of what the electrical work on a battleship is like.

"We naturally commence our review of the electrical system with the engines and dynamos. Of these there are three, each of the machines being capable of an output of 400 amperes at 80 volts—*i.e.*, 48 e.h.p.—or sufficient current to maintain 500 16-c.p. lamps at their ordinary brilliancy. The three dynamos (Fig. 2) are connected to omnibus bars on the main switchboard from which the circuits are led. The dynamo bars are horizontal, and the circuit bars form vertical bridges over the dynamo bars, the connections between the two being made by means of plunger switches with springs inside them to give quick break. This switchboard is of standard British Admiralty design, but I, for one, do not like it, and I think he would be a very poor electrical engineer who could not design a better one. By the use of such a board the dynamos cannot be worked in parallel, but each machine running must take a certain number of circuits, the other circuits being connected upon the other dynamos. Of course, in ordinary peace times all the ordinary electric lighting work is done by one machine, but in times of war, or in carrying out manœuvres, when searchlights have to be employed, these are worked from a separate dynamo or dynamos. There are six main circuits on the 'Fuji' for supplying lamps with current; three of them are protected, and three unprotected, the three unprotected ones supplying respectively (1) the cabins and saloons at the after end of the

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vessel, behind the screen armour, and above the protective deck; (2) the crew spaces in the forward part of the ship; (2) the central parts of the ship above the protective deck and between the armour bulkheads, in addition to bridges, deck cabins, etc., but not including lights in casemates or conning towers, which are upon the next circuit. The three protected circuits supply respectively—(1) the 'citadel,' with which is included the lighting of the barbettes, the ammunition passages, auxiliary machinery-rooms and stores; (2) the magazines, shell-rooms and handing-rooms; and, lastly (3), the engine and boiler rooms, and coal bunkers.

"Besides the six circuits for incandescent lighting, there are five circuits for the projectors; a pair of cables running direct from the main switchboard to a terminal box near the projector, and from thence by flexible cables to the projector itself. The projectors are mounted, two on the forward bridge, two on the after-bridge, and one on the after searchlight top. All of them being in exposed positions, the cables leading to them are armoured with steel wire, so as to protect them from injury by flying splinters, fragments of shells, and such like, in time of war. The projector upon the after-mast is fitted with electric motors, so that it is trained and elevated by electricity, the movement of the projector being simply controlled by moving a switch handle, fitted upon a pedestal on the after-bridge. There is a similar switch and equipment of cables upon the foremast ready to take another automatic projector on the forward searchlight top, but the ship will not be fitted with this additional projector in this country.

"All the cables and wires used in the ship are lead covered. The mode of fixing them up is to provide battens of mahogany to which the wires are attached side by side by means of brass cleats or saddles. Occasionally, when dealing with runs of small wires, they are attached directly to the steel bulkheads. Where the cables go through watertight bulkheads, of course the bulkhead has to be made watertight behind them. This has been done on the 'Fuji' in a very simple and effective way. Two pieces of wrought-iron plate are taken and drilled with holes slightly larger than the size of the cables that are to come through. Similar blocks of indiarubber, about ½in. thick, have holes formed in them just the neat size of the cable. The bulkhead is drilled with clearing holes. A slab of rubber and an iron plate are placed on either side of the bulkhead, the cables are drawn through, and then the plates screwed up tight. By this means pressure is put upon the rubber, which makes the holes through which the cables pass smaller, so that the cables are gripped, and the holes are watertight. I got the germ of the idea of this from some similar arrangements which I saw upon H.M.S. 'Majestic' some 18 or 20 months ago; but the 'Fuji' is, I think, the first vessel to which this type of gland has been generally applied, and the result is entirely satisfactory, one advantage being that the cables can be made to pack so much more closely together, thus economising space, which is very important. They are also much cheaper than the usual tubular glands. A good general idea of the arrangement of cables in the ship will be obtained from the photograph (Fig. 3) representing a corner just outside one of the ammunition passages—one of the most crowded places in the ship for pipes and wires. The pipes passing overhead, coloured brown and white, are voice tubes.

"The next section of electrical work of importance, as regards magnitude, is the voice-pipe and bell-communication system, which on the 'Fuji' is particularly extensive; indeed, I believe no previous ship has so elaborate a system. There are in all 263 points in the ship from which speaking or signalling by electric bells can be effected, and these include all the gun positions, machinery compartments, searchlights, navigating and steering stations, and the like, so that, in fact, any executive officer at his post of duty has at his elbow ready means of communication with the other sections of the ship with which he is co-operating. I have included, as a typical voice-pipe station, a photograph (Fig. 4) of the arrangement of the instruments in the wheel-house upon the forward bridge. It will be seen from this view, and from the views of similar instruments in the air-compressing chamber and conning tower, that combination watertight instruments have been employed throughout, the push-piece and the shutter indicator being invariably together, and one or more bells serving for a group of instruments. The current for working these instruments is obtained from batteries placed in watertight boxes in convenient positions, and in this system, as in the lighting system, any necessary junction or cross connecting of wires is effected in watertight junction boxes, so that there should be no joints in the wires.

"The same photograph shows the way in which the cables end—namely, in what are called 'section boxes.' These are watertight boxes containing a switch and four pairs of terminals for the attachment of fuses and the branching of cables, each of the four pairs of cables running from a section box terminates in a 'distributing box,' which is a similar box to the section box, also containing fuses and a switch, and from each distributing box eight pairs of wires are taken, each pair leading direct to the terminals of one lamp. This 'distributing-box

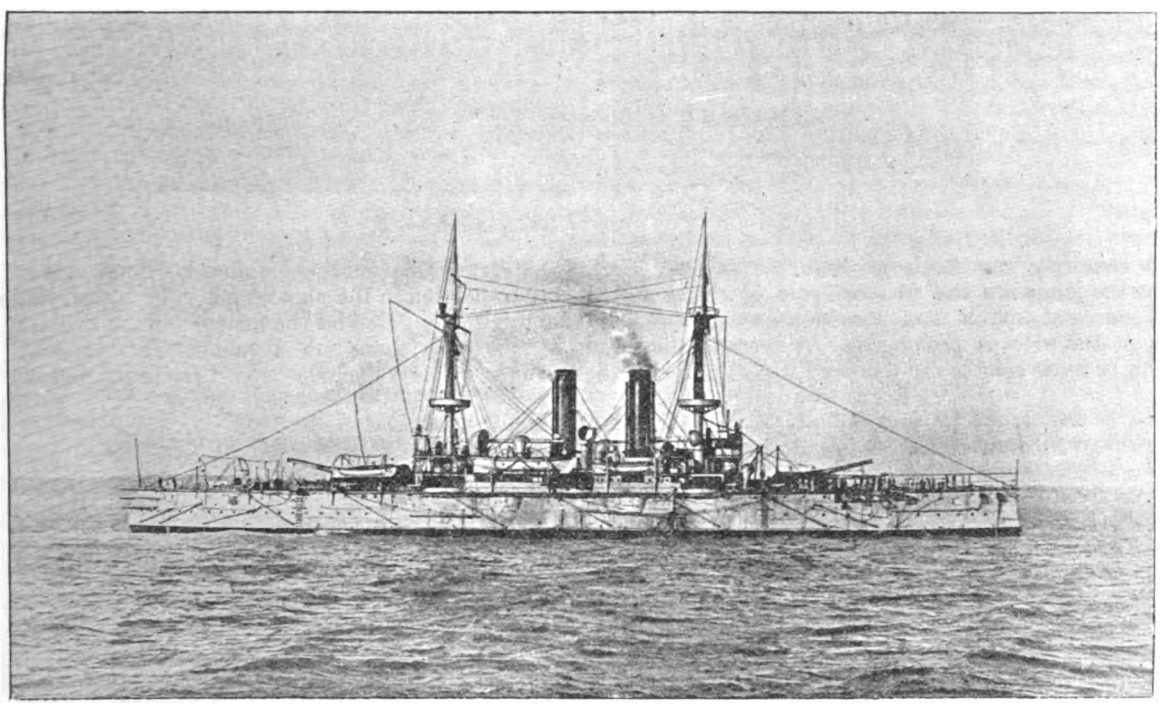

FIG. 1.—The Japanese Warship "Fuji."

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system,' as it is called, was introduced into British Admiralty ships about seven years ago. It had been previously used in a considerable number of hotels, blocks of mansions, and such like places. Its advantages are that it enables an electric light system to be entirely laid out without requiring any joints or branches in its wires. Thus, as the joints are the weakest part of the system, a fruitful source of trouble is at once done away with, and the life of the wires is prolonged. As regards ships, the work can be more completely rendered watertight. In the event of any part of the system becoming injured, it can at once be switched off at the nearest distributing or section box, and the working of the system in general is not interfered with.

"The total number of lights in the ship, exclusive of projectors, is 778, and one of the features of the system employed is the very large number of portable lamps that are used. These number 125 in all, and in this respect, as in some others, the responsible officers have made a record. In the principal saloons and officers' quarters very handsome silver-plated fittings carrying both electric lamps and candles have been employed. Some views of these are to be seen in the photograph (Fig. 5) of the admiral's dining-room. Besides the fittings for the ordinary lighting of the ship there are a number of 'special' electric fittings. These include two 'yardarm reflectors,' each containing eight 50-c.p. lamps for use at night when coaling, receiving visitors, or for general deck illumination. There are also several sets of lanterns for signalling purposes, as, for, example, the Ardrois speed signal gear, which is used by the flagship for indicating to the other ships of the squadron orders as to

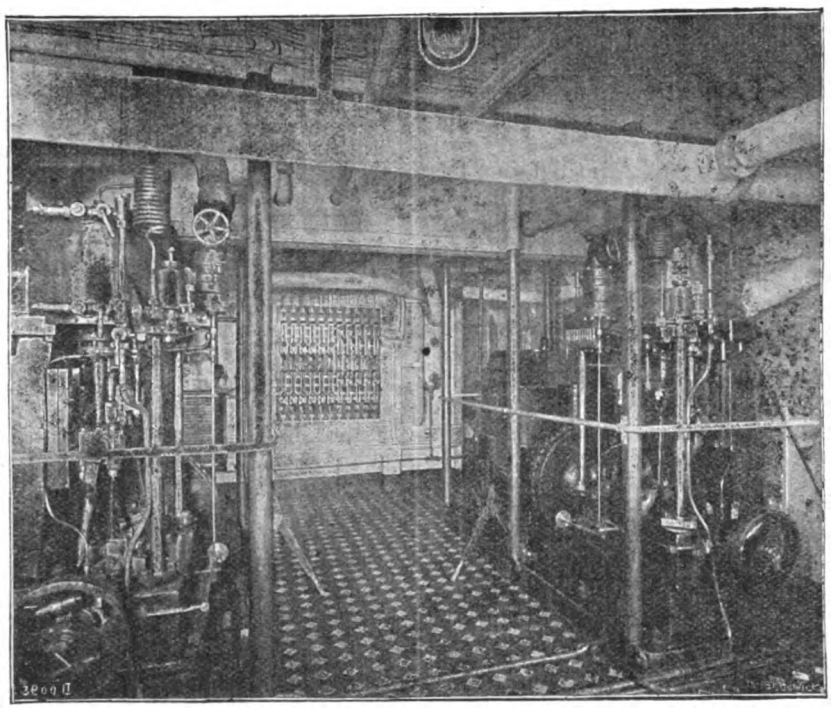

FIG. 2.—View of the Engine-Room and Switchboards on the "Fuji.

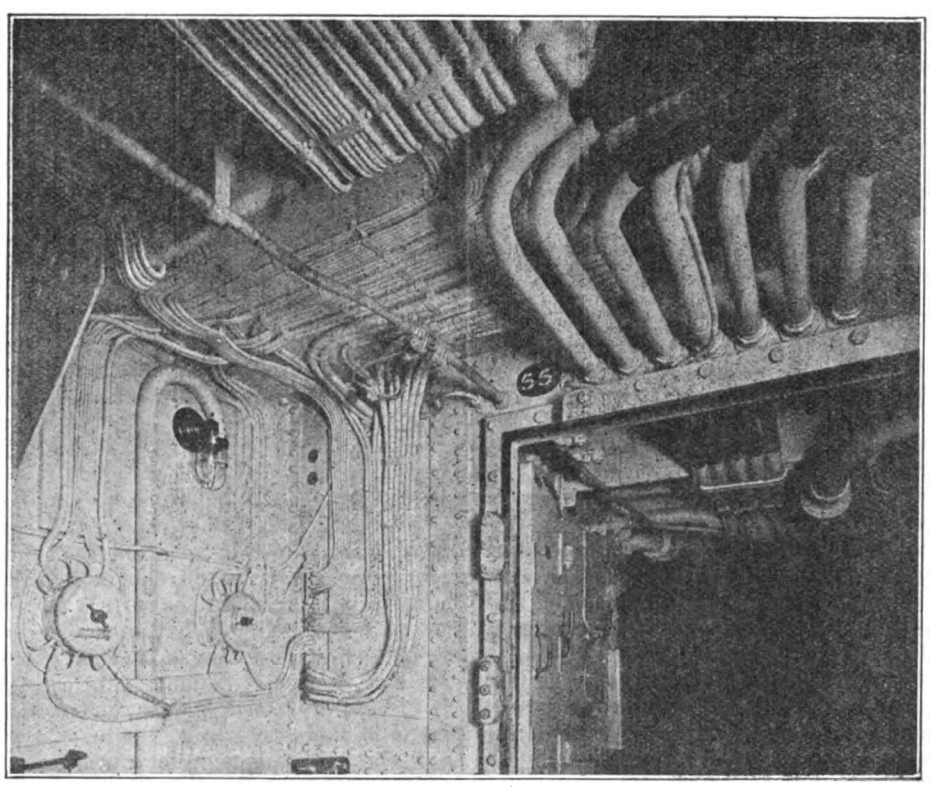

FIG. 3.—View of the Electric Light Wires in an Ammunition Passage on the "Fuji."

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speed. For this purpose a fixed lantern containing one white light is attached to the fore starboard yardarm. Suspended near this, over a sheave, is a double lantern containing one white light and one red. These lamps are, of course, separately operated by switches. When the movable lantern is close up to the yardarm, if the lower light is white, it means 'full speed ahead,' but if red, 'full speed astern.' When the movable light is half-way between the yardarm and the rail, it means 'half-speed ahead,' but if in this position the red light is shown, it means 'half-speed astern.' If the white light is shown quite low down, it means 'slow speed ahead,' and the red light in the same position means 'slow speed astern.' These signal lights can also be operated from the after-bridge, so that the light is seen only astern, as when manœuvring in line formation. There are also two sets of lanterns for illuminating the semaphores placed on the bridges, so that these may be used for transmitting ordinary semaphore messages to ships near; and there is a set of three lamps, arranged in triangular fashion upon the after searchlight top, which burn continuously at night when the admiral is aboard, and so indicate that fact to the rest of the fleet.

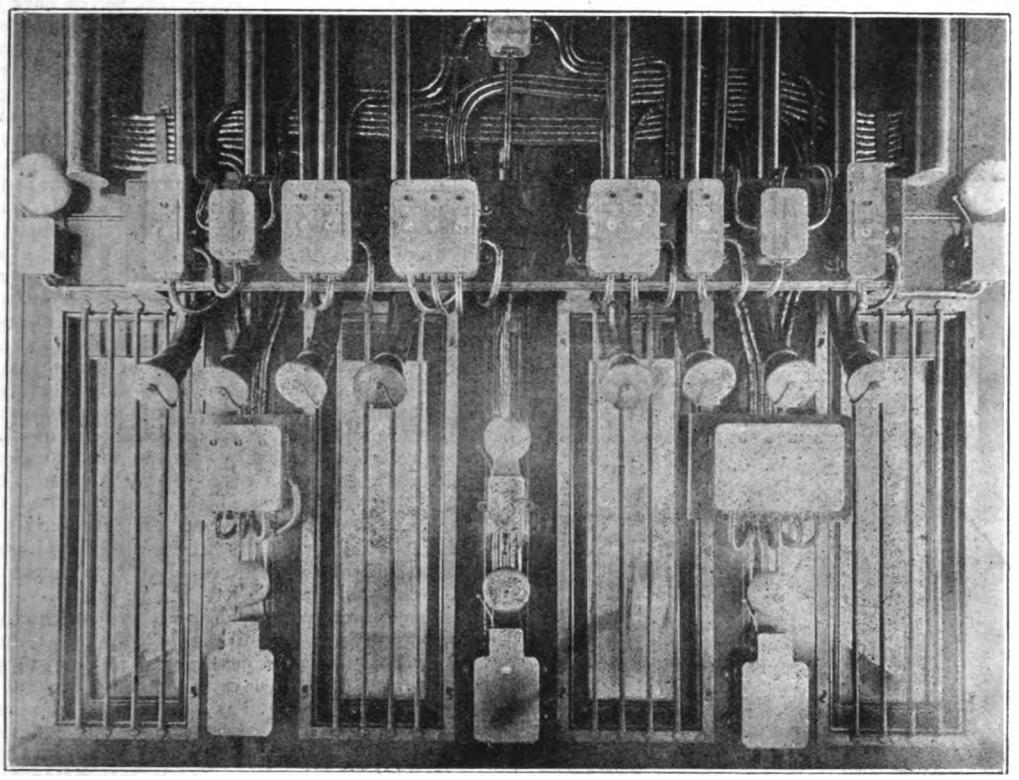

FIG. 4.—A Typical Wire Tube Arrangement on the "Fuji.

"A system of electrical instruments, the invention of Signor Molinari, an Italian engineer, formerly in the Italian Royal navy, are worked off the propeller shafts, and indicate in each engine-room the speed of both sets of engines, showing this also in the chart-house and in the conning tower. The connections to these instruments were made by us for Messrs. Humphrys, Tennant, and Co. For Messrs. Armstrong's we have installed the electrical work in connection with the armament, including circuits for discharging torpedoes, and firing the large guns by electricity, also circuits for working

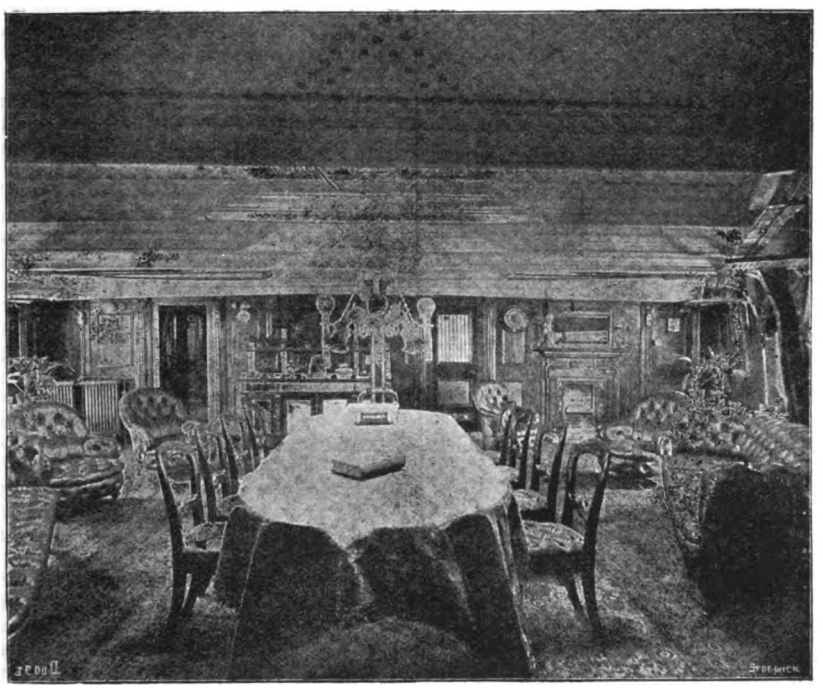

FIG. 5.—The Admiral's Dining-room.

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electrical pumps and for training the turrets by electro-motors. In connection with the ordinary mechanical ship's telegraphs there is a little electrical work, but the makers of the instruments did this themselves. For those who like such statistics, I may mention that there are in all rather more than 23 miles of cable and wire in the 'Fuji,' of which over five miles contains four wires to each cable, and more than a mile two wires per cable, the total equivalent length of single conductor being about 40 miles. The history of the work has been quite uneventful. Without accident or mishap of any kind it has been quietly carried to a successful conclusion, and the Japanese officers have expressed their appreciation."

MUNICIPAL ELECTRICAL ASSOCIATION.

SECOND ANNUAL CONVENTION, MANCHESTER, JUNE 30.

(Continued from page 51.)

Prepayment Meters.

BY W. H. COUZENS, A.I.E.E., BOROUGH ELECTRICAL ENGINEER, TAUNTON.

Those electricity supply undertakings of municipalities which have been in operation for a few years have reached a definite stage in their growth when they have to consider seriously the extension of their undertakings. Their stations have been built and their mains have been laid with the object of supplying primarily the crowded business portions of the towns, and during the first two or three years their hands are full connecting up the customers who are eager to have their shops and offices supplied. But at the end of that period they have gleaned most of their harvest here, and to maintain the rate of increase of their lamp connection they have to seek fresh woods and pastures new.

There are two extensions which immediately suggest themselves—viz., the outlying suburban districts on the one hand, and the thickly-populated districts on the other. At the present time the tendency is to cater for the former and to neglect the latter. This, the author will endeavour to show, is neither a wise nor a proper policy. The extensions to the outlying districts require very large expenditure on mains, and possibly some change of system. The capital outlay per consumer is very great as the houses are more scattered, and the revenue per lamp connected is low, as it will be largely residential lighting where the maximum demand will not exceed about one-third of the number of lamps installed. But there is in the poorer districts, which are usually much nearer the supply station, a class of supply where the number of lamps installed is practically a register of the maximum demand, which demand is used with unfailing regularity from dusk to 10 or 11 o'clock, or even after, and where, with the prepayment meter, may also be secured that great commercial desideratum—viz., cash with order.

The poorer districts are quite unable to become ordinary customers of the electricity supply department. But they would like to have the light if they could, and it is in many ways essentially the "poor man's light." Further, the corporation has a duty to perform to these less wealthy members of the community: they are ratepayers (directly or indirectly), and they form the backbone of the municipality. With town's water, she considers herself bound to supply them, and with the electric light, as the safest, healthiest, and best illuminant, she should consider it no less obligatory on her to furnish a supply. It may, indeed, with judicious care, be made a source of great profit as well as a duty, but it must be worked in the right way.

It is evident that the people themselves have not the money to spend in installation, and if they had, they would not care to lay it out in this way, as their tenure is so precarious. The landlords are not likely to go to the necessary outlay, and so a free-wiring scheme forms a necessary corollary of extensions in these districts. The prepayment meter is even more of a necessity, and is the only thing which will make such extensions commercially possible. Consumers of this type, in which the weekly wage-earning class is predominant, cannot stand the strain of a quarterly account, but can usually find a small coin to obtain their light as wanted. The prepayment meter further solves the vexed question as to the cost of the wiring, for the payments can be adjusted to cover the interest and upkeep of the installation, which will, of course, be only trifling. The gin palaces and small shops, which abound in such neighbourhoods, will hail such a scheme with delight. All these consumers will have a small number of lamps installed, but will burn them for a long time. The essential feature for the electricity department to bear in mind is that the cost of connection and of the prepayment meter must not be great. The former difficulty can often be met by making one connection for a block of houses and getting the necessary permission to carry the wires through the party walls, which should not be a difficult matter for the corporation to obtain. With regard to the prepayment meter, the cost of this will be considered later, and should be about half the listed prices of average meters at the present time.

But beyond the poorer classes there are many shopkeepers, and residents too, who will also hail the prepayment meter with delight, as they would far rather pay as they go, and thus know how they stand, than have a quarterly account; and electric supply companies, as well as corporations, will shortly be largely taking up this question of prepayment. For offices, for instance, where the daily consumption is very small, and where each two or three rooms has to have its separate meter, the prepayment meter possesses many obvious advantages. Many people also view the electric light with disfavour, as it is to them a new thing, and they do not feel sure as to what it will cost. They would far rather pay a fixed price per lamp per annum if they could. With the aid of this device, if the current is charged for at 6d. per unit, one has only to tell them that an 8-c.p. lamp will burn for 5½ or 6 hours for a penny and they will be delighted with it.

Prepayment devices or coin-freed (so-called automatic) apparatus of all kinds have been one of the noteworthy features of the last decade. First brought forward apparently for the sale of sweetmeats, the principle has met with such general favour that examples are seen at all railway stations and places of amusement and recreation. The essential principle, that a coin when in the slot shall release or actuate the mechanism for a particular purpose and then lock it again, is so familiar, and examples may be seen on any so-called automatic weighing machine with a glass front, that the author will not take up the time of the association by dilating upon it, suffice it to say that the idea has been taken up by the gas companies within the last few years, and has proved an immense success in purveying small quantities of gas to the poorer classes. The author is informed that the London Gaslight and Coke Company alone had a short time ago over 150,000 consumers on this system upon their books, and between 16,000 and 17,000 more waiting their turn to be joined up.

There are certain essential features of a prepayment electricity meter which the author will now proceed to consider. Firstly, he reiterates that it must be cheap, for, as has been already referred to, the number of lights on each meter will usually be few, and the revenue earned will be small; and to be productive of gain, the capital outlay per consumer must be kept down. The author suggests 40s. as an acceptable price and 50s. as an outside figure, and considers that an expression of opinion from the association will be desirable in the matter, that manufacturers may know what is expected of them. Further, the meter must be of a reliable nature, solid and strong, with as few parts as possible, as it will not be put under a glass case, and may, indeed, be treated on occasion with more vigour than respect. It should also be capable of storing up several "penn'orths" (or whatever the unit of payment may be), so that advantage may be taken of any desire on the part of the customer to provide against a rainy or foggy day. It is essential that it should be fairly accurate, though an error of 1 or 2 or even 5 per centum is better than a high price and absolute accuracy. It is, further, more in accordance with the ideal that it should be a wattmeter rather than an ampere-hour indicator, as any deviation of the voltage from the normal will have an appreciable effect on the duration of the pennyworth. It would

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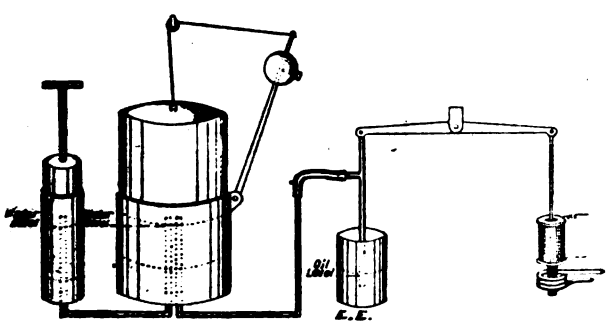
perhaps be premature and idle to expect to get this condition fulfilled at present at the proposed price, but it should not be lost sight of in future developments. It must also be proof against being tampered with, and there must be no practicable means by which ingenious contrivances can be made to extract an unlimited supply with a single coin, as is the case with the automatic sweatmeat machines at present. The prepayment meter will not have the advantage of the public gaze to defend it from these frauds.

The evolution of the prepayment meter will be watched with solicitous interest by electricity supply engineers, whether connected with municipalities or companies. To the former, however, it should appeal more strongly as enabling them to fulfil their obligations to the whole of the ratepayers. They are, further, in a better position to undertake extensions of mains for this supply, as they should always reckon on the connection of all the public lamps *en route* to form the nucleus of a remunerative load. On the other hand, companies are able to adopt a more forward attitude, as they are untrammelled by the question of the correctness of using the public funds for installations on private premises. Some there may be who will doubt whether the Local Government Board will grant permission for a loan of this kind, for it is evident that free wiring forms a *sine quâ non* of the programme. But though they may impose a somewhat shorter period for the repayment of the loan, the author cannot see why they should object. Ample arrangements to secure the safety of the money laid out should be obtained by judicious negotiations with the landlords, and Section 25 of the Electric Lighting Act of 1882 fully protects both meter and fittings from distress and distraint for rent.

The author is informed that there is legally no obstacle to a corporation undertaking this work and borrowing the money for it, and that chairman who first pilots such a scheme safely through a voyage in committee and council will confer a great benefit on municipal electric lighting throughout the country. Though there has been no movement in this direction at present, the blame cannot be laid upon electricity supply engineers, as the author is convinced that they are only waiting for a meter having a modicum of the qualities enumerated to take it up assiduously and develop this fruitful ground for electric lighting. Apparently they will not have to wait long. The air is thick with rumours of apparatus just at or beyond the patentable stage, and a few months may alter the aspect of affairs completely. Meantime there are several developments which will repay consideration.

The first practical forward step towards the realisation of the prepayment meter was the invention of Bastian and Hodges, whose patent, No. 2,224 of 1896, describes what is really a prepayment device attached to an ordinary meter. This constitutes a kind of half-way house between the ordinary meter and the prepayment meter pure and simple. The annexed illustration



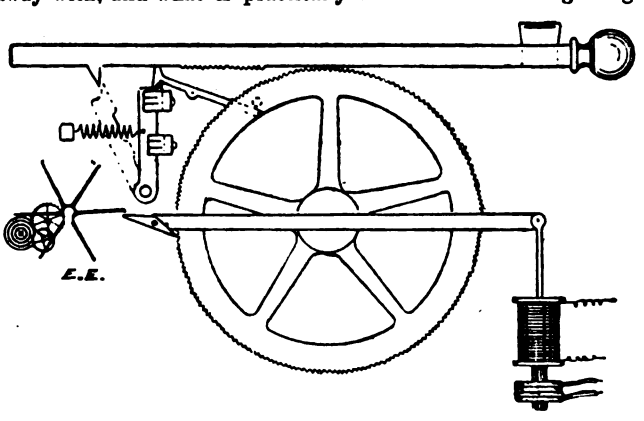
will give some idea of the mechanism, and the mode of working is as follows: The insertion of a token or coin of the proper size in the slot enables the operating rod to be pushed forward by the push-piece which projects outside the case, and which without the penny will slide over the operating rod without pushing it forward. When this is done, the penny falls down a shoot into a receptacle, not shown. The movement of the operating rod pushes over a catch against the resistance of a spring. This allows two contacts to dip into mercury and so complete the circuit. At the same time a small tooth engages a wheel, and winds up a weight through a measured height. This weight is hung over a pulley which gears into the clockwork of the meter, and gradually descends as the current passes through the meter. By the time that the prearranged quantity has been consumed, the weight has descended on to two contracts, thus completing the local circuit of a small electromagnet, and this attracts its armature, releasing a lever catch, which allows the arm dipping into the mercury to fly out and cut off the supply of current. The number of pennies that can be put in at one time is only limited by the height to which the weight can be wound—practically I believe it is about 12.

The disadvantage of this apparatus is that its cost is altogether beyond what has been laid down by the author as practicable, and probably that is the reason why the meter has not, to the author's knowledge, been bought by local authorities. It is however exploited by a syndicate in connection with a scheme of free wiring, and they have connected up or have on order some 5,000 lights on this system in the St. Pancras Vestry's district alone. They are also commencing operations in the town with which the author is connected, and have already fixed up a few meters, from one of which, in a private house, the photo of this apparatus is taken. This movement, if it serves no other purpose, will draw the attention of municipalities to the great field which will be opened to them by the advent of a prepayment meter possessed of sound commercial and electrical qualities.

Regarding solely prepayment meters, though at present there are none actually on the market, almost everyone, as indicated before, has some type or other just emerging from the chrysalis stage. Some work on the voltmeter principle, some are electric clocks—in a word, history repeats itself, and the earlier experimental types of recording meters are reproduced (without the dials) for the sake of recording quantities, and instead of the dial we have the prepayment mechanism. The field is indeed wider than with ordinary meters, for only small quantities have to be measured, and elaboration of detail is not necessary.

The most promising of the forthcoming prepayment meters is the one which is patented in the names of Ellis and Atherton. The former gentleman, well known to the members of the Municipal Electrical Association as the able and enterprising chairman of the Portsmouth Electricity Committee, has devoted a considerable amount of time and skill to the invention of these meters. His earlier labours resulted in a meter which would have been quite practicable, but which has been discarded owing to more promising developments. It consisted of a small air-pump connected by a glass tube to a gasholder, and the action of putting in the penny gave the pump one stroke and pumped one pennyworth of air into the gasholder. This latter was also connected (as per sketch) through a flexible tube, with one end of a balance scale, dipping into a vessel containing oil. On the other end of the balance was hung the soft-iron core of an electromagnet, with a series shunt winding. The series winding was at the bottom, and when the current was utilised (after the insertion of a penny) it sucked down the armature, raising the tube at the other end of the beam, and allowing the air to escape more or less rapidly from the gasholder. When all the air had escaped, a contact was made, and the current was cut off. The varying weight of the gasholder dipping in the water was compensated for by another weight hung from it at a particular angle by means of pulleys.

In the improved form of meter, however, the liquid is done away with, and what is practically an intermittent integrating



ammeter takes its place. The whole apparatus is very simple and ingenious, and seems to promise to achieve great success. The vital parts consist of a small American clock with a special star wheel, containing six arms shaped liked the Mordey alternator field magnet, attached at one end, a large wheel or disc with a milled edge and a catch to engage this, which is connected by a long arm to the current-regulating device, which is an electromagnet similar to the one used in the previous meter. The mode of working is as follows: The operation of putting in a penny enables the operating rod carrying a ratchet to engage the big wheel and move it round a twelfth of its circumference (the instrument will therefore store up twelvepennyworth), and at the end of its stroke it makes a contact and switches on the current, the switch being held in position by a small catch, which is released by a pin on the big wheel when it has come back to the end of the pennyworth. On the return or back stroke of the operating rod it makes another contact at the other end of the instrument, the effect of which is to let into circuit a small electromagnet, which starts the clock and also lifts the hinged arm containing the catch previously mentioned through a distance depending on the amount of current used by the consumer. As each star on the wheel of the clock comes over it touches a light pawl, making the catch engage with the main wheel, and carry the latter forward till the pawl comes against a stop, and the catch springs off the main wheel and back to the

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position taken owing to the current. This operation is repeated until the pennyworth is consumed, when, as aforesaid, the pin on the main wheel comes round and knocks off the switch. This also cuts off the supply of current from the other magnet and stops the clock. There is, further, a little disengaging lever which works on the back (or outward) stroke of the operating rod, whose function is to prevent damage to the catch on the main wheel supposing it stops when the star on the clock wheel is causing it to engage with the main wheel. The clock, which is an 18-hour one, is wound up by the consumer, and if allowed to run down, the catch which puts on the first switch will not make contact, but slides over. He then has to wind up the clock and put in another penny, when contact will be made, and he will also get twopennyworth of light. This description is not so clear or full as the author would wish to have made it owing to the patent rights not being fully secured at the time of writing the paper, but he trusts that sufficient has been said to give the association some idea thereof. This meter has much to commend it, and the author predicts that when put upon the market it will meet with prompt appreciation from electricity supply engineers.

In conclusion, the author has endeavoured to show that the prepayment meter will open up fields for electric lighting the importance of which has been left quite in the background, and that municipalities are, or should be, most deeply interested in the development of these fields. He trusts that the association will take the matter up, and by a vigorous expression of opinion show manufacturers what they want, and let them know that they will eagerly welcome a good prepayment meter. From the results which the inventive skill of electrical engineers have already achieved, there need be no doubt that the supply engineer will soon be able to choose from several good and ingenious types of instruments, each fulfilling all the stipulations and conditions he has laid down.

DISCUSSION.

Mr. Bastian took it that a prepayment meter involved two parts—an instrument which measured the current which passed, and then a prepayment device which allowed the current to go. He therefore did not see where any economy in price was to come in. Of course, the present form of meter might be used without the registering dials, but that would be a disadvantage, because if the prepayment mechanism got out of order there would be no indication of what to charge.

Mr. Evershed thought the prepayment meter was intended for small consumers. If it was an ordinary meter, with a prepayment device attached, that would raise its price too much. He would rather look for a meter that would allow the consumer to get his pennyworth of current on payment, but did not pretend to do anything else. Though the manufacturer could not get down to 40s., he could reduce the price of a meter somewhat if he was not tied down to size. He would like to hear from Mr. Couzens the maximum size which could be used. Would it be out of the question to use a thing as big as a gasmeter? He (Mr. Evershed) never could understand why electricity meters were made so small.

It being past one o'clock the discussion was then adjourned.

In the afternoon there was a visit to Liverpool. This account of the convention has, however, from one cause and another already got considerably out of phase with the order of the proceedings, and having once got out of correspondence it will probably be more convenient that in the few words that need be said about them all the excursions should be taken together.

FRIDAY, JULY 2.

The discussion of Mr. Couzens's paper was resumed at 10 o'clock.

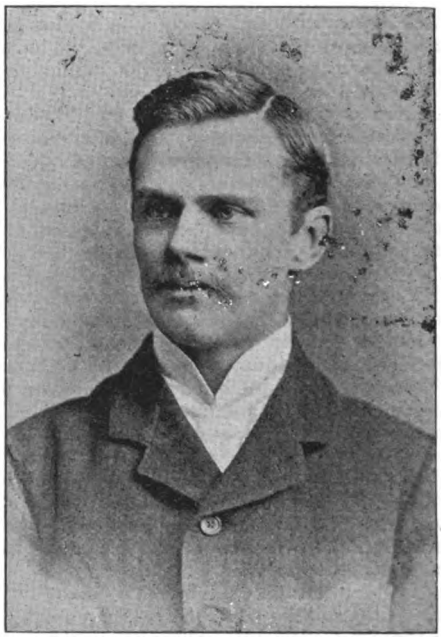
Mr. Mountain (Huddersfield) said Mr. Edgcome, of Kingston-on-Thames, had a system of charging so much per annum per lamp. He had a lock upon them, so a man could not change an 8-c.p. for a 16-c.p. At present most engineers had their hands so full of work for better consumers that the question of prepayment meters was not pressing.

Mr. Ruthven Murray (Worcester) said the amount of copper taken by the South Metropolitan Gas Company every week for their prepayment meters amounted to several tons, and it cost the company a great deal to subsidise the banks to take the copper off their hands. That might mean another deduction off the price per unit. He did not see, unless the prepayment meter could be bought very cheaply, how they were going to attack the working-man. Small consumers were anxious to take the electric light if they could get it. At Worcester they had a number of £18 houses which were wired, and everyone of them took the electric light.

Mr. Couzens then replied. All the speakers had commented on the excessive price of meters. His point was that a meter was required which should be constructed upon totally different lines. They did not want a scientific instrument, but something cheap and rough like a gasmeter. No one would contend that a gasmeter was a scientific instrument, but it was good enough for its purpose Mr. Evershed mentioned the question of size. There was no objection to an inch or a foot or two, more or less, in a meter for a workman's dwelling. Other points he would defer.

Distributing Systems.

BY JOSEPH A. JECKELL, A.I.E.E., BOROUGH ELECTRICAL ENGINEER, SOUTH SHIELDS.



Jeckell, J. A., A.I.E.E.—Commenced his technical life in a mechanical engineering firm. After some telephone experience he joined the staff of the London Electric Supply Corporation. His special charge was chiefly that of the mains but he had also experience in running the plant. He left this company in 1892, being appointed electrician and works manager to the now defunct Okonite Company. In 1893 he was appointed borough electrical engineer to the South Shields Corporation. He drew up the full specifications for the works there and superintended the laying down of the plant. Since the completion of this work he has acted as resident engineer running the station.

This is a very wide subject, and, of course, it is impossible to deal with it exhaustively in the compass of a paper like this, and, moreover, it is one upon which there must be a very large number of divergent views held by different engineers. The author therefore has no intention of laying down hard-and-fast lines, but merely proposes to open up the ground and afford opportunity for discussion so that each engineer may give his own experience, and thus all may mutually benefit. The author takes it for granted that the system to be adopted in any one case is that which is most suitable, and that there is no one method which is in every case superior to all the rest. It follows, therefore, that as very likely the circumstances are entirely different, the systems will in various places also be different, and that which may be very advisable in a densely-lighted area may be very unsuitable in a sparsely-lighted one. Again, an engineer who has used one system may be pardoned if he is not anxious to try another, and so he may use that same system in another place for which it may not be so well suited as it was for the place where it had previously been used. A central-station engineer has generally quite enough to do without trying experiments, and if he errs it is likely to be on the safe side; but this is rather a recommendation than the reverse from a ratepayer's point of view. Further, an engineer who has used one system and has had a rather unfortunate experience with it, possibly owing to circumstances over which he may not have had full control, takes care to adopt any other but that system when next he has to decide, on the chance that another system could not give more trouble and might readily give less. Thus we find every reason why there are likely to be as many different opinions about systems as there are engineers, and even more, because it may happen that an engineer may advocate one system to-day and another a short time hence.

In the last year or two, it has become much more general, with regard to the generating plant, to accept the tender which in the opinion of the engineer offers the best value for the money, and not that which happens to be the lowest in price. This has been found to be much the wisest course to pursue, since it is so very essential that a thoroughly reliable plant should be installed if the supply of electric energy is to be a profitable undertaking. It is to be very much regretted that this policy has not been more universally adopted, and especially so with regard to the distributing plant, for it seems to be more general to accept the lowest priced tender for cables, etc., whatever may be the policy adopted with regard to the generating plant. If, however, we carefully consider this policy, it is very evident that the distributing plant, including as it does everything from the switchboard at the generating station to

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the fuses in the consumer's premises, should be the very best procurable. (1) In the case of the generating plant there is always, or ought to be, a reserve, whereas the same cannot be said of the distributing plant; (2) the generating plant is always under observation while working, and an incipient fault can very often be rectified before it has time to occasion harm—the reverse is the case with the distributing plant; (3) the generating plant is in a dry place, whereas a great deal of the distributing plant is buried in the ground; (4) the facilities for inspecting and testing the generating plant are vastly greater than they are for inspecting and testing the distributing plant; (5) if a fault occurs in the generating plant it is at once apparent what is wrong, and steps can be immediately taken to put it right, whereas in the case of a fault in the distributing plant it very frequently takes several hours to find out what is wrong, the more especially if faults are not of frequent occurrence. Any one of these considerations would appear to be a sufficient reason for the advisability of having the very best distributing plant procurable; how much more does the combination of them point to the same course.

The methods of distributing electrical energy, as at present used in this country, may be divided up under three headings: (1) low-tension direct; (2) high-tension direct; (3) high-tension alternating. It may be fairly assumed that no engineer will use high tension if he can use low tension merely for the sake of having it, for whatever pressure the current is generated at we are compelled to supply it at low tension, and the use of high pressures is only to convey the energy a considerable distance without abnormal loss or excessive expenditure in copper.

Low-Tension Direct.—Now that the Board of Trade have raised the limit of pressure for a low-tension direct-current supply, there is little doubt that this system will be more generally adopted, especially on account of its suitability for tramway work, which is now coming so much to the fore. The advantages of this system are very great; being able to drive motors and charge accumulators is of immense importance, and especially is this felt by engineers in charge of alternating stations, where they can do neither directly. These advantages are being more appreciated now that it is admitted by all how extremely important it is that the load factor of our stations should be improved and how cheaply current can be generated after the standing-by charges have been covered, and therefore how important it is that a system should be adopted which facilitates the improvement of the load factor, and thereby decreases the cost of production. It shows how even now the full importance of a good load factor is not fully appreciated when we consider that though a great many figures are published with regard to the costs of generating electric energy and records of all kinds are being made, that no list, as far as the author is aware, is published of load factors, nor is any account taken of them when comparing the costs of the various stations one with another; though a careful study of Mr. Wright's paper at the last convention will show that a good load factor is a much more important factor in reducing the costs than the total amount of current sold which is often mentioned. However, anyone interested in the subject can easily calculate the selling load factors of the various stations from the figures published. With the low-tension direct system there is, of course, more expensive switching apparatus at the generating station, but beyond that it is very simple—there are no transformers to break down, no risk of injury to men by coming into contact with the high-tension current, etc. The greatest trouble is keeping the pressure at the consumer's terminals anything like constant, but this will be materially lessened with the higher voltage now permitted and higher-voltage lamps.

High-Tension Direct.—This system promises to be a very useful method of reaching certain outlying areas which may be beyond the reach of a low-tension direct supply. Of course, the objection to the system is that of having moving machinery in sub-stations where there is no attendant. These rotary transformers, however, seem to give very little trouble, much less, in fact, than might be supposed. It is a system, however, which is not applicable to a large sparsely-lighted area, since in that case the low-tension mains would be a very expensive item if the drop when the lights are being supplied from the batteries is not to be abnormal. It would seem that this system is very suitable for a fairly compact area when the generating station has to be some distance from the centre of that area.

High-Tension Alternating.—This system, which presumably will not be used except in places where the lights are so scattered that a low-tension direct system would not answer, is a great boon, for without it many places which are now enjoying the advantages of the electric light would still be in darkness; and as there are a very large number of these places it naturally follows that this system is very frequently used, and it will be well to consider this system somewhat carefully, because the disadvantages which belong to it are considerable. The only system in use in this country is the single-phase, and the author only refers to that one. At present, at any rate, there is no alternating-current single-phase motor which is satisfactory for ordinary stopping and starting. The author has unfortunately found this to be so, because he is frequently being asked for them, and cannot recommend one that will do. This circumstance, coupled with the fact that batteries cannot be used directly with this system, causes the load factor on many of the alternating stations to be so poor, or perhaps we ought to say the selling load factor—viz., the average amount sold as a percentage of the maximum load. Still, however, the extreme flexibility of this system is of paramount benefit, especially in exploiting a new district. There are three stages, if we may call them so, in this system: (1) in a very scattered district where house transformers are used; (2) where street transformers are used to supply a low-tension network; (3) where motor-transformer sub-stations with batteries are used. This last stage promises to be a means of supplying the trams and larger consumers, and the demand for current suitable for use with motors. The batteries can be charged at times of light load, and thus the load factor of the station can be made very much better. In the case of very large consumers, sub-stations can be placed on their premises, if they will agree to take the current for a term of years. This would be especially useful in the case of theatres, where a very considerable number of lights are frequently switched off and on suddenly, and thus make regulation difficult on the mains. With regard to the house transformers, those engineers who have had them will know they are not to be desired; and it does not seem to be the correct idea that when current is supplied at a specified pressure, that it should be supplied at another pressure, and rent charged for the apparatus used to reduce it, and no doubt this system will be only used for pioneering. With regard to the second phase, the transformers which can now be obtained to place direct in the ground seem everything to be desired, and this system has many advantages over the transformer chambers, as they are called, where there is too often the minimum of space with the maximum amount of danger; and switch-gear is too often used which would not be tolerated at the central station, where it is in a dry place, and where there is plenty of supervision, but which for some occult reason is deemed good enough to put into what is liable to be a damp hole, and where there is no supervision. It will be found that most of the fatal accidents have taken place in these chambers. If it is necessary to use sub-stations, let them be such as are used by the London Electric Supply Corporation, at Trafalgar-square and the Grosvenor Gallery, where there is plenty of room and where there is proper switch-gear and attendance. It seems to the author that the transformers placed direct into the ground are much safer than the chambers; there is no fear of damp or gas accumulating, both are not unfrequently found in the chambers, and with properly designed switch-boxes, care being taken that the very best are obtained, there is every convenience and safety. The extreme flexibility of this system is wonderful; a transformer tank can be used which will contain a 30-kilowatt transformer and only a 15-kilowatt used at first. If the load increases, the 15 is just lifted out, and a 30 put in instead. If a low-tension main becomes too heavily loaded, the high-pressure main can be cut and a transformer put in to feed that part. Nothing can be simpler or safer, and less expensive, as money is only expended just when and where it is needed. This system, with its three stages, seems, therefore, likely to be very extensively used, but owing to the fact that batteries cannot be used directly with it, and that it does not lend itself to the use of motors directly, the selling load factors of stations with this system are likely, when first put down, not to be very good, and therefore the cost of producing the current will not improbably be high. Of course, there are sure to be some exceptions caused by special circumstances, but then it must be remembered that in many districts where this system is in use, no other system would have answered as well, so it was this or none. It seems probable that the use of battery sub-stations will increase in the future, and then the selling load factor will be improved. The fact that some engineers use a small motor-alternator with batteries, shows how anxious they are to increase the load factor, and even use a system of this sort, when the loss must be very high.

(To be continued.)

Tramways Institute.—The annual general meeting of the Tramways Institute of Great Britain and Ireland will be held at the Frascati Restaurant, 32, Oxford-street, London, W., on Thursday, July 22, 1897, at 11 o'clock a.m. After the adoption of the report and accounts for the past year, election of president, vice-presidents, executive committee, and auditors, and the appointment of quarterly meetings for next session, there is one paper, on 'Light Railways," by Mr. Stephen Sellon, A.M.I.C.E., to be read and discussed. In the afternoon there will be a visit to the works of the Central London Electric Railway, and at 7 p.m. the annual dinner of the institution.

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THE

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SAFETY REGULATIONS.

We give elsewhere in this issue the interim report and conclusions of the Departmental Committee of the Home Office on the dangers incurred in electrical generating works. This report we welcome as a thorough and honest attempt to treat the matter fairly, and to protect those engaged in high-tension electricity works. Perhaps the witnesses examined might have been of more representative character, although we do not suggest that the witnesses selected were not suitable. A few of those engineers and workmen actually engaged on switchboards or on the mains of an electric light station would have given their views of the dangers they incur and of the means by which they keep themselves safe. Thus some of these gentlemen make it a rule never to use both hands when handling high-tension switch-gear, either in regular work or when doing repairs. They then find that a single glove on one hand is a most efficient reminder that the other hand is not to be used. Hence should a fault occur in the glove the shock to earth only could be experienced, and when standing on rubber mats this is not dangerous. They also say that the use of two hands both protected by rubber gloves leads to careless handling of dangerous connections, and to undue reliance being placed on the state of repair of the gloves. We most thoroughly endorse the first five regulations, as it should be impossible for the engine tender, or anyone on the floor of the engine-room, to touch either the high-tension connections or the collecting rings. This has been recognised by most of our leading engineers for many years, but competition perhaps has led to it not always being observed. The next regulation (No. 6) goes, we think, rather too far. The switchboard, both back and front, is bound to be dangerous, and hence access by anyone but the attendants to it should be most strictly forbidden. This regulation, if amended to read that the construction should be such that it is impossible for the attendants in the ordinary course of using the switch-gear to inadvertently touch any charged metal, would be better. This amendment would meet the case of the fatal accident at Brighton in 1893, when a switchboard attendant was killed owing to a badly-designed switch. The present rendering of the regulation practically asks for all high-tension contacts to be covered up. This is not advisable for two reasons. The first is, that inaccessible switch-gear is more likely to get out of order, as it cannot be readily inspected; and the second, that any repairs then become much more dangerous to effect than if exposed contacts were used. In fact, a switchboard, however designed, contains dangerous parts, and we believe that the switchboard attendant is less likely to receive a shock if such dangers have always to be guarded against. These remarks, however, do not apply to the switch-gears in small sub-stations where a skilled attendant is not employed. We notice that it is suggested to make the nineteenth regulation retrospective. This is to the effect that switches are to be provided for all transformer chambers, to cut off both the high and low tension connections of the transformers, which switches are

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to be operated from the outside of the chamber. The need for this was shown by the late accident at Hampstead, where the workman killed in a sub-station could not be got out till a messenger had gone back to the generating works to get the current cut off. The other rules are generally of advantage, and we think that none of them will hamper the engineer of any well-designed station. The fact that all accidents will have to be notified at once to the authorities would lead to the real facts being brought out, and any departure from the safety regulations being noted. In conclusion, we may say that we have read through carefully the fourteen cases of fatal accidents recorded and note that practically all of them could have been avoided; also, that the only accident to a skilled switchboard attendant was the one referred to above, and that the use of unskilled labour to work near sub-station switch-gear has been the cause of the other switchboard accident. There are also among the list several cases of death in which the deceased deliberately disobeyed instructions given him for his own protection.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

DROP IN ALTERNATE-CURRENT LINES.

SIR,—I have read with much interest the article by Mr. Mershon in your number of the 25th ult., extracted from the *American Electrician*. With regard to the note on p. 815, at the bottom of the first column, I should like to ask for information. It seems to me that the "equivalent resistance" is that of the high-voltage coil, plus the resistance obtained by increasing, *in the ratio* of the transformation, the measured resistance of the low-voltage coil—*i.e.*, in the case given, $R + 10\ R^1$, not $R + 100\ R^1$. It is not a case of finding the $C^2 R$ losses. I should be glad if you will let me know your view as to whether or not my suggestion is correct.

Finally, the method of obtaining the "reactance volts" mentioned further on in your note is no doubt correct, but far from obvious. Can you add a few words of explanation?—Yours, etc., ATLAS.

[Our correspondent is right in his method of determining the equivalent resistance. The square of the transforming ratio should not be used. It is evident that Mr. Mershon made a slip in this, as his text higher up contradicts the statement in the footnote. As regards the second point, we hardly see where "Atlas's" difficulty lies. The reactance volts are mainly due to magnetic leakage, and as their E.M.F. is at right angles to that of the supply, it is difficult to ascertain their value from observations at full load. Hence all load but that due to copper resistance is removed by short-circuiting one winding. The voltage then required to drive the full current through the short-circuited coil is mainly due to the magnetic leakage, and a value thus obtained is sufficiently accurate, seeing that it is often only a small component of the total voltage. The same method is also used for alternators to determine from the short-circuit current at a given voltage what the potential difference will be at different loads.—ED. *E. E.*]

REVIEWS.

Electric Railways and Tramways: Their Construction and Operation. By PHILIP DAWSON. Offices of *Engineering*, 35 and 36, Bedford-street, Strand, W.C.

This is a most valuable book, being written by a practical man with an expert knowledge of the subject he writes upon. The author shows due appreciation of the traction work done in all countries, and his list of memberships is evidence that he is *au fait* with the writings of most engineering societies. This list of memberships, comprising some dozen institutions and associations, is too lengthy to repeat here. The book comprises 35 chapters and 677 pages, containing 500 illustrations, so that the difficulty of reviewing the volume adequately will be understood. The book may be considered in sections, and without doubt it will repay the reader to peruse it in the order in which it is arranged. Thus the first chapter is historical, and deals with the early ventures in electric traction. The printer's devil has evidently had a hand in the chronological statements on page 4, where Mr. Dawson is made to say that a financial successful electric line was opened in New York in 1850, and that some 118 lines were at work in America by 1870. The years 1880 and 1890 are evidently meant. The great strides made in the States are said by the author to date from the introduction of the trolley system. Again, the introduction of the overhead trolley, in spite of opposition on the part of the authorities, is said to be due to the appreciation by the general public of the benefit of rapid transit. We agree with Mr. Dawson in this view, and are sure that if the general public in England would only value the time spent in travelling to business and back at its true worth we should find the authorities powerless to prevent the influx of the trolley and electric traction. The author then gives a few concise comparisons as to the relative first cost and annual working expenses of different systems of traction. We are glad to see that the figures given are not estimated by the author, but are extracted from actual cost of lines now in regular work. After this first chapter comes a series of seventeen chapters dealing with the detailed components of an electric traction system in which the overhead trolley is used. The order of the subject-matter is as follows: Chapter II. deals with the permanent way, with section of typical rails, and tracks; details of the points, crossing switches, curves, etc., are also given. The next two chapters treat of the return circuit, and take up the consideration of the troubles arising from electrolytic action due to stray currents to earth. The various methods of bonding are then described, and also the somewhat newer process of welded joints for the rails. Cast joints are referred to, and the author concludes that it is too early yet to give an opinion as to the ultimate value of either of these methods of obtaining a continuous rail. Chapter V. deals with the elevated conductor construction, and the next two chapters with the erection of the trolley wire. The author states that the deviation between the centre of the track and the trolley wire should never exceed 2ft. to 2ft. 6in., but he refers to the equipments at South Staffordshire and Bristol, where a special trolley allows a much wider deviation. He concludes that the general consensus of opinion is very strongly in favour of the system in vogue in the United States. If this is so, we feel sure that the Americans have contributed largely to the general opinion, as no one who has seen the two systems can deny that the perference lies with the Bristol and Stafford arrangements. The supporting wires of the American system are almost more or less unsightly, and cannot compare with the central or side-pole construction. The numerous details of the supporting gear will be found of great service to engineers, and the practical directions for erecting the overhead wires are especially valuable. Chapter VIII. deals with the motors to be used on the cars. The author thinks the single-reduction motor has the preference over other types. As regards the requirements from such motors, he would specify a temperature rise of not more than 50deg. C. after two hours' run at the rated load. The motor should also be capable of taking $1\frac{1}{2}$ times its rated load without injurious sparking. The other details, such as large starting torques and lightness, good mechanical protection, etc., are obviously needed. The accessibility of parts is another point on which the author rightly lays particular stress. The illustrations of typical motors are in many cases working drawings, but are too numerous for individual mention. Amongst them will be found examples of the leading types of motors now in use both at home and abroad.

(To be continued.)

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THE MECHANICAL CONSTRUCTION OF ELECTRICAL MACHINERY.

BY F. M. WEYMOUTH.

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THE DYNAMO.

(Continued from page 806, Vol. XIX.)

Bearings (continued).—The question may naturally arise as to the relative advantages of the swivel bearing and the bearing with divided brasses and cap. We have already pointed out the cheapness of the swivel bearing, such as that illustrated in Fig. 192. But setting cost aside we may note some other considerations. Thus it will be evident, if we take the case shown in Fig. 230, where there is a bearing each side of a pulley, that if these were of the swivel type instead of the ordinary bearings depicted, they would not afford such an immediately solid support to the shaft and pulley. For as represented, the shaft journals are rigidly borne by the brasses quite up to each shoulder; and the shaft may be said to be more essentially in shear each side of the pulley, rather than to be exposed to any special bending strain. With swivel bearings, on the other hand, the journal, although carried by the sleeve along its whole length, receives its vertical rigid support only at the centre of the sleeve, where the latter rests within the bearing. Two such bearings thus on either side of a pulley would have their centres so far apart that the bending strain on the shaft between them would become additionally important. It would thus seem advisable with a pair of swivel bearings to have a stouter shaft than when ordinary brasses are used. A further point moreover lies with the difference between driving with ropes and driving with a belt: for in the former case there will be smooth running as compared with shocks liable to occur when the joints in a leather belt pass the pulley. Hence with belt driving it would seem to be better to use the ordinary brasses, and to adopt rope driving with swivel bearings.

Further reasons against the swivel pattern are their tendency to wear oval at the ends if used for steadying the shaft longitudinally, as previously pointed out, and the consequent necessity of having them somewhat long. This tendency does not exist with the ordinary brasses. The length of bearings is perhaps better discussed when shafting is being considered.

With a triple bearing machine, however, while substantial

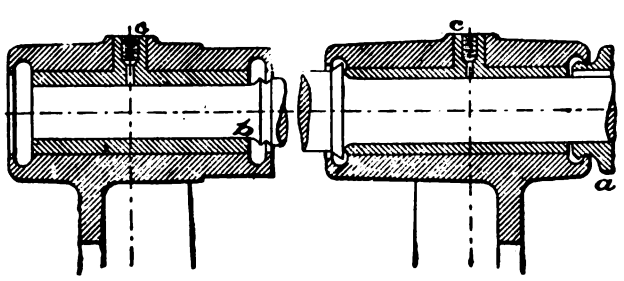

FIG. 236.

bearings with ordinary brasses are used each side of the pulley, a swivelling bearing may yet well be used at the commutator end, where the work is light, and free from the shock due to the belting, though practice, as has been stated, appears to incline toward making all three similar.

In Fig. 236 herewith is represented a method of doing without flanges on the brasses. These are two bearings, one for the commutator end and one for the pulley end of a Paterson and Cooper dynamo, which we take borrowing once more from Prof. S. P. Thompson's "Dynamo-Electric Machinery." They are presumably cap bearings. The end of the pulley boss is shown at *a*; and the clearance between this and the end of the brass will indicate the amount of end play allowed the shaft. It will be seen that the upper brasses are held by the bosses, *c c*, which latter are drilled and tapped to receive lubricators. How the lower portions are held is not indicated.

This method of dispensing with flanges to the brasses is to be met with in marine engine work, of which an example came under the writer's notice not long ago. In the case referred to the brasses were halves of mere plain gunmetal cylinders with some small snugs at the sides to keep them in place. They were square at the ends, as at *b* (Fig. 236), their length being confined to the truly cylindrical portion of the journal, as, of course, with a marine engine all end play would be prevented by the thrust block. But this is very cheap work, and does not look so well as when there are flanges on the outer ends of the brasses Such a remark, however, of course, does not apply in the case of a dynamo or motor where the brass ends are covered by hoods.

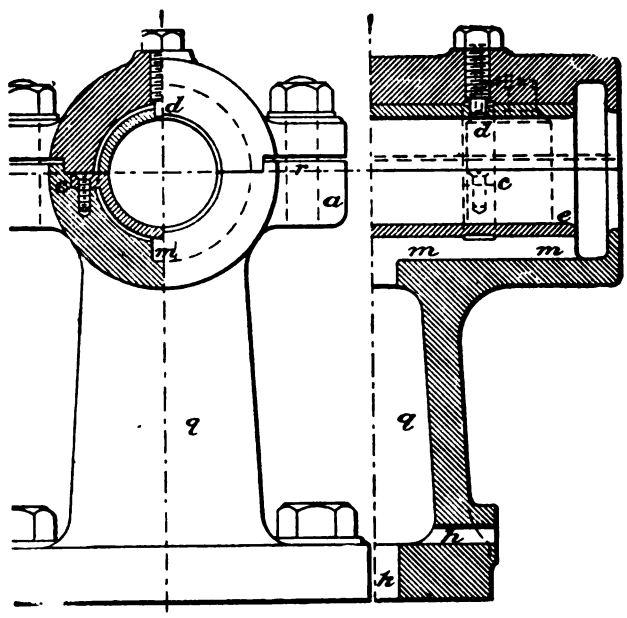

FIG. 237.

Figs. 237 and 238 show a method, approximately one adopted by Messrs. The India Rubber, Gutta Percha, and Telegraph Works Company, Limited, Silvertown, by means of which, flanges on the brasses are dispensed with.

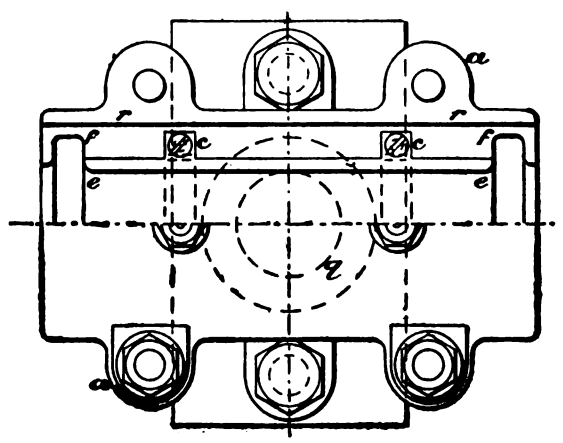

FIG. 238.

It will be observed that the bottom brasses are retained in position by snugs, *c c*, and are further made secure by small screws passing through the snugs as shown. The screws may, however, be dispensed with, as in the case depicted in Fig. 239. For holding the upper brass such snugs may also be added, or dependance may be put simply on the points of the lubricating screws, as at *d d*, that is, to prevent end motion; while its rotation with the journal is, of course, also prevented by the snugs of the lower brass. If intended to steady the shaft endways, the ends of the brasses will be rounded to fit the shoulders at the ends of the journals, as shown at *e e*.

Some other points may be noted. It will be perceived that the method of holding down the cap is in a manner a compromise with that of having flanges on both the cap and base, as was illustrated in Figs. 234 and 235. Only as much flange, however, is added as is required, with the result that the appearance is that merely of bosses, as shown at *a a*. Instead of bolts, moreover, studs are used, with their lower ends fixed in the base. The cap is held

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sideways by the raised portions, *r r*, as in other cases we have described; and here also it will be seen that the vertical joint between cap and base is beyond the oil-catching hoods, as evident at *f f*. Hence when the cap is bolted down the hoods are oil-tight at the joints. The oil is drained away by passages, *m m*, and so gets below, whence it is drawn off by a small tap at *h*. A hole, *k*, at the bottom, needed for coring purposes, is, of course, plugged. The base, *q q*, is a slightly coned cylinder, as shown dotted in the plan (Fig. 238).

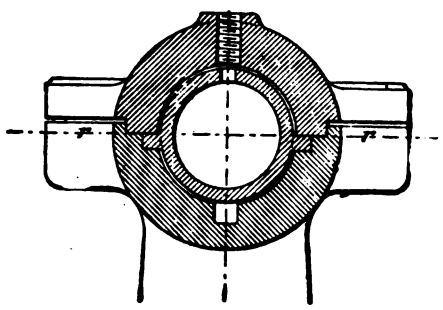

FIG. 239.

Fig. 239 illustrates approximately a variety of bearing also made by this firm wherein a bush in one piece, instead of two separate brasses, is put into a bearing with a cap.

We now come to a type of bearing which, so far as the writer has been able to discover, is very little, if at all, in use at the present time in connection with electrical machinery. Two examples are illustrated herewith, Figs. 240 to 243, showing a pair of bearings for a pulley-driven dynamo, that lettered A being for the commutator end, and B for the pulley end. These will be seen to be cast-iron cap bearings lined direct with white metal, without any "brasses" whatever: and the white metal is poured in hot with the shaft in place. The white metal in cooling thus fits itself exactly to the journals, and there is no need for

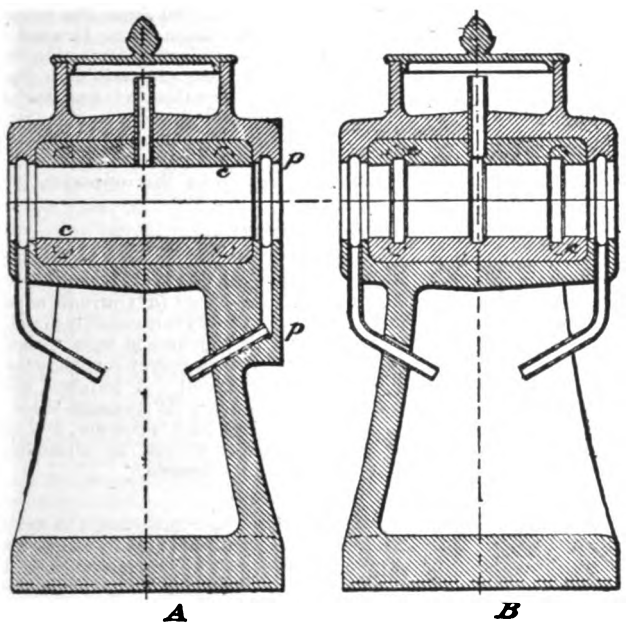

FIG. 240.

any boring. In this manner, therefore, a very cheap and expeditious method of getting good bearings is arrived at: and this especially applies, it will be observed, in the case of the bearing B, wherewith there are collars or corrugations on the journal to steady the shaft longitudinally. The process of pouring in the white metal, which requires to be carried out with certain precautions, and with care, must be left for subsequent remark.

It has to be noted, however, in connection with these drawings, that the recessed portions containing the white metal, both of the cap and the base, are not turned, but are left rough. Moreover, additional small holes shown dotted at *c c*, but in full at *a*, where the section at that point must be taken as a bastard section, serve the purpose by the white metal running into, and forming in, them, of further securing the white metal in place, and of precluding any possibility of its rotating with the shaft.

A feature that may be noted is the sideways registering of the cap. This will be seen to be similar to that shown Fig. 210, but with this difference, that the stepped-down surfaces, *s s*, are below the centre line, *x y*, instead of being coincident with it; and the raised portions, *r r*, merely rise to the line, *x y*. But this is, of course, necessary, so that the joint between the upper and lower white metal linings may come exactly on the horizontal centre line where

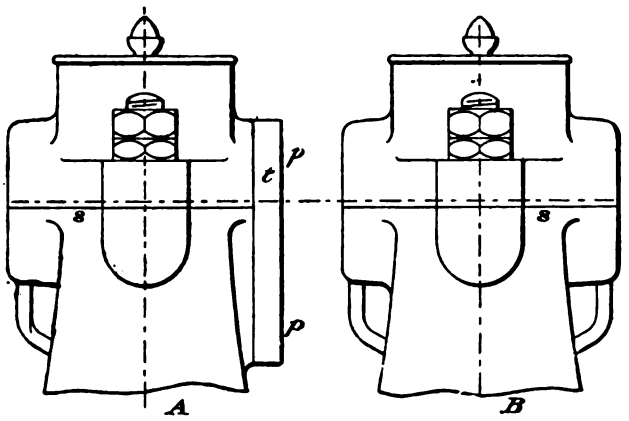

FIG. 241.

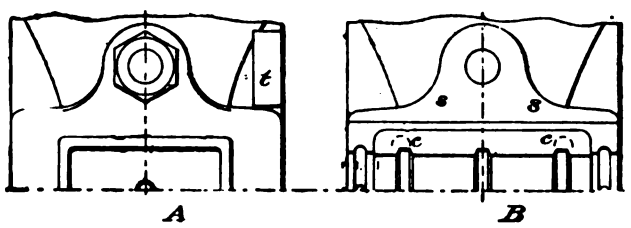

FIG. 242.

adjacent to the journal, as in the case of ordinary brasses. Endways the cap is merely registered by a fit on the studs. With these latter it will be observed that lock-nuts are used as in Fig. 217.

For carrying the brush gear, horns, *t t*, rise not much dissimilar to those shown, Figs. 216 and 218. These do not in this case carry the brush rockers in their outer periphery; but a flanged brass ring is screwed to the end

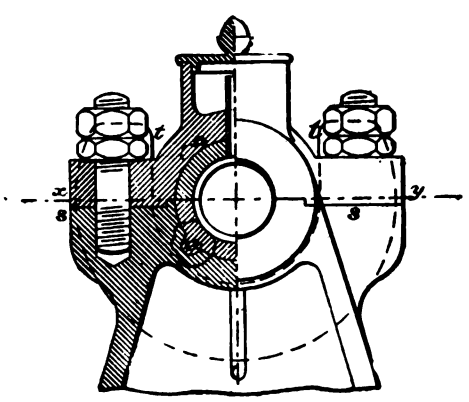

FIG. 243.

face, *p p*, and the rocker can rotate on the outer periphery of this ring, between the flange of which, and the face, *p p*, it is kept in place.

The lubrication is accomplished on the syphon-wick principle, as indicated; and the waste oil from the hoods is carried away by bent pipes, as shown, from which latter it drips into a can placed in the recess beneath. Bent pipes are used, inasmuch as it is more easy to drill vertical holes in the hoods to receive them than sloping holes, such as were shown in Fig. 230. But a choked pipe is, of course, more easily cleared when straight than when bent.

In Fig. 242 the commutator bearing, A, is shown in half plan with the cap on, but without the cover of the oil-box on top. The bearing, B, is shown with the cap removed. It will be noticed here, as in Fig. 240, B, how that the

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corrugations of the journal are wider at their base, or inner diameter, than at their periphery: they will thus the more easily leave the white metal when the parts are dismounted after the operation of pouring in the melted white metal, and when this latter has become solidified. In the case of a cap bearing like this, as compared with a solid bearing, it will of course be necessary to insert parting plates of thin sheet steel or iron, which will be tightly held between the cap and base when the former is bolted down, so as to divide the white metal below from that above, before pouring the melted metal in, these plates, one on each side, having gaps cut in their edges next the journals to fit the corrugations. This is somewhat to anticipate, but we state this much here inasmuch as our next sketch illustrating the method of putting in the white metal will refer more particularly to a solid bearing wherewith no such parting plates as those above alluded to will be needed. All the machining of the bearings, A and B, Fig. 242, will be accomplished before adding the white metal, and it will be seen that the only boring necessary will be on the lips of the hoods at either end to ensure a clean clearance round the shaft: the hoods themselves also, being very shallow, may have a cut taken out of them.

These latter two examples, it should be mentioned, are taken from the "Agir" prize motor, designed by Messrs. F. V. Andersen and Girdlestone, illustrated and described in Prof. S. P. Thompson's "Dynamo-Electric Machinery." But they represent a type of bearing formerly much used by Messrs. Latimer Clark, Muirhead, and Co., Westminster, a Firm, however, to whom we have already had occasion to refer as being no longer extant.

(To be continued.)

SAFETY REGULATIONS FOR ELECTRIC WORKS.

The following is the text of the second interim report of the Departmental Committee of the Home Office appointed to enquire and report upon certain miscellaneous dangerous trades. The first interim report dealt with some seven different industries, but the present one is restricted to electrical matters. The committee consisted of the following members: Harold John Tennant, M.P. (chairman); May Edith Tennant, her Majesty's superintending inspector of factories; Thomas Oliver, M.D., F.R.C.P., physician to the Royal Infirmary, Newcastle-upon-Tyne; Hamilton P. Smith, retired commander, R.N., her Majesty's inspector of factories (secretary); and Charles Vernon Boys, F.R.S., who was appointed on February 9, 1897, to be an additional member of the committee, for the special purpose of assisting the committee in their enquiry into the conditions of work as they affect the safety and health of operatives in electrical generating works.

The committee have visited some 26 generating stations and sub-stations in all parts of the United Kingdom, and, besides, have held some 30 meetings in the course of the year to examine witnesses and draw up their report to Sir Matthew White Ridley, Bart., M P., which is as follows:

Electrical Generating Works.

1. In presenting their report upon the electrical question the committee would mention that they have been in consultation with the Board of Trade in order that there should be no division of authority or overlapping of jurisdiction between that department and the Home Office. The committee believe that completely harmonious working can be achieved with the least amount of difficulty by the application of the recommendations which follow at the end of this report to all generating stations and transformer stations into which one or more persons can enter, and that cables or wires outside such stations or chambers should remain, as now, the care of the Board of Trade. The committee are further of opinion that these recommendations should be applied to all stations and transformer chambers where electric currents are generated or transformed by way of trade, for consumption by the public, or where they are used in any factory or workshop, or in any place of public resort for business or amusement, including Government establishments, shops, warehouses, and theatres, and exclusive only of private houses and premises. For it has been suggested that where corporations or public bodies carry on a generating supply for the public good, such cases might not be considered to come within the scope of the mischief aimed at. The committee do not admit this argument; they consider it equally important to safeguard the lives of the workers, whether they be employed by individuals, urban corporations, or other public bodies.

2. The committee have found some difficulty in dealing with electrical generating works in consequence of the technical difficulties of applied electricity. In framing their recommendations, therefore, they have attempted to avoid technicalities as far as possible. In the earlier parts of the report the committee have been content with indicating merely in outline the nature of the process and the dangers inherent to it, feeling that anything like an explanation would lead to the writing of a text-book, of which many are already available.

3. The committee have also met with certain difficulty owing to the great diversity of system which is to be found in different generating stations. In addition to this it is impossible to foresee every accidental combination of circumstances which might lead to serious risk. The committee would assert that, broadly speaking, the accidents which have occurred are those which are most likely to occur. They believe their recommendations will be found to have provided against such accidents, and others suggested by these fatalities, although they would desire to record it as their opinion that the dangers from electric shock in the generation and distribution of high-pressure currents can never be entirely obviated.

4. The committee would further wish it to be understood that owing to the great increase in the production and consumption of electrical energy in late years, and to the prospective growth and development of the industry, the suggestions they put forward in this interim report are necessarily of a somewhat tentative nature; and they wish to take this opportunity of disclaiming for their proposals any element of finality. At the same time they desire to emphasise that in their opinion it is of the greatest possible importance that the workpeople in electrical generating works and sub-stations should be protected by every reasonable precaution from the grave dangers inherent in these operations. If any confirmation of this opinion were required it will be found by a reference to the schedule of accidents in Appendix I., from which it will be seen that in the last five years 14 fatal accidents have occurred, including five since the appointment of the committee. But while disclaiming finality for their proposals, the committee would claim for them that they are framed with an earnest desire to prevent a recurrence of the deplorable fatalities which have occurred in the past, with the strong conviction that without these or similar requirements no efficient protection for the lives of the workpeople can be afforded, and with the full belief that the occupiers and employers in this industry, while finding no insuperable difficulty in carrying them out, will be grateful for the relief from responsibility which their acceptance and execution will accord.

5. The committee desire to express their grateful acknowledgments for the invaluable help they have received from the several gentlemen of eminence and learning who have come forward to assist them. In this manner they have derived information and guidance which it would otherwise have been impossible for them to secure. To Major Cardew, R.E., electrical adviser to the Board of Trade, they feel especially indebted, and to Sir David Salomons, Bart., Prof. Ayrton, F.R.S., Dr. Hopkinson, F.R.S., Prof. Kennedy, F.R.S., Prof. Silvanus Thompson, F.R.S., Mr. F. Bailey, and Mr. James Swinburne they take this opportunity of tendering their sincere thanks.

General Remarks.

6. Electrical generating stations may be conveniently divided into three classes—those which supply current (*a*) at low pressure, (*b*) at high pressure, (*c*) at extra high pressure: (*a*) Currents at low pressure distributed from generating stations are invariably direct—*i.e.*, they flow in one direction only. (*b*) Currents at high pressure are either direct or alternating. Alternating currents change their direction a great number of times in a second. A hundred complete alternations a second is very usual. (*c*) At present there is in Great Britain only one station at extra high pressure, and this supplies alternating current, but either direct or alternating current might be produced at extra high pressure.

(*a*) *Low Pressure.*

7. When the current is direct and of low pressure, the cables from the generating station have to carry the whole current which passes through the houses, and in order that the resistance to the passage of so great a current may not be serious, very large cables involving the use of a large quantity of copper are essential. In scattered districts, especially, the amount of copper necessary would be so great that electric supply under this system could hardly be carried on economically.

(*b*) *High Pressure.*

8. A method of enabling consumers to be supplied with current greater than that passing through the mains which leave the generating stations is provided where high-pressure currents, whether direct or alternating, are employed; thus the essential advantage of high-pressure systems—viz., the reduction of the amount of copper in the mains—is attained. This is effected by means of motor-generators or of transformers, which are appliances for converting a small current at high pressure to a large current at low pressure, or *vice versâ*. According to the proportions of the two sets of windings upon them, the current in the consumers' circuit, which it may be stated is not metallically connected with the high-pressure mains, is caused to have any desired relation to that passing through the mains. Where, as is usual, the current on the consumers' circuit is 10 or 20 times as great as that conducted by the high-pressure mains, the pressure at which it flows is in the same proportion less, and thus it is that, while 100 or 200 volts conveyed into a house is safe, so far as accidental contacts are concerned, a

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dangerously high pressure is necessary in the mains and generating stations. Expressing the same thing somewhat differently, the generating stations have to supply the consumer with electrical power; this is measured anywhere on the route by the product of the current and the electrical pressure.* The power in the mains is a certain product made up of a high pressure and a small current, whereas on the consumers', or low-pressure, side the same power (neglecting the small loss in the motor-generator or transformer) is made up of a greater current and a low pressure. Thus the consumer is supplied with electrical power at a safe pressure, while the producer can transfer it from the station by a comparatively thin cable, because a small current only is necessary if the pressure is high, and the losses in the cable depend upon the current, and not upon the electrical power supplied.

(c) Extra High Pressure.

9. Owing to the fact that in this country there is only one station on this system, the committee do not feel that any generalisation could safely or fairly be deduced from a single example; and, beyond stating that the danger of 10,000 volts is out of all proportion greater than that of five times 2,000 volts, they do not propose at present to deal with this branch of the subject. But they understand that projects are on foot for employing 10,000 volts, or some other number constituting extra high pressure, in connection with electric railways. When these schemes have assumed more definite shape, the committee feel that special rules will have to be drafted and issued for the protection of the workpeople employed.

THE PROCESS.

10. The primary source of power in this country is almost invariably the combustion of coal, oil, or gas, which is converted into mechanical power by steam, oil, or gas engines. Any of these may be employed to drive machines which are known as dynamos, and which convert the mechanical into electrical power. The electric current is directed into the proper channels at the switchboard, and conveyed along the conducting cables or mains into the districts served by the generating station.

11. There are many forms of dynamo, but in every case there must be a field magnet and an armature, either of which is made to revolve. In consequence of the rotation of one or other, currents are induced in the armature. If the armature is stationary, these may be led away by cables directly connected to the terminals of the armature. In this case the current is necessarily alternating. If, on the other hand, it is the armature which revolves, direct connection between the armature terminals and the cables is impossible. For this reason sliding contact between fixed collectors or brushes and conducting rings or commutator strips upon the shaft of the armature is required to convey the current to the cables. Where conducting rings are used the current is necessarily alternating, but where a direct current is intended the commutator strips are employed.

12. The switchboard is a structure which enables the electrician in charge readily to make any of the changes in the electrical connections between the dynamos, cables, fuses, and measuring instruments, which the ordinary working of the station may require.

13. Cables of various forms and make are employed to conduct the electric current from the generating stations to all parts of the district served. In those cases where the cable is conducting at low pressure, as in low-pressure systems, and in the low-pressure branches of high-pressure systems, no danger is to be expected; to these cables, therefore, no further reference need be made. High-pressure cables generally consist of stranded copper wire. When they are to be laid underground, this is invariably coated with insulating material. The two conductors necessary for the passage of the current from and to the station may consist of two distinct insulated cables, but what are known as concentric mains enable a single cable to serve the double purpose. Conductors which are fixed overhead, and which are usually known as aerial cables, are often bare over their entire length. This is more likely to be the case within the curtilage of a factory, where the Board of Trade rules do not apply.

14. The motor-generators or transformers, the purpose of which has been indicated above (paragraph 8), are placed in "sub-stations." These may be rooms of considerable size; chambers in which there is space for one or two people in addition to the transformers, or mere boxes practically filled by the transformer. Transformers are sometimes placed in cellars or other parts of the consumers' premises. The motor-generator is a combination of motor driven by the energy of the current in the high-pressure mains and a dynamo generating the low-pressure current of the local circuit. If the current is alternating, branches from the mains are connected to the primaries of transformers which supply the local circuits. In both cases fuses are inserted in the circuits in various places proportioned to the heaviest current that can properly be allowed to pass, so that if by accident an excessive current should arise the fuse will melt and disconnect the circuit.

15. In addition to the ordinary transformer and motor-generator already referred to there are contrivances of many different kinds known as "rotary converters," "boosters," etc., by means of which a current may be converted from direct to alternating, or the reverse, or may have its pressure altered or adjusted in any direction.

Uses of the Electric Current.

16. Either alternating or direct currents are supplied from generating stations to private consumers for domestic and general use. For arc lighting also, and for driving motors, either a direct or alternating current may be employed. The same is true where the current is used for electric heating, electric welding, and electric furnaces. For charging secondary batteries, however, and for various electrolytic manufacturing operations, direct currents are used, and ordinarily at low pressure.

THE DANGERS OF WORKING.

17. The dangers inherent in steam and other motive machinery, being well known and provided against by the general law relating to factories, do not require consideration in this report.

18 In the handling and preparing of plates for storage batteries risks of lead-poisoning exist; but the workers are already protected by the special rules framed for "Electric Accumulator Works;" beyond this no special dangers to health have been noticed. There is, however, a risk in the use of these accumulators in consequence of the evolution of an explosive mixture of gases when the plates are overcharged. Where the ventilation is very imperfect, a quantity of gas may accumulate sufficient to take fire or explode on coutact with a spark or flame.

19. The danger peculiar to electrical generating works is the liability to shock, which is often fatal if, by accident, anyone comes into contact with the conductors when charged to a high pressure. The contact need neither be very perfect nor direct, provided two parts of the body are made to touch conducting materials which themselves differ in pressure by 1,000 volts or more, or even by much less if the contact with the flesh is very good, a dangerous and possible fatal shock will result. The ground, especially if damp, is sufficient for one of the contacts, damp leather boots affording no protection, so that anyone standing on the ground or on metallic or damp wood flooring cannot safely touch a single object charged to a dangerous pressure. If, however, he should be standing upon a dry indiarubber mat, which is an excellent non-conductor, he will come to no harm on touching any number of dangerously charged bodies which are at the same electrical pressure; but if he should simultaneously touch, even through his clothes, two bodies which differ from one another in pressure by about 1,000 volts, the actual amount depending largely on the perfection of the contact, or if, while safely touching highly-charged metal, he should touch or pass by hand any conducting article to someone else who is not also insulated, then a fatal shock may follow.

20. The metal which is highly charged, and which would be liable to be touched if not properly protected, is to be found in the dynamo machines, the switchboard and its metal connections, the high-pressure mains, and the transformers, and, in the case of series arc lighting, in the lamps themselves.

21. In alternate-current dynamos with fixed armature and rotating field magnet, the terminals of the machine to which the cables are connected are the only parts which could well be left exposed, and these are so easily boxed in that the most negligent user would hardly leave them unprotected. On the other hand, when the field magnet is fixed and the armature revolves, there are on the shaft two contact rings which form the terminals of the armature, and the terminals of the machine are connected with these by two brushes. In this case the terminals of the machine can just as readily be protected as in the last, but there are in addition the contact rings and brushes. These may require attention either at starting or during the running of the machine, or they may be a source of danger if the attendant, in oiling with a metal can or working with ordinary tools, brings any of these accidentally in contact with the highly-charged metal. In the case of direct-current dynamos, the commutator and brushes take the part of the contact rings and brushes in the alternator with moving armature, and what has been said before applies equally to both.

22. The switchboard should be easily and quickly accessible on the front, where all the ordinary operations of connecting and disconnecting the various dynamo machines and cables are effected. The back should be inaccessible, except to those skilled persons who have the right and means of entry. Here each cable end and conductor from the dynamos is connected to its appropriate block of metal. These blocks are generally exposed for convenience of repair and alteration. None of the everyday work of the switchboard is carried out here, so that the risk of accident can only exist when alterations are being carried out within reach of highly-charged metal. There is no necessity for any metal directly connected with the high-pressure mains or dynamos to be exposed on the front or working face of the switchboard to accidental contact.

23. High-pressure main conductors may be erected as overhead wires, but are almost universally laid underground. Bare overhead high-pressure conductors may lead to accident in case of breakage or by swinging into contact with buildings, etc., under the action of the wind, or by earthing at the points of support in consequence of damage to the insulators; or they may become sources of danger to persons who unintentionally put themselves in contact with them by a ladder or other means. High-pressure overhead wires, even if insulated over their entire length, can never be considered as entirely free from risk. In underground cables the insulation which is employed to prevent loss of current will, when it is perfect—*i.e.*, undamaged—amply protect anyone touching it from any dangerous pressure from the metal within, but an injury which would not be sufficient to be detected in ordinary working might nevertheless allow of the escape of sufficient current to produce instantaneous death. As the cables are liable to injury when being drawn in, workmen who handle mains charged to high pressure with their bare hands may be injured or killed. Concentric mains are often employed with a central high-pressure wire or cable, and an external group of wires insulated from the central cable. The outer wires are, in general, insulated again, and the whole is often enclosed in a lead tube. If the outer conductor is efficiently

* All reference to the intricacies of phase difference in the alternating system is purposely avoided.

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connected with earth at the generating works, no part of it will attain a dangerous pressure, and the risk of handling such a cable is greatly reduced.

24. Transformers and the metal cases in which they may be enclosed, if not efficiently connected to earth, are a source of danger in the event of "running to frame," or of any deficiency in the insulation of the high pressure wire or cable. If there is any moderate insulation leakage the earth-connected case cannot become charged; or if the insulation fail, and the high-pressure main becomes connected with the casing, the extra strong current resulting will blow the fuse in the transformer or its chamber, or at the central station, and disconnect the faulty part from the circuit. So long as no highly-charged metal is exposed, and the conditions indicated are correctly fulfilled, it would appear almost impossible for accidents to occur to men at work outside the transformer casing.

25. By efficient earthing is meant metallic connection to some good conductor which is in contact with damp soil over a considerable area. An earth cannot be considered efficient unless, under all weather conditions, in case of accidental contact with metal charged to high pressure, it will secure the passage of a current sufficient to blow the fuse employed for the protection of that metal. The best earth often available is the system of cast-iron pipes through which the cables pass, provided all the joints are metallic. A mere bolt or rod in brickwork, concrete, or in the ground, especially when that is liable to become dry, would be useless as an efficient earth in the case of metallic connection with high-pressure supply; but it might be sufficient to discharge the very small leakage that would occur with sound and, ordinarily speaking, perfect insulation. Transformers become warm in working, and thus the chambers, especially if well ventilated, are apt to become very dry.

26. Arc lights, when supplied with current from a central station, are usually arranged in series—*i.e.*, the same current is sent through a number of lamps. As an arc lamp requires an electrical pressure of from 40 to 50 volts, dangerous pressure becomes necessary when several lamps are arranged in series, for the electrical pressure is the sum of the electrical pressures of all the lamps separately A workman who is himself insulated cannot obtain a serious shock by handling even the two terminals of any single arc light, but if he is not insulated, and he touches any charged part of an arc light, a current may pass through his body. This may or may not be dangerous in itself, but in consequence of the fact that these lamps can in many cases only be reached by means of a ladder, a shock, harmless in itself, may cause a man to lose his hold and be seriously injured. If the whole electrical system is perfectly insulated, the shock depends upon the accidental pressure of the particular lamp touched. If, however, the insulation of the system at any part which differs greatly in pressure from the lamp touched be defective, then a dangerous shock is certain to follow.

27. As illustrating the dangers incidental to the use of electricity, it has been stated that in addition to minor accidents, of which we hear little or nothing, 14 deaths have been reported since 1892. The effects of the passage of an electric current through the human body are extremely uncertain and variable. Whilst the pressure required to cause death has in America been fixed at 1,500 volts, it is clear from the evidence laid before the committee that a smaller pressure may prove fatal, provided circumstances are favourable to the passage of the current through the body. People are known to have been accidentally brought into contact with higher pressures than 1,500 volts without any serious consequences following. These cases illustrate the extreme uncertainty and variableness indicated above. If a person receives a powerful electric shock, his muscles are thrown into such a state of tetanic rigidity that it is impossible for him to relax his grasp or extricate himself from his dangerous position. Such a shock may simply stun the person who receives it, rendering him unconscious for a brief period; it may, however, burn him, charring the surface of the body and inflicting deep wounds which heal with difficulty, or, as is usual where the pressure has been great and the conditions of resistance slight, it may cause sudden death. It is believed that strong electric currents may cause death in one of two ways—(*a*) either by arresting the breathing, or (*b*) by suddenly stopping the heart. With the view of ascertaining the cause of death, and of devising and testing means for resuscitation, Dr. Oliver undertook a series of experiments upon animals, most of them under the influence of an anæsthetic. Although in nearly all instances death was due to arrest of the heart's action, it is impossible to say upon which organ the current primarily exerted its harmful influence. In attempting to resuscitate them, the one method which above all others gave the most satisfactory results was artificial respiration. By this means some of the animals recovered even though the heart had ceased beating for a period, in one instance for as long as 13 minutes. Artificial respiration, therefore, should in all cases of apparent death from electric shock be resorted to at once, and persisted in for a considerable time, for recovery is known to have taken place where it has been practised for fully half an hour. Since this is the best treatment at our command, and every minute passed after finding a body in a perilous position without any attempt at restoration diminishes the chance of recovery, it is desirable not only that workers in electrical generating and distributing stations should be made thoroughly cognisant of the dangers incidental to their calling, but should receive practical instruction in methods of treating suspended animation. The rules for this purpose, subjoined in Appendix II., originally appeared in the *Electrical World* of New York, and afterwards reprinted by the *Electrical Review*.

(To be continued.)

MANCHESTER CORPORATION.

The following is the report of the Electricity Committee for the year ended March 31, 1897, together with the revenue account, balance sheet, and statement of electricity generated, sold, etc.:

The committee have pleasure in submitting to the City Council the abstract of the accounts for the year ended March 31, 1897. The members of the City Council are reminded that hitherto the work of the electric light department has been under the control of a sub-committee of the gas department, and that in future, as from the date of these accounts, by resolution of the City Council on March 17, 1897, this department was placed under the control of a separate standing committee, which for the current year consists of the following—viz., Alderman Higginbottom (chairman), Councillor J. Phythian (deputy-chairman), the Lord Mayor, Aldermen Gibson, Griffin, Sir J. J. Harwood, King, Milling, and Rushworth, Councillors Bax, Bowes, Brooks, Estcourt, Jennison, Lambert, Lloyd, Mainwaring, Royse, and Uttley. The committee beg to report the following particulars of the year's working and extensions, from which it will be seen that progress continues and prosperity has been fully maintained. The number of consumers at the close of the year was 1,581, being an increase of 433 as compared with the previous year. The total number of lamps connected was 120,142 (of 8 c p.), arc 1,172, as compared with 89,294 and 806 respectively. There were also in use 122 motors, representing 217 h.p., showing an increase over the previous year of 75 motors, equivalent to 162½ h.p. The total length of single conductor laid was 166 miles 1,455 yards, equal to 33 miles 961 yards of mains. The total quantity of current measured and accounted for was 2,775,107 units, or 91·64 per cent. of the quantity generated. A reference to the accounts shows that the financial results of the year have been very satisfactory. The net profit, after defraying all charges for cost of production, etc., providing for renewals, sinking fund, and interest on loans, amounts to £16,812. 8s. 1d.

Revenue Account (Abstracts 3 and 4).	£	s.	d.
Amount derived from sales of current, which works out at 4·34d. per unit accounted for, was	50,194	5	8
Receipts for meter rents amount to	1,289	6	11
Producing a total income of	51,483	12	7
Expenditure was £17,060. 3 7			
To which is added amount transferred to renewals suspense account 3,307 0 4			
	20,367	3	11
Showing a gross profit of	31,116	8	8
Out of this sum the following requirements had to be met:			
Interest on mortgage debt, etc. 7,171 9 7			
Sinking fund 7,132 11 0			
	14,304	0	7
Leaving a surplus, or net profit, for the year of	16,812	8	1

This surplus, together with the balance of £1,153 brought from last year's account, showing a total of £17,965. 8s. 1d., has been appropriated in the following manner—viz.:

Paid to city fund in aid of rates	10,000	0	0
Placed to reserve fund	7,965	8	1
	£17,965	8	1

The following statement shows the financial position of the undertaking at March 31, 1897:

Total capital expenditure	£309,190	19	10
Mortgage debt	257,011	5	0
Amount of mortgages redeemed to date by action of sinking fund	16,318	15	0
Balance at credit of renewals suspense account	10,798	15	1
Balance at credit of reserve fund	16,486	12	0
	£27,285	7	1

On September 30 last, concessions were granted to the long-hour consumers by reducing the fixed charges from £12 to £9 per annum per unit of demand, and the price of current from 2d. to 1½d. per unit as measured by meter. In consequence of the great and increasing demand made upon the committee for the supply of electric current it is imperative that further extensions of plants and mains be carried out as speedily as possible, and it has been decided to lay mains in the following streets—viz., Wilmslow-road to city boundary, Plymouth-grove Stockport-road to city boundary, Hyde-road to Fenton-street, Clowes-street, Oldham-road to Ten Acres-lane, Cheetham Hill-road to Cheetham Town Hall, Bury New-road to city boundary. To carry out these extensions further borrowing powers will be required, and in accordance with a resolution of the City Council application has been made to the Local Government Board for their sanction to raise an additional sum of £130,000. Agreements have recently been entered into with the Urban District Council of Moss Side and the Urban District Council of Levenshulme for the supply of electric current to their respective districts.

Electricity Generated, Sold, etc., Year ended March 31, 1897.	
Quantity generated	3,028,357
Quantity sold to private consumers	2,508,588
Quantity used on works	266,519
Total quantity accounted for	2,775,107
Quantity not accounted for	253,250
Total maximum supply demanded (watts)	2,737,400

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REVENUE ACCOUNT FOR YEAR ENDING MARCH 31, 1897.

Dr.				£	s.	d.
Generation of Electricity.						
Coal (including cost of unloading, etc.)	£4,145	10	9			
Oil, waste, water, and engine-room stores	1 176	19	5			
Wages at generating station	2,204	4	6			
Repairs, maintenance, and renewals as follows: buildings, £82. 4s. 4d.; machinery, etc.—engines, boilers, dynamos, switchboards, cranes, transformers, stokers, instruments, tools, etc., £1,031. 13s. 7d.	1,113	17	11			
Current used on works, etc., for lighting and motive purposes, £1,738. 10s. 8d.; and maintenance of lamps, etc. (lighting of station), £29 3s. 4d.	1,767	14	0			
				10,408	6	7
Distribution of Electricity.						
Wages	558	16	10			
Sundries	83	5	11			
Repairs, maintenance, and renewals, as follows: machinery, etc., at distributing stations — Hunt's Bank, £6. 11s. 9d.; Piccadilly, £2. 6s. 1d.; Royal Exchange, 3s. 5d.; All Saints, £10. 6s 8d.; Ardwick Green, £2. 3s. 10d.; mains, fuses, etc., £409. 14s.; meters, £80. 11s. 8d.; tools, £67. 4s. 4d.	579	1	9			
				1,221	4	6
Rents, Rates, and Taxes.						
Chief rents	170	4	8			
Rents of sub stations, etc., including £100 paid to Gas Committee for rent of office	317	7	0			
Rent of telephones	26	0	0			
Rates	873	3	1			
Income tax	717	17	4			
				2,104	12	1
Management Expenses.						
Salaries—viz., engineer's department (including C. H. Wordingham, £628. 3s. 6d.)	1,106	7	9			
Superintendent's department and clerical staff	1,141	3	5			
Stationery, printing, and advertising	305	10	10			
General establishment charges	489	19	6			
				3,043	1	6
Law and Parliamentary Charges and Expenses.						
Law charges	49	17	1			
Stamp duty	35	6	6			
				85	3	7
Special Charges.						
Insurances	17	6	6			
Bank commission (including 2s. 1d. transferred from sinking fund account)	23	14	3			
Contributions to Manchester Corporation thrift fund	49	2	9			
Commission on loans	5	0	4			
Repairs and maintenance of office furniture	25	5	10			
Official clothing	40	0	11			
				160	10	7
Bad debts—amount written off				37	4	9
				17,060	3	7
Amount transferred to renewals suspense account, being difference between the estimated wear and tear of buildings, machinery, mains, etc., during the year, and the repairs and maintenance actually charged				3,307	0	4
Balance carried to net revenue account				31,116	8	8
				£51,483	12	7

Cr.	£	s.	d.
Current	50,194	5	8
Rental of meters	1,289	6	11
	£51,483	12	7

GENERAL BALANCE-SHEET, MARCH 31, 1897.

Dr. Liabilities.	£	s	d.
Mortgage debt—Loans as per capital account	257,011	5	0
Amount owing to city treasurer for wages advanced	445	11	1
Amount owing bankers	16,274	6	9
Sundry creditors—deposits held as security for current supplied, £1,270. 6s. 7d.; interest accrued on ditto, £40. 5s. 4d.; trade accounts owing, £9,644. 1s. 7d.	10.954	13	6
Amount at credit of renewals suspense account	10,798	15	1
Amount at credit of reserve fund	16,486	12	0
Balance, being surplus—mortgages redeemed by sinking fund	16,318	15	0
	£328,289	18	5

Cr. Assets.	£	s.	d.
Land, buildings, plant, etc.—amount expended as per capital account	309,190	19	10
Stocks on hand	2,229	4	11
Sundry debtors—Accounts due for current supplied, £16,069. 9s. 4d.; other accounts due, £589 5s. 9d.; cashier, cash in hand, £210. 18s. 7d.	16,869	13	8
	£328,289	18	5

LEGAL INTELLIGENCE.

PATENTING AN ELECTRICAL INVENTION.

In the Westminster County Court on Wednesday, his Honour Judge Lumley Smith, Q.C., had before him the case of Parkington *v.* Wenkel, in which the plaintiff, Colonel Parkington, sued the defendants, a firm of patent agents carrying on business at Chancery-lane, to recover a sum of money paid to them in respect of the patenting of an invention for production of electric light on bicycles.

The plaintiff's case was that he conceived an idea for attaching a dynamo to bicycles, and thus producing electric light by the rotation of the wheels. For the purpose of getting the invention patented, he went to the defendants and paid them a sum of 12 guineas to act for him in the matter, but he afterwards became dissatisfied with them, and took the matter out of their hands, and now sought to recover back his money, or at least a portion of it.

The defence was that nearly the whole of the 12 guineas had been expended in the work, and that the small balance which was left had been paid into court.

After hearing the evidence, his **Honour** said he thought the defendants were entitled to six guineas for their labour and £1 for the stamp, and therefore judgment would be for the plaintiff for £5. 6s, without costs.

DISPUTED LIABILITY FOR ELECTRICAL WORK.

In the Westminster County Court on Tuesday, his Honour Judge Lumley Smith, Q.C., had before him the case of Cooper *v.* Rice, in which the plaintiff sought to recover payment for electrical work done to the defendant's order at his offices in Victoria-street, S.W.

The **Defendant** disputed liability, and said his partner gave the order and ought to pay.

His **Honour** said that was all nonsense, and gave judgment for the plaintiff for the full amount, payable in a month.

CLAIM FOR ELECTRICITY SUPPLY.

In the Westminster County Court on Tuesday, his Honour Judge Lumley Smith, Q.C., had before him the case of the Westminster Electric Supply Corporation *v.* Raynor, in which the plaintiff company sought to enforce payment of a judgment debt for electric light supplied to the defendant.

The defence was inability to pay, and after hearing evidence his **Honour** decided to adjourn the case until October 13 next.

COUNTER-ACTIONS OVER A DYNAMO.

At the Hanley County Court, on Wednesday, before Judge Jordan, Joseph Blackburn and Co., electrical engineers, Nottingham and Hanley, sued Messrs. T. W. Harrison and Co., colour manufacturers, Hanley, for £12 for repairing a dynamo. There was a counter claim for £20, damages sustained by the defendants by the dynamo being unfit for the purpose for which it was supplied.

Mr. F. W. Harris appeared for the plaintiffs, and Mr. B. C. Brough (instructed by Messrs. Challinor) for the defendants.

The case for the plaintiffs was that in 1893 they obtained through Mr. C. Osborne for the defendants a second-hand dynamo for £35. This was fixed at the defendants' mill at Hanley, and for a time worked well. To suit the defendants' convenience the situation of the dynamo was changed, the work being done by the defendants' men. On this occasion it did not work satisfactorily, and in July, 1895, and April, 1896, was repaired by the plaintiffs, and for this work they now sued. It was stated that no complaints were made about the machine for the first 18 months after it was supplied.

For the defence, and in support of the counter-claim, it was contended that it was on the advice of Mr. Osborne that the defendants bought the dynamo, and it was denied that they had refused to buy a new one Complaints were frequently made to Osborne, and on his advice several changes were made and the repairs executed. Everything proved unsatisfactory, however. The machine did not work more than a quarter of the time during the first 18 months and the defendants had to fall back on their old dynamo. Osborne admitted that the machine was a bad one, and the plaintiffs' electrical engineer (Mr. Starling) wrote that the construction was radically wrong.

His **Honour** said the plaintiffs' claim was undisputed, as the repairs had been done at the request of the defendants. As to the counter-claim, if the defendants were dissatisfied with the dynamo they should have complained to the plaintiffs within a reasonable time. In his opinion the defendants got what they bargained for.

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He gave judgment for the plaintiffs on both the claim and the counter-claim, with costs.

CLAIM FOR ELECTRIC LIGHT.

The case of Easton *v.* Gilbert was before his Honour Judge Lumley Smith, Q.C., in the Westminster County Court, on Tuesday, by way of a judgment summons to enforce payment of a judgment debt for electric light supplied to the defendant at Ashley-gardens, Victoria-street.

The **Defendant** said his wife was liable and was well able to pay, but his **Honour** said he could not go behind the judgment, and made an order for payment in a month.

COMPANIES' MEETINGS AND REPORTS.

CROMPTON AND CO., LIMITED.

Directors: John Trotter, Esq., chairman; Rookes Evelyn Bell Crompton, Esq., and John Francis Albright, Esq., managing directors; Bernard Gibson, Esq.; Carleton F. Tufnell, Esq.

Ninth report of the directors to be presented to the shareholders at the annual general meeting to be held at the City Terminus Hotel, Cannon-street, E.C., on Thursday, July 22, 1897, at 3 p.m:

The directors have pleasure in submitting the annual statement of accounts made up to March 31 last, from which it will be seen that, notwithstanding the fact that the business is still being carried on at considerable disadvantage at the old works, the result of the year's working shows a profit. Acting upon the pledge given to the shareholders at the last meeting, the directors have prepared a scheme for reducing the capital of the Company, the particulars of which are set out in the accompanying circular, and, in accordance with the notice herewith, a special meeting of the shareholders will be held at the conclusion of the ordinary business for the purpose of considering, and, if approved of, passing the necessary resolution for altering the articles of association. The net profits for the year amount to £12,172 19s. 4d., and, after providing for debenture interest and the payments set out in the revenue account, there remains a balance of £4,180. 11s. 5d. The new works of the Company, after being considerably impeded by the wet and the tempestuous weather of last winter and spring are now practically completed, and so soon as the new machinery is erected the work of manufacture there will be commenced with every prospect of considerable economies. Notwithstanding the difficulties of manufacture in the old works, a larger business was carried on last year than ever before, and the prospects for the future are decidedly encouraging. The lease of the London works at Lillie-road has been given up, and the manufacturing work carried on there has been removed to Chelmsford. In accordance with the articles of association, Mr. John Trotter retires from the Board of directors by rotation, but offers himself for re-election. The auditors, Messrs. J. H. Duncan and Co., also offer themselves for re-election.

The following statement has also been issued to the shareholders:

"At the general meeting of the Company in August, 1895, some of the shareholders, with the general approval of many others present, urged upon the Board of directors the advisability of their taking in hand the question of rearranging the capital account of the Company by writing down the value of some of the assets. At last year's meeting the directors pledged themselves to give effect to these views, and since then the failure of the Australian Company renders it still more necessary that the matter should be decided. After careful consideration, the directors propose to write off the debit balance of the revenue account at March 31, 1896, and the preliminary expenses account, to write down the various investments of the Company and doubtful debts, the patents accounts, and the goodwill account, the total amount thus dealt with being £78,396. To give effect to this they recommend the following scheme: That the whole of the share capital of the Company, both preference and ordinary, be reduced by writing off £2 per share from the nominal value of £5, and that the distinction between the preference and ordinary shares be abolished. As a consideration for this cession of their rights of priority on the part of the preference shareholders, the holders of the fully-paid ordinary shares have consented, if the proposed arrangement is carried out, to relinquish for cancellation half—namely, 2,000—of their ordinary shares. It will be necessary that the uncalled capital be called up, and instead of the position shown in the accompanying balance-sheet, the future paid-up capital of the Company will be £96 324 in 32,108 shares of £3 each, and there will still remain 21,892 shares of £3 each, which may be issued at some future date with the object of providing working capital. In making these proposals my directors have in view the desirability of effecting an arrangement by which the profits which are likely to be earned by the Company in the immediate future may be distributed to the shareholders, and they have therefore carefully weighed the claims and rights which both the existing classes of shareholders now possess; the ordinary shareholders on the one hand, so soon as the prosperity of the Company is re-established, would be practically taking half the profits of the Company, and on the other hand the preference holders are entitled to certain arrears of dividends. Setting these claims and rights one against the other, the arrangement herein proposed appears to be a fair and just one. It should be borne in mind that in the new arrangement the holders of the ordinary shares, which originally stood at £49,640, will in the future only rank as £11,784 paid, as compared to £84,540 held by the present preference holders. The directors are of opinion that the capital of the Company should be written down by reducing the various assets of the Company to the amount of £78,396, and unless the two classes of shareholders combine to carry into effect an equitable arrangement such as is herein proposed it would be necessary that the whole of this amount be written off out of profits before any dividend can be paid to either the preference or ordinary shareholders. To those ordinary holders who will now be called upon to pay up £4 per share by instalments, and who will in return only get a certificate for a £3 share, it should be pointed out that the liability has been incurred by them, and would have to be met sooner or later, while under present circumstances, unless some such arrangement as is herein proposed be adopted, the prospects of a dividend coming to them are indefinitely postponed. The vendors, who surrendered 4,000 £5 ordinary shares in 1894, have now agreed to surrender a further 2,200 shares, and that the remaining 2,000 shares still held by them shall be written down to £3 per share in common with those held by other members. They consent to this as a consideration for the concession proposed to be made by the preference holders as they believe it to be in the interests of the Company that the scheme should be adopted, and it should be mentioned that they are by far the largest holders of the preference shares, for which they subscribed and paid in cash. Under the new scheme the ordinary holder will rank for dividends with all the other members of the Company, and as the capital will only stand at £96,324, the directors look forward with confidence to the time when regular dividends will be paid and when at the same time they may be able to build up a substantial reserve fund, which should place the Company in a position of security and independence. As a first step towards carrying this scheme into effect it will be necessary to alter the Company's articles of association by the addition of the clause set out in the notice of extraordinary general meeting herewith. Should it appear likely that you will be unable to attend the meeting, the directors request, if you approve of the scheme, that you will fill up, sign, and return to me the enclosed form of proxy, as it is desirable to obtain the views of the shareholders as fully as possible.—FRANCIS R. REEVES, secretary.

STATEMENT OF LIABILITIES AND ASSETS AT MARCH, 31, 1897.

Capital and Liabilities.	£	s.	d.
Authorised issue, 56,000 shares at £5	280,000	0	0
Ordinary shares, 4,000 issued as fully paid	£20,000 0 0		
Ditto 1,928 shares, £1 called, £1,928; payments in full, £24	1,952 0 0		
	21,952	0	0
Preference shares, 28,180 at £5	140,900	0	0
	162,852	0	0
Debentures, 5 per cent.	83,600	0	0
Loans from bankers	35,851	19	1
Sundry creditors	39,712	6	8
Three months' debenture interest accrued	1,010	3	4
Doubtful debts and contingencies account balance	188	11	0
Unclaimed dividends	10	14	0
Revenue account balance	4,180	11	5
	£327,406	5	6

Property and Assets.	£	s.	d.
Freehold property	28,880	0	9
Plant, tools, furniture, fixtures, etc.	46,946	19	0
Stock-in trade and work in progress	71,723	13	11
Trade debtors	67,935	2	7
Investments in shares of other companies	3,909	10	0
Chelmsford Electric Lighting and other subsidiary companies	30,432	12	7
Cash at bankers and in office	8,182	18	2
Suspense account—preliminary expenses, premium on debentures paid off, and costs of issue of debentures	9,775	3	3
Patents account	13,403	4	4
Electric cooking and heating department, cost of establishing	5,166	0	0
Goodwill	30,000	0	0
Suspense account (loss by fire)	11,051	0	11
	£327,406	5	6

PROFIT AND LOSS ACCOUNT YEAR ENDING MARCH 31, 1897.

	£	s.	d.
Trading expenses (steam and electric power, labour and stores, works' salaries and expenses)	15,901	8	8
Administration and office expenses, rents, rates and taxes, salaries, advertisements, etc.	9,404	15	5
Repairs to buildings and plant	625	4	10
Depreciation of plant and machinery, patents, and fixtures	4,185	17	3
Balance carried to revenue account	12,172	19	4
	£42,290	5	6

	£	s.	d.
Gross profit from trading account, pupils' premiums, and dividends on investments	42,290	5	6
	£42,290	5	6

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Revenue Account.	£	s.	d.
Interest on debentures	4,026	16	5
Interest on bankers' advances	1 284	11	10
Directors', managing directors', trustees', and auditors' fees	2,528	12	9
Income tax, £152. 6s. 11d.; balance, £4,180. 11s. 5d.	4,332	18	4
	£12,172	19	4
	£	s.	d.
Net profit from profit and loss account	12,172	19	4
	£12,172	19	4

ELECTRICAL POWER STORAGE COMPANY, LIMITED.

The ordinary general meeting of this Company was held on Thursday at the offices, Great Winchester-street.

Mr. J. Irving Courtenay (chairman and managing director), who presided, stated that the free balance, including the sum brought forward, amounted to £4 485, out of which they recommended a similar dividend to that of last year—namely, 5 per cent.—which would leave £242 to be carried forward. The number of plates sold during the year showed a marked advance on the sales of any previous year, thus indicating to some extent the importance of the goodwill of the Company's business. The new Faure-King accumulator was receiving the favourable consideration of a large number of buyers, and they had on hand, among numerous other orders, contracts for this class of their manufactures for the electric supply stations of the Corporations of Belfast, Aberdeen, and Dundee, and had already secured important orders for these batteries for motorcar propulsion. In regard to the recent debenture issue, he might state that all the debentures they had desired to issue were quickly subscribed. Competition was of the severest character, and the margin of profit was now so low that he doubted much whether some at least of their competitors could succeed in making both ends meet at the prices which they were quoting. As to the demand for personal sureties for duly carrying out the contracts made by corporations and companies, wherever there were large contracts to be dealt with their Company had always given really effective guarantees in connection with such contracts; but he did not see how the class of guarantee, say, for five or ten years, which he heard of as being given could possibly be considered an effective guarantee.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Konigsberg-i.-Pr. (Germany).—Tenders will be received on July 19 by the Municipal Authorities of Königsberg for two 350-h.p. dynamos.

Novorossjisk (Russia).—Tenders will be received up to November 13 by the Municipal Authorities of Novorossjisk for the concession for the construction and working of an electric tramway.

Herve (Belgium)—Offers will be received up to October 1 by the Municipal Authorities of Hervé, in the Province of Liège, for an installation of town lighting. No information is given as to the system (electrical or otherwise) which would be preferred.

Halifax.—Tenders are invited for the supply of trolley wire, bonds, and insulators. Sealed tenders, endorsed "Electric Line Construction," must be sent to Mr. Keighley Walton, town clerk, before 10 o'clock a.m. on Monday, July 26. See advertisement.

Wigan.—The Gas and Electric Lighting Committee require tenders for the supply of gas coal. Particulars and form of tender may be obtained on application to Mr. Jos. Timmins, engineer. Tenders, sealed and endorsed "Tenders for Coal," to be delivered to Mr J. J. Charnock, town clerk, Town Hall, on or before 20th inst.

Derby.—The Corporation are prepared to receive tenders for the supplying and laying of high-tension cablee, junction boxes, cable and hauling winch (Section A); transformer boxes, switches, safety fuses, etc. (Section B), in the borough of Derby. Tenders, endorsed "Electric Lighting, Tender for Cables, etc," to be sent in not later than 12 noon on July 26. For further particulars see advertisement.

Lincoln.—Tenders are required by the Electric Lighting Committee for the erection of a tall chimney on Brayford Side (North), Lincoln Plans and specifications can be seen and forms of tender and quantities obtained at the office of Mr. R. A. Macbrair, city surveyor, Lincoln, on payment of £1. 1s., which will be returned upon receipt of a bona fide tender. Sealed tenders, endorsed "Tender for Chimney," to be sent to the Surveyor by 20th inst.

Sunderland—The Corporation are prepared to receive tenders for (1) combined arc lamp and trolley poles, (2) arc lamps and accessories. Sealed tenders, addressed to the Chairman of the Highways Committee, Town Hall, Sunderland, must be sent to Mr. Fras. M. Bowey, town clerk at his office, on or before July 28, not later than 12 o'clock noon. Tenders to be submitted separately, and endorsed "Tender for Lamp and Trolley Poles" and "Tender for Arc Lamps" respectively. See advertisement.

Lincoln.—Tenders are required by the Electric Lighting Committee for the erection of electricity works, offices, and stores on Brayford Side (North), Lincoln. Plans and specifications can be seen and forms of tender and quantities obtained at the office of Mr. R. A. Macbrair, city surveyor, Lincoln, on payment of £1. 1s., which will be returned on receipt of a bona fide tender. Sealed tenders, endorsed "Tender for Works, etc.," to be sent to the Surveyor by 20th inst.

Brighton.—The Council invite tenders for the supply of coal required at the Corporation electricity generating station during the year commencing August 1, 1897. Particulars of the descriptions of coal to be tendered for, and of the estimated quantity required, together with the conditions of supply, may be obtained on application at the office of Mr. Francis J. Tillstone, town clerk, Town Hall, Brighton. Sealed tenders, endorsed "Tenders for Coal," must be delivered before 10 o'clock in the forenoon on Monday, July 26.

Rathmines (Ireland)—Tenders are required for the supply and erection of turbine and dynamos, etc., for the lighting of the new town hall by electricity, by the Commissioners of the Townships of Rathmines and Rathgar. Specifications can be had on application to Mr. Frederick P. Fawcett, secretary, Town Hall, Rathmines, co. Dublin, on payment of 10s.; plans and specifications to be returned with tender. The contractor will be required to enter into a bond, with two sureties, for the due performance of the contract. Tenders, endorsed "Tenders for Machinery, etc.," to be delivered at the Secretary's Office by 10 a.m. on the 19th inst.

War Office, S.W.—Tenders are required for the supply of specific quantities of the undermentioned articles during the next 12 months—namely, electrical instruments (submarine mining), indiarubber goods, metals (copper, lead, tin sheet, zinc sheet), and telegraph cable and wire. Manufacturers who may wish to be applied to when tenders are required should address Mr. A. Major, director of army contracts, War Office, Pall-mall, S.W., by letter, stating the particular articles which they manufacture, and the names of at least two well-known firms or public bodies who have purchased from them, and are in a position to certify as to the quality of their productions.

Birkenhead.—The Corporation invite tenders for the supply and laying complete of cables, street boxes, etc., in certain streets in the borough. Plans can be seen, and a copy of the general conditions and the specification, with form of tender, can be obtained on payment of £1. 1s., to be returned on the receipt by the Corporation of a bona fide tender, at the Town Clerk's Office, Town Hall, Birkenhead, or at the office of Mr. James N. Shoolbred, C.E., 47, Victoria-street, London, S.W. Tenders, which must be on the prescribed form, sealed and endorsed "Tender for Electrical Cables," must reach Mr. Alfred Gill, town clerk, Town Hall, Birkenhead, by 5 p.m. on 23rd inst.

Jassy (Roumania).—Tenders will be received on September 6-18 at 4 p.m., in the hall of the Communal Council of the Mairie of the Commune of Jassy, for the concession for a term of 40 years of the contract for gas or electric lighting, or gas and electric lighting, of the public thoroughfares and communal buildings. Every applicant, before being entitled to tender, will be required to deposit a provisional security of 70,000fr. in cash or Roumanian public bonds. All tenders must be sealed and lodged at the Mairie by the day and hour named. Conditions of tender and specification respecting this concession will be forwarded on application to Mr. C. Gall, secretary.

Hull.—The Electric Lighting Committee of the Town Council are prepared to receive tenders for the supply, erection, and hiring of certain plant and machinery required in connection with the electric lighting installation during the winter of 1897-8. Specifications for the above, with conditions of contract and any further information, may be obtained at the office of Mr. A. S. Barnard, borough electrical engineer, Dagger-lane Hull. Tenders, sealed and marked "Electric Lighting—Temporary Plant," are to be addressed to the Chairman of the Electric Lighting Committee, and to be delivered at the Town Clerk's Office, Town Hall, Hull, before noon on Thursday, July 29.

Egypt.—The Secretary of State for Foreign Affairs has received a despatch from her Majesty's Agent and Consul-General at Cairo, drawing attention to a notice published in the *Official Journal* of the Egyptian Government of 23rd ult., in which it is stated that tenders are invited by the Egyptian Government for Welsh coal for the use of the Administration of Railways and the Port of Alexandria. Tenders should be sent under cover by registered post, and should reach the President of the Administrative Council by October 15 next. Such further particulars as have been received may be seen at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 6 p.m.

Birkenhead.—Tenders are invited by the Corporation for the wiring and lighting by electricity of Woodside Ferry. Plans can be seen, and a copy of the general conditions and specification with form of tender obtained, on payment of the sum of £1. 1s. (to be returned on receipt by the Corporation of a bona fide tender), at the Town Clerk's Office, Town Hall, Birkenhead, or at the office of Mr. James N. Shoolbred, M.I.C.E., 47, Victoria-street, London, S W. Tenders, which must be on the prescribed form, sealed and endorsed "Tender for Electrical Wiring and Lighting of Woodside Ferry," must reach Mr. Alfred Gill, town clerk, Town Hall, Birkenhead, by 12 noon on 20th inst.

Jassy (Roumania).—Tenders will be received on and after September 6-18 at 3 p.m., in the hall of the Communal Council of the Mairie of the Commune of Jassy, for the concession for a term of 40 years of a line of tramways to serve the Commune of Jassy, the said concession to include the construction, maintenance, and working of the line. Every applicant, before being entitled to tender, will be required to deposit a provisional security of 50,000fr. in cash or Roumanian public bonds. All tenders must

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be sealed and lodged at the Mairie until the day and hour above named. Conditions of tender and specification respecting this concession will be forwarded on application. Tenders will be subject to articles 68-79 of the Public Accounts Act. Mr. C. Gall, secretary.

Newport (Mon.).—The Electricity Committee require tenders for the erection of buildings and machinery foundations for extensions of the municipal electricity works of the county borough. The drawings and specification, with conditions of tender and contract, may be seen at the offices of Mr. Robert Hammond, M.I.E.E., the consulting electrical engineer to the Corporation, Ormond House, Great Trinity-lane, London, E.C., or at the offices of Messrs. Conyers, Kirby, and Son, the architects, Stow-chambers, Newport, on and after 17th inst., and copies of bill of quantities may be obtained from the Architects on payment of £2. 2s., which sum will be returned on receipt of a bona fide tender. Tenders, sealed, and marked "Tender for Electricity Works Buildings," must be addressed to Mr. Albert A. Newman, town clerk, Town Hall, Newport, and delivered before 10 a m. on 30th inst.

Sofia (Bulgaria).—The Municipality of Sofia will receive offers up to September 22 for the concession of the public and private lighting of the city, for power, and also for electric tramways. The duration of the concession is for 50 years. Such further information as has reached this country can be seen at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 6 p.m., and particulars, in French or Bulgarian, can be obtained for 5f. from the Mairie at Sofia. The mayor is Mr. D. M. Yablanski, and the engineer Mr. Chr. Taneff. NOTE.—In accordance with a custom prevalent in the Balkan States, when the tenders have been opened, it will be admissible for anyone to underbid the lowest one up to October 2. In the language of the notice, "tenders will be received for either or both of the undertakings at the offices of the Municipality of Sofia up to September 22 next, and will then be examined, but a final adjudication will be held on October 2, if in the interval a reduction of 5 per cent. is offered on the tenders containing the most favourable terms."

St. Helens (Lancs.).—The Electric Lighting Committee of the Corporation are prepared to receive tenders for the supply and erection of the following plant for the extension of the municipal electricity works: (Section A) boiler-house plant—Lancashire boiler and fittings, forced draught apparatus, feed pump, economiser, etc.; (B) engine-house plant—steam alternator and exciter, etc., steam exhaust, feed, blow-off, and sundry pipes, valves, etc.; (C) switchboard and instruments; (D) underground work—culverts and cables; (E) transformer sub-stations. Tenderers are at liberty to tender for any section or sections, or for the whole of the sections, but not for part of a section. The plans of plant and specification, with terms and conditions of tender and contract, may be obtained at the office of Mr. Robert Hammond, M.I.E.E., consulting engineer to the Corporation, Ormond House, Great Trinity-lane, London, E.C., on payment of £2. 2s. for each copy, which sum will be refunded on the return of the specification, filled up with a bona fide tender. Tenders (sealed, and marked "Tender for Electric Lighting") must be addressed to Mr. W. J. Jeeves, town clerk, Town Hall, St. Helens, and delivered by July 20.

Newport (Mon.).—Tenders are required by the Electric Lighting Committee for the supply and erection of the following plant for the extension of the municipal electricity works (the whole bound up in one specification, price £2. 2s., returnable on receipt of bona fide tender): (Section A) boiler-house plant—Lancashire boilers and fittings, mechanical stokers, feed pumps, economiser, electric motor, etc.; (B) steam and exhaust pipes, valves, etc.; (C) engine-house plant—steam alternators and exciters, accumulators, oil filter and tanks; (D) switch gear and instruments; (E) arc lamps, posts, and accessories; (F) coal elevator; (G) allowance for day-load plant. The ground plans of plant, and specification, with terms and condition of tender and contract, may be obtained at the offices of Mr. Robert Hammond, consulting engineer to the Corporation, Ormond House, Great Trinity-lane, London, E.C., on payment of £2. 2s. for each copy, which sum will be refunded on the return of the specification filled up with a bona fide tender. Tenders, sealed and marked "Tender for Electric Lighting," must be addressed to Mr. Albert A. Newman, town clerk, at the Town Hall, Newport (Mon.), and must be delivered on or before 30th inst.

Madras.—Tenders are invited for the utilisation of water flowing from the Periyár Lake for purposes other than irrigation and not incompatible with the use of the water for drinking. The irrigating season extends over nine to ten months, during which time the discharge is likely to be from 1,100 to about 500 cubic feet a second, according to the demands for irrigation and the available quantity in the lake. Subject to the risk of interruption by accident or drought, supply can be given throughout the irrigation season. No supply can be guaranteed at other times, but, so long as water is available, the Government will be prepared to issue it in such daily quantities as may seem to it advisable with reference to the time which is likely to elapse before the supply is replenished by the setting in of the rains. The fall from the tunnel to the foot of the hills is approximately 900ft., and the distance measured along the course of the stream about 6,800ft. One cubic foot per second falling 900ft. is estimated to produce over 60 effective horse-power. Intending lessees should state the quantity of water required in cubic feet per second and the annual rent offered for each cubic foot per second. No rent will be charged for the first year from the date of the concession; for the second year the charge will be one-fifth, and an additional charge of one-fifth will be made every year until the full rent is reached. The whole or part of the concession may be surrendered on a year's notice being given. Lessees will construct at their own expense, on plans to be approved by Government, all the weirs and other works required to divert the water from the river below the tunnel. For further information, application may be made to the Chief Engineer for Irrigation, Madras, by whom tenders will be received up to October 31, 1897.

RESULTS OF TENDERS.

St. Pancras.—The Vestry have accepted the tender of Mr. T. W. Eastwell, 129, Ossulston street, N.W., for cleaning and painting the arc lamp columns at 12s. 6d. each.

Leeds.—For erection of a battery station in connection with the tramways at Kirkstall, the Corporation accepted the tender of Messrs. J. Schofield, Sons, and Co., Limited, Kirkstall-road, at £485. 9s. 11d.

Lyons.—The successful tender for the electric lighting installation at the lunatic asylum at Bron (Rhone) on June 23 was that of the Compagnie Electro-Mécanique, Paris, at 15 per cent. reduction on the official estimate of 104,841fr.

Leeds.—For the alteration, etc., at the new entrance, Roundhay Park, necessary for the formation of an electric battery station for the electric tramways, for the Corporation, the tender of Messrs. Wade Bros., Woodhouse-lane, at £451. 3s. 6d., was accepted.

BUSINESS NOTES.

Hereford.—The Town Council have decided to light the asylum by electricity.

Outing.—Messrs. Henry F. Joel and Co.'s annual outing took place at Broxbourne on Saturday last.

Western and Brazilian Telegraph Company, Limited.—For the past week the receipts were £2,443.

Newington.—The Vestry's provisional order for electric lighting has passed through the House of Lords.

Ayr.—The Town Council have agreed to fit up a number of the street gas lamps with incandescent electric lamps.

St. Pancras.—The Vestry have postponed for two months the proposed extension of the electric mains to Highgate.

Hampstead.—The Vestry have resolved to make a trial of incandescent electric street-lighting and to extend the mains.

Birkenhead.—The Town Council have appointed another special committee to consider and report upon the tramways question

Glasgow.—About 30 of the street arc lamps have been finished and lighted. There are over 60 more street lamps to be fitted with new arms.

Clontarf.—It is anticipated that in about two weeks the new electric tramline from Annesley Bridge to Dollymount will be open for traffic.

Leeds.—A preliminary trial of one of the cars to be used in connection with the Roundhay-Kirkstall electric tramways has been made. It was very satisfactory.

Personal.—Mr. John Burbridge has been appointed chief electrical engineer in the tramways department of the Leeds City Council, at a salary of £300 per annum.

Globe Telegraph and Trust Company, Limited.—The directors recommend the payment of a final dividend of 3s. 6d. per share on the ordinary shares, carrying forward about £1,950.

Bootle.—The Town Council have adopted the scheme of electric lighting, and have decided to apply to the Local Government Board for power to borrow £35,000 for the purpose.

St. Helens.—The electric light scheme is being proceeded with by the Town Council, irrespective of any idea of electric tramways, which may form the subject of an independent scheme later on.

Lewes.—The Electric Lighting Acts have been considered in committee, and it is reported that a movement is taking place with a view to the introduction of the electric light into the town.

Bangor.—The Town Council have appointed a sub-committee to visit several gas and electric light works, and report upon the information they might thus gain as to the working of gas and electric lighting works.

Cork Electric Tramways.—By an order of the Lords Justices and Privy Council the Cork Electric Tramways Company, Limited, have been empowered to construct electric tramways throughout the city and suburbs of Cork.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended July 11 amounted to £1,483, as compared with £1,252 in the corresponding week of the previous year, being an increase of £231.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended July 9 were £2,608. 19s. 9d., compared with £2,419. 5s. 7d. for the corresponding period of last year, being an increase of £189. 14s. 2d.

Manchester.—The City Council have adopted a revised scale of charges for the electric light supplied from the Corporation electric light works. The old customers are to have the option of remaining under the old scale or adopting the new.

Edinburgh.—At a meeting of the Electric Lighting Committee of the Town Council it was resolved to recommend an extension of the low-tension continuous-current mains from Crosscauseway to Salisbury-place, at a probable cost of £1,200.

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Dewsbury.—On the recommendation of the Lighting Committee the Town Council have passed a vote of thanks to Mr. Mitchell, the Corporation electrician, for the services he had rendered in the electric lighting of the façade of the town hall.

Hammersmith.—The Vestry are about to extend their electric main so as to supply, among other places, the Lyric Theatre. It has also been decided by the Vestry to organise an exhibition of electric fittings, heating and cooking appliances.

The Telegraph Grievances.—The grievances of the telegraph clerks are to be discussed in the House of Commons to-day (Friday) on the motion of Sir Albert Rollit. In view of an unfavourable answer being given, a strike is seriously threatend.

Charing Cross and Strand Electricity Supply Corporation, Limited.—The directors have declared an interim dividend for the half-year ending June 30 at the rate of £6 per cent. per annum on the ordinary share capital, payable on August 14 next.

Paddington.—The Vestry have received an intimation from the County of London and Brush Provincial Electric Lighting Company, Limited, stating their intention to apply before the end of the year to Parliament for a provisional order for electric lighting

Mold.—At the Urban District Council meeting a letter was read from Messrs. Walter Webb and Co., on behalf of the Great Western Electric Company, stating it was proposed to apply to the Board of Trade for a provisional order to supply electricity within the district.

Warrington.—At the Town Council meeting, Councillor Grace enquired as to what was being done with regard to providing electric light in the town. Had an order been applied for? The Town Clerk said he had given notice to apply for an order in this session of Parliament.

County of London and Brush Provincial Electric Lighting Company.—The directors have declared an interim dividend for the half-year to June 30, 1897, on the first and second issues of preference shares at the rate of 6 per cent. per annum on the amounts paid up thereon.

Stafford.—Alderman Peach stated at the Town Council meeting that in the electricity department 5,945 Board of Trade units had been sold during the past quarter, as compared with 3,062 units in the corresponding period of last year—an increase of 94 per cent., which it was hoped to see maintained.

Auckland.—A circular letter from the Imperial Electric Lighting Company was read at the Urban District Council meeting, asking the Council to give them power for electric lighting in the district. The clerk was instructed to reply that the Council intended to keep the power itself.

Carnarvon.—A letter from the Great Western Electric and Power Company was read at the Town Council meeting intimating that they intended in the next session of Parliament to apply for a provisional order to supply electricity in the district of the Council. The letter was referred to the Gas Committee.

Tramways and Light Railways Association.—This Company has been registered with 100 members, each liable for £1, to promote, encourage, and facilitate the construction, extension, and working of tramways and light railways. The management is vested in a council with a president and vice president.

City and South London Railway.—The returns for the week ended July 11 were £902 compared with £937 for the corresponding period of last year, being an increase of £35. The total receipts for the half-year 1897 amounted to £1,933, compared with £1,118 for the corresponding period last year, being an increase of £115.

St. James's and Pall Mall Electric Light Company.—The directors of the St. James's and Pall Mall Electric Light Company have declared the following interim dividends for the half-year ending June 30: at the rate of 7 per cent. per annum on the preference shares, and at the rate of 7 per cent. per annum on the ordinary shares.

Chiswick.—The District Council have received letters from the Imperial Electric Light and Power Company, Limited, stating that they intended applying next session for a provisional order for the electric lighting of the district, and to ask the Board of Trade to revoke the existing order. It was decided to let the letter lie on the table.

Nelson.—Councillor W. C. Smith complained at the Town Council meeting about the way in which electric cables had been laid between the co-operative society's offices and the Baptist school. Alderman Wilkinson said there had been no loss or negligence. Councillor Smith gave notice that he should bring the matter forward at a future date.

Yarmouth.—At the meeting of the Town Council a report was presented by the surveyor recommending the Council to carry out a tramway scheme at a cost of £36,000. The Lands Committee sent up a resolution adjourning the matter *sine die*, but the Council, at the instance of Mr. Frank Arnold, resolved that the report should be further considered at a special meeting.

Colchester.—The Electric Light Works Committee reported at the Town Council meeting that they had approved the proposal of the Electric Construction Company to extend the guarantee in respect of the engines to four years, subject to the period for guarantee of feeders and cables being reduced to four years, and an arbitration clause being included in the contract.

Coseley.—The Clerk reported at the District Council meeting that he had received notices from the Midland Electric Corporation for Power Distribution Company, Limited, and the South Staffordshire Blast Furnaces Power Syndicate of their intention to apply for power to supply electricity in the district. It was resolved to discuss the matter at the next meeting.

Direct United States Cable Company, Limited.—The Board recommend a final dividend of 2s. 6d. per share, and a bonus of 2s. per share, making, with the three interim dividends already paid, a distribution of 3 per cent. for the year ended June 30, placing £4,000 to reserve fund, and carrying forward about £3,927.

Peterborough Electric Light and Power Company, Limited.—This Company has been registered, with a capital of £10 000 in £5 shares, to carry on the business of electrical engineers, electricians, contractors, suppliers of electricity, and electric apparatus manufacturers. The directors are to be elected by the subscribers. Qualification, one share. Remuneration as fixed by the Company.

Morley.—The Electric Lighting Committee reported at the Town Council meeting that the cost of extending the mains to the Methodist Free Church would be £75. A short discussion followed on the subject, during which it was stated that enquiries were being made if there was a likelihood of other customers *en route*, for if there was not, it would not be worth while to go to this expense.

Weymouth Electric Light and Power Company, Limited.—This Company has been registered, with a capital of £10,000 in £5 shares, to carry on the business of electrical engineers, electricians, contractors, electrical apparatus manufacturers, and suppliers of electricity. The directors are to be appointed by the subscribers. Qualification, one share. Remuneration as fixed by the Company.

Llangollen.—At the Urban District Council meeting a letter was received from an electric lighting company in London giving the Council notice that they had applied to Parliament for permission to erect electric lighting plant in the town. Mr. Jones moved that a committee be appointed to look into the matter, and, if they thought fit, to petition Parliament not to grant the required permission. This was agreed to.

Safety Concentric Wiring Company, Limited.—This Company has been registered, with a capital of £30,000 in £1 shares, to acquire, upon the terms of a certain agreement, the undertaking of the Safety Concentric Wire Company, Limited, of 5 and 6, Bovay-street, Holloway, and to develop and extend the same. The directors are to be elected by the signatories. Qualification, £100. Remuneration to be fixed by the Company.

Electric Lighting in the Isle of Man.—On Tuesday the first installation of electric light for public lighting purposes in the Isle of Man was inaugurated at Onchan, the enterprising town to the north of Douglas. Five arc lamps of 1,000 c.p. each have been erected at different points in Onchan in the leading thoroughfares, and the light is supplied from the Douglas generating station. The lighting is eminently satisfactory.

Marconi's Telegraphy.—Signor Marconi has left Spezzia for London to submit his invention for telegraphing without wires to a company. He states, however, that he will grant to the Italian Government the free right of making use of his invention. The Emperor William has requested the inventor to give a demonstration of the working of his apparatus in Berlin. Signor Marconi consequently goes to Germany on his way home from England.

Cardiff.—At a meeting of the Building Committee of the Guardians, a letter was read from the town clerk, in which the Corporation offered to supply electric current to the workhouse at the rate of 6d. per Board of Trade unit for the first hour and 1½d. per unit for subsequent hours of lighting each day. The matter was deferred to the next meeting, the clerk being instructed to ask the Corporation to give an estimate of what the annual cost of lighting would be.

New French Cable.—Soundings have been taken for the new cable between Brest and New York *vid* Cape Cod, Massachusetts, which is to be laid by the Compagnie Française des Cables Télégraphiques in the course of the ensuing summer, and which will give a second direct telegraphic communication between France and the United States. The cable will be of French manufacture, and the undertaking is to be subsidised by the French Government.

Luton.—A letter was read at the Town Council meeting from a firm of solicitors on behalf of the Electric Lighting Corporation, Limited, Mansion House-buildings, London, giving notice that it was their intention to apply to Parliament during the session of 1898 for a provisional order, granting them statutory powers to undertake electric lighting works within the whole of the borough of Luton. The Mayor remarked that the company were somewhat late in the day.

Electric Construction Company, Limited.—The report for 11 months ended May 31 states that the net profits amounted to £17,309, and, adding the balance brought from last year, the amount available for dividend is £30,696. The directors recommend a dividend for the 11 months on the ordinary shares of 5½ per cent. (being at the rate of 6 per cent. per annum), tax free, one half payable on July 31 and the other on January 31 next. These dividends will absorb £14,197, leaving a balance of £16,499 to be carried forward.

Wakefield.—At the City Council meeting Councillor Bolton reported that operations at the electric light works at Calder Vale were going on satisfactorily. The chimney shaft was 143ft. above the ground, and 37ft. had still to be added. The preparation of the engine beds was so far advanced that next week Messrs. Fowler, of Leeds, would commence fixing the engines, one of which would be in readiness in time to enable the Corporation to carry out their agreement with the West Riding County Council for supplying the electric light to their offices.

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The Engineering Dispute.—The secretary to the Brush Electrical Engineering Company, Limited, writes to the daily papers as follows: "With reference to the statement that this company has posted lock-out notices in connection with the engineering dispute, I am directed to inform you that such is not the case." According to yesterday's daily papers, the Brush Electrical Engineering Company and the Otis Elevator Company have decided to withdraw from the employers' federation.

Motorcar Factory Burned—According to a Dalziel's telegram from Paris, the greater part of the works of the Working Carriage Builders' Co-operative Society in Rue Ponchet have been destroyed by fire. The damage is estimated at one million francs. About 60 autocars under construction were entirely destroyed. The fire is believed to be the work of an incendiary, the outcome probably, says the telegram, of the agitation amongst Paris cabmen against the adoption of the auto-motors. Two arrests have been made.

Falkirk.—At the meeting of the Town Council a letter was read from the Electric Lighting and Power Company, London, in which notice was given that it was the company's intention to apply to the Board of Trade for a provisional order for the electric lighting within the Council's district, and asking their consent to the same. The Town Clerk said a similar request had been made by another company some time ago, and he had written objecting to it, and they had heard no more about it. On the motion of Mr. Rennie, it was agreed to object to the company applying for such powers.

Portsmouth.—The Town Council have decided by a practically unanimous vote to give notice to acquire the local tramways, which are now owned by the Provincial Tramways Company, as the periods for purchasing the various sections fall due, with a view to producing electric traction. Last year the company obtained a special Act for this purpose, and the Corporation's opposition was withdrawn on their agreeing to take their supply of current from the municipal works. Negotiation for purchase followed. The actual cost of the purchase by arbitration is now estimated at £100,000.

Wycombe (Borough) Electric Light and Power Company, Limited.—This Company has been registered, with a capital of £15,000 in £5 shares, to adopt a certain agreement, to take over and exercise all the lighting powers conferred on the Corporation of Chipping Wycombe, Buckinghamshire, by the Electric Lighting Orders Confirmation (No. 1) Act, 1894, and to carry on the business of an electric light and power company. The subscribers are to appoint the first directors. Qualification, £200. Remuneration as fixed by the Company. Registered office: 7, Ridgmount-street, Bedford-square, W.C.

City and South London Railway Company.—The accounts for the half-year ended June 30 show a balance, after providing for the debenture interest and the full dividend on the 5 per cent. preference shares, sufficient to allow the payment of a dividend on the consolidated ordinary stock at the rate of 2 per cent. per annum, carrying forward a balance of £1,035 to the new account. The dividend for the corresponding period last year was at the rate of 1¾ per cent. per annum, the balance carried forward being £1,072. The amount of £1,000, received as rent for the Jubilee stands, has been carried to a reserve account.

Rotherhithe.—The Vestry have received a letter from Mr. Sydney Morse, 4, Fenchurch-avenue, E.C., giving notice on behalf of the County of London and Brush Provincial Electric Lighting Company of their intention to make application on or before December 21 next, by memorial to the Board of Trade, in pursuance of the Electric Lighting Acts, 1882 and 1888, for a provisional order to authorise the said company to supply electrical energy for public or private purposes within the area of the jurisdiction of the local authority, as defined by the above Acts, for the parish of Rotherhithe. The letter was referred to the committee.

Walsall.—On the recommendation of the General Purposes Committee, the town clerk has been authorised to oppose the application of the Midland Electric Corporation for a provisional order to empower such corporation to supply electricity for public and private purposes within the borough, unless clauses are inserted for the protection of the rights and interests of the Council. The Mayor emphasised the fact that the Council simply desired to protect their own electric lighting rates. The total number of consumers of electricity supplied by the Corporation in June was 83, the total number of units generated being 6,178, and the total number registered on the meters 3,987.

Sheffield.—At the meeting of the Parliamentary Committee at which further negotiations with the Electric Light and Power Company were suspended, the chairman laid before the committee the draft of proposed heads of agreement between the company and the Corporation for the purchase of the company's undertaking, and also the opinions of counsel and London agents with respect to the progress of the action commenced by the Corporation. Negotiations were suspended until it is ascertained by legal decision what really is the position of the Corporation in the matter. The Highway Committee have disapproved of certain applications of the company to lay electric light mains.

Birmingham Tramways Bill.—The Birmingham Tramways Bill was to have come before a Select Committee of the House of Lords on Wednesday, presided over by Lord Wantage, but a settlement having been arrived at, the Bill will now go to Lord Morley's Committee on Unopposed Measures. The Bill authorises the City of Birmingham Tramways Company, Limited, to construct additional tramways, to use animal, electrical, or any mechanical power, to provide for the supply of electrical energy, etc. The opponents were the Rural Urban District Councils of Kings's Norton, Aston Manor, and Handsworth, and the Worcestershire County Council, with all of whom clauses were arranged.

Smethwick.—At the meeting of the District Council the Clerk reported that he had received notices from the South Staffordshire Blast Furnace Power Syndicate, Limited, and the Midland Electric Corporation for Power Distribution, Limited, of their attention to apply for provisional orders to permit them to supply electricity for lighting and other purposes in the Smethwick district. It was pointed out that the Public Works Committee had authorised the clerk to oppose any Bill for the introduction of electric light or electricity into the district. It was resolved to take steps to oppose the applications of the companies named.

The Demand Indicator.—The County of London and Brush Provincial Electric Lighting Company, Limited, announce that they have adopted the demand indicator system of charging for energy, and that the following reduced scale of prices will come into effect as from July 1: For lighting purposes, for the first two hours' daily use of the maximum demand 7d. per unit, and for all current in excess of such two hours' average daily consumption 3d. per unit; for power purposes (when taken from the company's direct current power mains at 500 volts), for the first one hour's average daily consumption of the maximum demand 6d. per unit, and for all current in excess of the first one hour's consumption 2d. per unit.

Jandus Arc Lamp—Messrs. Drake and Gorham were successful in obtaining the contract for the lighting of the Linotype Company's new works, near Manchester, and the Jandus arc lamp has been approved to the extent of some 300 lamps after a long and severe test under practical working conditions. The Jandus lamp and the best of the open-type lamps were switched on alternately each night, and the operatives, who were asked to throw in the weight of their opinion at the last moment, decided unanimously in favour of the Jandus. These lamps are in daily use in Messrs. W. T. Glover's and Co.'s works in Manchester, also Willans and Robinson's new works, and a large number of other well-known places where a white soft light is required, including Waterlow's, with nearly 70 lamps.

Crieff.—At the meeting of the Town Council the question of the proposed introduction of the electric light to the town was discussed. The Provost said it would be unfair to Sir Patrick Murray, Bart., of Ochtertyre, who had offered to present them with the water motive power, and unfair to themselves, if a report on the subject was not first got from practical electricians, and he moved accordingly. Councillor Pickard said they could hardly expect the electric light to be offered at any cheaper rate than the gas, and moved an amendment that the offer of Sir Patrick Murray be refused, and that the proposal be given over. A vote was taken, when seven voted for the motion and five for the amendment. Mr. William Arnot, city electrician, Glasgow, is to be asked to report on the proposed scheme.

Poplar.—The District Board have received a letter from Mr. Sydney Morse, on behalf of the County of London and Brush Provincial Electric Lighting Company, Limited, giving notice of their intention to apply to the Board of Trade on or before December 21 next for a provisional order for the electric lighting of the district. A letter has also been received from the Imperial Electric Light and Power Company giving notice of their intention to apply in the next session of Parliament for a provisional order for the lighting of the district, and of their proposal to ask the Board of Trade to revoke the Board's order on the ground that they had failed to carry the same into effect. These letters have been referred to the Electric Lighting Committee. The Board's provisional order expired on June 9, but an extension has been sought for.

Brierley Hill.—The joint report of the representatives of the Council and the Kingswinford Rural District Council, who visited the Isle of Man on June 16 and 17 and inspected the electric tramways there, was presented at the Urban District Council meeting. After some discussion it was referred back for the amendment of the last clause. Councillor J. Skidmore, as a member of the deputation, also presented a second report, upon which the committee expressed the opinion that if satisfactory arrangements could be made with the British Electric Traction Company, Limited, it was desirable that electric traction should be substituted for the present system of steam traction in connection with the trams running through the district of the Brierley Hill Urban District Council. The actions of the committee were ratified on the motion of Councillor Fisher, seconded by Councillor Clulee.

Hanley.—A letter was received at the Town Council meeting from the Board of Trade asking whether the Corporation had any objection to the extension by one year of the time during which the North Staffordshire Tramways Company may use steam as a motive power on their lines in the borough, and the General Purposes Committee recommended the Council not to approve of the extension of time beyond six months. The committee also recommended that a grant of £50. 4s. 5d. be made out of local taxation (Customs and Excise duties) to the Free Library Committee. In moving the adoption of the committee's report, Mr. M. Huntbach said the committee did not wish to prevent the use of steam power on the tramways for 12 months if it should be necessary, but they were anxious that the introduction of electricity as the motive power should take place at as early a date as possible. The report was adopted.

Telegraphing Race Results.—Some extraordinary allegations of 'tapping" telegraph wires were made a few days ago in a case heard at the Liverpool County Court, in which the plaintiff sued the defendant, the secretary of a small local club, for £2. 10s. in

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connection with a bet on a horse race. The claim was resisted on the ground that the race was over when the bet was made, and it was alleged that the result was not received in the club in proper time owing to the telegraph line connected with the tape machine having been tampered with. A foreman lineman in the employ of the Exchange Telegraph Company said that on two occasions, one being the day of the race in question, it was found that a fine copper wire had been attached to the telegraph wire serving the club, and that the end of the copper wire had been led into a cistern of water. The result was an interruption. The interruption was wilful, and, said witness, "I only wish I had been smart enough to catch them." The Judge held the action was in respect of a betting transaction, and that the plaintiff could not recover.

Bacup.—The Town Clerk read a communication at the Town Council meeting from the Imperial Electric Light and Power Company, Limited, London, dated June 30, 1897, giving notice of their intention to apply in the next session of Parliament for a provisional order for the electric lighting of the borough of Bacup, and asking the Board of Trade to revoke the order of the Corporation, on the ground that they had failed to carry the work into effect. In a letter accompanying the notice the secretary of the company wrote stating that they were not prompted by any desire to act in opposition to the wishes of the Council, and were prepared so meet the Corporation with a view to the transference to the company of the existing order, if the Council would favour them with an appointment for that purpose. It was resolved to inform the company that the Corporation are prepared to enter into negotiations with any company, who will undertake to carry the order into effect, for the transfer of the powers of the Corporation under the electric lighting order of 1890.

Buxton.—At the Urban District Council meeting the Chairman said the question of electric lighting came before them in a proposal that had been sent to the town by Mr. Farrer Morgan, a solicitor, who is acting for a company. The proposal was before them, and, of course, there was a good deal to be said about it in every way. He thought they ought to have a special meeting to discuss a serious matter like that, as no doubt there would be a great deal to be said about it. They had got formal notice from Messrs. Farrer Morgan and Co., solicitors, of Manchester, acting on behalf of the Buxton District Light and Power Company, "that they intended forthwith to apply to the Board of Trade under the provision of the Electric Lighting Acts, 1882 and 1888, for the grant to themselves of a provisional order for the supply of electricity within the said district of the Buxton Urban District Council" In face of that he thought it would be advisable for every member of the Council within the next week to get himself well up in the subject, either by talking with Mr. Taylor or in other ways. It was decided to have a special meeting the following week to discuss the matter in the presence of the reporters.

Natal.—Durban has always been distinguished by its municipal activity, one of the fruits of which has been a scheme for the complete illumination of the town by electricity. This scheme is interesting, inasmuch as the determining voice in the matter was that of Mr. W. H. Preece. It is close upon three years ago that the plan was first mooted, but before committing themselves to a definite policy, the Town Council determined to place themselves in consultation with Mr. Preece. Three schemes were submitted by Mr. F. H. Hadfield, electrician to the Council, and the one selected by Mr. Preece was finally adopted. The Corporation have combined their sewage and electric lighting machinery in one station at the Point, and have a battery of boilers common to both services, whilst using separate engines. Mr. Hadfield had placed at his disposal a sum of £25,000 to provide an installation of electrical plant capable of supplying electricity for 60 2,000 c.p. arc lamps and 2,500 16-c.p incandescent lamps; and it was anticipated when the mail left that the installation would be complete and every lamp available on Jubilee night—than which there could hardly have been any more suitable occasion chosen for the inauguration of the new plant.

Birkdale.—At the District Council meeting the Chairman read a letter from Messrs. Deacon, Gibson, Medcalf, and Goddard, of London, giving formal notice on behalf of their clients, the Electric Supply Corporation, Limited, of the latter's intention to apply for a provisional order in respect of Birkdale in the next session of Parliament. The service of the notice was a necessary preliminary to the application. The notice itself stated that on behalf of the Electric Supply Company, Limited, Mansion House-buildings, London, notice was given that the Corporation intended to apply during the parliamentary session of 1897-8 for a provisional order, under the Electric Lighting Acts, 1882 and 1888, for granting to the applicants statutory powers under the said Acts within the whole parish of Birkdale. The Rov. Fred. Smith stated that Mr. Barrett wished him to say that while it had been necessary to serve the notice upon July 1 that there was no need for anxiety upon the point until November 1, and he (Mr. Barrett) suggested that it should be referred to the Lighting, Town Hall, and Licensing Committee. On the motion of Mr. Clinning, seconded by Mr. Milvert, this course was adopted. In reply to Mr. Hartley, the Chairman said the Corporation were not applying for a license but for a provisional order.

W. Lucy and Co., Oxford.—This enterprising firm of iron-founders and engineers have now opened an electrical department. In this new departure they are fortunate in being assisted by Mr. J. Hardie McLean, M.I.E.E., the late manager of the Oxford Electric Lighting Company. Anyone who has had dealings with Mr. McLean or has heard him express his opinion on the burning topics of the profession will have recognised his business capability; and we wish the firm every success. We understand from a recent little volume of some 50 pages sent us that special attention will be devoted by the firm to the supply of arc lamp-posts, complete with all accessories, such as Mr. McLean's automatic time switch, etc. The book in question gives a series of illustrations of such posts, with different methods of attaching the lamps. In some cases arms for traction wires are also shown. The drawings are to scale, so that a good idea of their dimensions can be readily obtained. There is also a lot of general information incorporated in the odd pages of the book, which the practical man will find most useful to have by him. The address of the firm is Eagle Ironworks, Oxford, but electrical showrooms are now opened at 22A, New Inn Hall-street, in the same town. The book looks as though it was printed at the Clarendon Press, but the printers are modest. Like a certain great soldier, they "don't advertise." The binding is a joy for ever.

Hospital Lighting.—At the meeting of the Metropolitan Asylums Board the North-Western Hospital Committee reported as follows: "On February 2, 1895, the managers accepted a tender for the work of lighting the new administrative block and some of the wards of this hospital by electricity, and on August 3, 1895, a further tender was accepted for an extension of the work to other wards then in course of erection. In order to complete the lighting of the whole of the hospital by electricity a further extension of the work is required—viz, to the building for staff now in course of erection. This additional work is estimated to cost about £250. The two contracts alluded to were carried out by Prof. Ayrton, working under the instructions of the committee for the North-Western Hospital, but as the new building referred to is in course of erection under the Works Committee we recommend that the question of the lighting by electricity of the additional staff block now in course of erection at the North-Western Hospital be referred to the Works Committee, to be dealt with in accordance with the powers delegated to them by the Board. The managers on July 4, 1896, agreed to employ Prof. Ayrton to prepare the specification and to superintend the work. The specification has accordingly been prepared, and tenders for the work should now be at once advertised for." The recommendation was carried.

Burnley.—Councillor Parsons, in submitting the minutes of the Gas and Electric Lighting Committee at the Town Council meeting, pointed out that they proposed to spend £2,000 in extending the electrical mains in Manchester-road to the end of Rose Hill-road. He said they had had promises from 11 persons in Manchester-road signifying their willingness to take the electric light, which would result in an income of from £80 to £110 a year. The length of the cable would be about three-quarters of a mile to Rose Hill-road. Councillor Macfarlane asked why they did not take the main into Burnley-lane? Over 50 persons had promised to take the supply. He moved as an amendment that the resolution with respect to the extension of street mains in Manchester-road be referred back to the committee. Councillor Parsons could not promise to do the impossible. The simple facts as to Manchester-road, as reported by the engineer, were that without increasing the plant at all and the working cost they could supply as far as Rose Hill-road. The committee were not disregarding the claims of Burnley-lane, but they could not deal with it with the present plant. The suggestions made with respect to Burnley-lane would be considered, and the committee would probably embody an application for further borrowing powers for Burnley-lane as well as Manchester-road, and extend the plant generally. The amendment was lost by 19 votes to 8.

Crompton and Co.—Notice has been given that an extraordinary general meeting of the shareholders of Crompton and Co., Limited, will be held at the City Terminus Hotel, Cannon-street, in the City of London, on Thursday, July 22, at 3.30 p.m., immediately after the conclusion of the business at the ordinary general meeting of the Company, or of the adjournment of such meeting, for the purposes of considering, and, if approved, of passing the following resolution: "That the articles of association of the Company be amended by the addition of the following article: '29A.—Whenever the capital, by reason of the issue of preference shares or otherwise, is divided into different classes, all or any of the rights and privileges attaching to each class may be modified, commuted, affected, or abrogated, by agreement between the Company and any person purporting to contract on behalf of that class, provided such agreement is confirmed by an extraordinary resolution passed at a separate general meeting of the holders of shares of that class, and all the provisions hereinafter contained, as to general meetings, shall *mutatis mutandis* apply to every such meeting, but so that the quorum thereof shall be members holding or representing by proxy not less than two-thirds of the nominal amount of the issue of shares of the class.'" If this resolution be passed by the required majority, it will be submitted for confirmation at a second general meeting in the usual manner.

Automatic Telephone Company, Limited.—This Company has been registered, with a capital of £100,000 in 5s. shares, to acquire the undertaking of the Apostoloff automatic telephone invention, and generally to carry on the business of a telephone, telegraph, and electric light, heat, and power supply company; to construct, erect, use, maintain, lay down, carry out, work, sell, let on hire, and deal in telephones and all kinds of works, machinery, apparatus, conveniences, and things capable of being used in connection with any of these objects, and in particular any cables, wires, lines, stations, exchanges, reservoirs, accumulators, lamps, meters, and engines; to acquire and turn to account any patents, patent rights, and inventions; to acquire and turn to account land; to negotiate loans, etc. The signatories are M. Margowski, 13 and 14, Abchurch-lane, E.C.; Honduras Government Banking and Trading Company, Limited, 13 and 14, Abchurch-lane, E.C.; M. J.

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Alexander, 16, Hatton-garden, E.C.; J. D. Gibbs, The Mount, Goring-on-Thames; Baron Cohen, 1, Piccadilly, W.; J. Mendelson, 56, Charlotte-street, W; J. W. Cohen, 58, Angell-road, Brixton; H. G. Sworn, 5, Highbury-crescent, N. The first directors—of whom there shall be not less than two nor more than five—are M. Margowski, J. D. Gibbs, J. W. Cohen, M. J. Alexander, and H. G. Sworn. Qualification, 1,000 shares. Remuneration, 5 per cent. of the net profits, divisible. Registered office: 13 and 14, Abchurch-lane, E.C.

North Shields and Tynemouth Tramways.—The report of the directors of the North Shields and Tynemouth District Tramways, Limited, to be submitted to the annual meeting of the shareholders on the 16th inst., shows that the gross receipts for the year ended June 30, including a balance of £29. 8s. 3d. brought forward, amounted to £1,992. 7s. 6d., and that the total expenditure was £1,634. 19s., leaving a balance of £357. 8s. 6d., showing a decrease of £111. 19s. 9d. as compared with the preceding 12 months. The directors recommend the disposal of the balance as follows: to providing a dividend of 4 per cent. for the year, £240, less £8 reserve for income tax; to depreciation and reserve fund, £115; and the balance of £10. 8s. 6d. will be carried forward. There was a decrease of £15. 7s. 6d. in receipts from passenger fares, and of 2,415 in the number of passengers carried, although there was an increased mileage of 692 car miles run. The decrease was entirely accounted for by the exceptionally cold spring, which undoubtedly interfered with the seaside traffic. Negotiations are now being carried on with the Corporation of Tynemouth with a view to arranging for the overhead system of electricity for the trams. The Corporation have agreed to the use of such a system for motive power (subject to the details being submitted to them), so that there now seems a good prospect of the tramlines being laid to the New Quay, for the ferries, and on to Whitley, the whole being worked by electricity.

The Brompton and Piccadilly Railway.—The Select Committee of the House of Lords, of which Lord Heneage is chairman, have given their sanction to the Brompton and Piccadilly-circus Railway Bill, under which it is proposed to construct an underground electric railway, two miles in length, running from Piccadilly-circus to Brompton, and having communication to South Kensington with the District Railway Company. There will be seven stations on the line including the terminals, and it is intended to introduce a three minutes' service, and to run the trains at such a speeed as will enable the total distance to be covered in about 10 minutes. Mr. Mott, chairman of the City and South London Railway Company, and one of the promoters, in cross-examination, denied that there had been any serious leakages of electricity on the South London line. Mr. Balfour Browne, Q.C.: Have you never heard that Mr. Preece detected the electric current from your railway as far away as Norfolk? I heard him say once that he could tell when the line was working and when it was not. Witness explained that when the line was first opened electrical disturbances did occur at Greenwich, which, on investigation, were found to be due to escapes of electricity through the brick tunnels at the stations. Connections were then put across the brick tunnels and the disturbance stopped. There was no brick tunnels on the present line. Sir Douglas Fox asserted that the scheme was in many respects inadequate, and that the estimates for making the line were much too low.

The Ediswan Plant Catalogue.—The seventh section of the Edison and Swan United Electric Light Company's catalogue has just been issued. It reminds us of the fact that since the amalgamation with the Manchester Edison-Swan Company the firm has added the supply of power plant to its other specialities. It is, of course, impossible to criticise the types of plant now adopted as standards merely from catalogue illustrations and descriptions, but we hope to meet with practical examples at an early day. To briefly review the articles listed, we may summarise as follows: The continuous-current dynamos are of the usual two-pole type, with horizontal brushes, drum armatures, and special lubrication. A series of Gramme machines are also listed, and the type of field magnet used is novel. It consists of a distorted Manchester field, in which the two limbs are displaced from the central line of armature and placed closer together at one end of the armature. We suppose that a saving of floor space and increased ventilation are the main advantages, but the want of symmetry will, we think, produce other disadvantages which will at least balance these. The construction of the alternators cannot be gathered from the description, but the details mentioned in the text, both for these machines and of the transformers, are most satisfactory. A series of flywheel alternators with a single revolving exciting coil are also listed. The other items consist of the usual accessories for power work and of special lines of small motors. The catalogue concludes with a report by Dr. J. A. Fleming on a three-kilowatt transformer, which had an iron loss of only 69 watts, and 60 watts due to copper resistance. The magnetic leakage drop of this machine was practically inappreciable.

Bradford.—At the Town Council meeting Mr. W. E. Aykroyd, deputy-chairman of the Gas and Electricity Supply Committee, moved that an application should be made to the Local Government Board for authority to borrow an additional sum of £50,000 required for the extension of the electricity supply of the Corporation. He said that the annual statement of the chairman of the committee (the Mayor of Bradford), which was made a few weeks ago, showed that the electricity department was in a very healthy condition, and the demand for electricity was growing at a fair pace. The department had now a capital of £120,000. On the last occasion when borrowing powers were sought, £40,000 was required for the establishment of new works. When the liabilities incurred for that specific purpose had all been met, the £40,000 would be exhausted. The £80,000 borrowed for the old works had all been spent, and there was, in fact, a considerable overdraft in connection with that department. The Corporation would, he thought, be glad to find that the electricity works were growing so rapidly, and the committee were taking care when pushing electricity not to enter into unreasonable competition with the gasworks. In carrying the cable to Heaton, for example, the committee had in mind the fact that the people there were being supplied with gas at a rather extravagant price, and the extension would place residents in Heaton in the same position as those in more favoured districts. The committee would, he thought, be glad to apply the same principle to Allerton. The extensions were very costly, about £24,000 having been spent during the last 18 months in cables and mains, but in view of the profit shown last year the Council would, he hoped, vote the money. Mr. E. Dobson seconded the motion, and it was carried.

Signal Light Indicator.—Messrs. Claud Hamilton, of Glasgow, have brought out an indicator and alarm for ship's signal lights, which has been already fitted into several important steamers and yachts with satisfactory results. The indicator is for use where electric masthead, side, and anchor lights, or other electric signal lights are fitted, and is for the purpose of giving notice to the officer of the watch should any of these lights fail. The lights are switched on from the indicator erected in the chart-room, pilot-house, or elsewhere, and should any light go out, an alarm bell will ring and an indicating lamp will light up. The bell will draw the attention of the officer in charge to the fact that some signal light has failed, and its indicating lamp will show which one. A reserve lamp is provided in each signal lantern, which, when switched in from the indicator, will, if burning properly, automatically stop the alarm bell and extinguish the indicating lamp. Should the dynamo supply fail from any cause the bell will ring, but in this case none of the indicating lamps will light, and the officer will know that the fault lies between the indicator and the engine-room. A testing key is provided for each lantern, on pressing which it can be ascertained whether the indicator is in proper working order or not, and also if each signal lamp is burning properly, and this is done without even momentarily breaking the circuit of the signal lamp. The mechanism of the indicator may be used to work other indicating lamps and alarm bells fixed on bridge or other part of the vessel, which work simultaneously with the main indicator. There is a pedestal form manufactured for the bridge, but the main indicator is an oblong affair which goes in the wall of the chart-room.

Bath.—At the meeting of the Surveying Committee, specially convened to consider an application from the National Telephone Company for permission to lay underground wires to a larger extent than had been sanctioned previously, Mr. H. Fedden, J.P., deputy chairman of the West Board of the National Telephone Company, explained the company's purposes in this matter. He stated that they were laying out a large sum of money in extending their underground system of wires all over the country. On their application 12 months ago, an agreement was entered into by which they might lay down these underground wires in certain streets, which the Post Office were opening up, and which were being opened for electric lighting purposes. Now, however, they had received from the committee's surveyor a letter stating that they could not complete the system proposed. They were unable to go in a westerly direction or to the north sufficient for their purpose, so that, if this were adhered to, it would be useless to finish the work they had commenced. By laying underground wires the number overhead was largely reduced, and it would stop further increase. Otherwise they would have to double all the overhead wires. The system by which underground wires were laid was this. Large gas-pipes were put down in certain streets, and into these pipes could be drawn a cable containing 100 or more—up to 500—wires. Therefore they put sufficient wires in these pipes for a number of subscribers not already on their books. For instance, if they had 50 subscribers on one route they would put down wires for 100 or perhaps 150. This prevented the necessity of reopening the roads again. He hoped the committee would see their way to allow them to carry out their scheme, which, in reality, had been unaltered from the first. Mr. Mitchell moved that consent be given to the extensions named, and that the surveyor carry out the work, charging the company for doing so. The motion was adopted.

Lighting the Embankment.—At the London County Council meeting, the Highways Committee brought up a report recommending the substitution of electric light for gas for lighting the Victoria-embankment and Westminster and Waterloo Bridges. The cost under the scheme of establishing an electric light installation for this purpose is £22,000. The annual cost of the undertaking, including interest and repayment of capital (which it is proposed to spread over 25 years), will be £3,430 in the first year, diminishing by £22 a year to £2,900 in the twenty-fifth year, and remaining afterwards at £2,000 a year. The present annual expenditure for lighting the Embankment and bridges with gas is £1,300. The committee considered that at present it was inadvisable to provide electric light for the Embankment gardens. Lord Onslow moved as an amendment that the report should be sent back to the committee. He contended that the proposed expenditure was wholly unnecessary and altogether premature. Rumours were abroad as to a proposal to erect a massive statute on the Embankment—he did not know whether it was of Queen Boadicea or of the greater Queen whose Diamond Jubilee they had recently been celebrating, and they were putting the cart before the horse in seeking to establish the fierce light that beat upon the throne before they had put up the throne itself. He believed that gas was

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amply sufficient for lighting the Embankment. Mr. Hoare seconded the amendment, and a long discussion took place. Mr. Westacott, Mr. Benn, Mr. N. W. Hubbard, Mr. Baker, and Earl Russell supported the recommendation of the committee, whilst the amendment was supported amongst others, by Sir J. C. Dimsdale, Mr. Emden, Dr. Longstaff, Mr. Beachcroft, and Sir J. Lubbock, M.P. On a division the amendment was lost by 63 votes to 43. The Hon. L. Holland, M P., moved an amendment to add to the recommendation words to the effect that the project should only be adopted on the adjoining parishes consenting to contribute towards the cost such a proportion as the Council might consider fair. Mr. Goulding, M.P., seconded the amendment. Mr. Emden opposed it on the ground that the Embankment was essentially a metropolitan thoroughfare. The amendment was on a show of hands defeated by a large majority, and after further discussion the recommendation of the committee was agreed to. The committee was instructed to report further to the Council as to the details of the scheme.

Larne.—At the adjourned meeting of the Town Commissioners the question of the lighting of the public streets of the town and the employment of a consulting electrical engineer to advise the Commissioners was under discussion. The Larne Electric Light Works, Limited, London, sent in a tender proposing to light the public streets and roads of the town with electric light for the space of three years from August 1 next by means of arc and incandescent lamps at the following prices: each arc lamp of 1,200 c.p. nominal (450-watt lamps), £11 per annum; each arc lamp of 600 c.p. (225-watt lamps), £7. 10s. per annum; each incandescent lamp of 32 c.p., £4 per annum; each incandescent lamp of 25 c.p., £3 per annum; each incandescent lamp of 16 c.p., £2 per annum. The contractors proposed to maintain the lighting of the town in a state of efficiency from dusk to midnight on every day from the first day of August till the last day of the succeeding April, both days inclusive in each year, provided that they shall not be bound to light the lamps during the night of full moon; also three days immediately preceding and two days immediately after the full moon in each month, except as provided. All lamps, posts, and mains now erected, or hereafter to be erected or supplied by the contractors, shall remain their property. Mr. Beatty strongly objected to put up any more plant for this company. He considered they had done it too long. The town was extending every year, and as it extended more lamps were required, and each year the electric company increased the charge for erecting them, although they remained their own property. The Chairman was of opinion the proper course to adopt would be to accept the tender for the lighting for the ensuing three years, and then take the necessary steps for obtaining a provisional order enabling them to erect a plant of their own. Mr. Picken spoke of including a purchase of the gasworks and market premises in the order. He sugested that the gas company be asked to tender for one year's lighting, and by that time they would be in a position to light with their own plant. Mr. Hay agreed that they had paid for the erection of plant for the electric company quite long enough, but it was their duty first to consider how the town should be lighted during the ensuing year. Mr. M'Gregor and Mr. Beatty suggested that an expert electrical engineer should be brought over for consultation with the view to obtaining a provisional order. On it being pointed out that this was rather premature, it was decided, on the motion of Mr. Hay, seconded by Mr. Beatty, "That the Larne Electric Light Works, Limited, be requested to inform the Board whether they are willing to enter into an agreement to light the town with electric light for one year from August 1 next on the same conditions as those existing for the last three years, no extension of the present lamps to be required." On the motion of Mr. Picken, seconded by Mr. Beatty, it was also decided to ask the Larne Gas Company to tender for the lighting of such parts of the town as they could light for one year from August 1 next. It was arranged to meet on the 12th inst. for the consideration of the tenders, but we have not yet heard the result.

Exeter.—At the meeting of the City Council, the Town Clerk read the following communication which he had received from Mr. W. A. Padfield, the secretary and manager of the Exeter Gaslight and Coke Company: "Gaslight Offices, Exeter, July 6, 1897. Dear Sir,—I have submitted your letter of the 28th ult. to a meeting of my directors, and they desire me to inform you that they are willing to enter into a new contract upon the terms of the existing one, subject, however, to the following conditions: (*a*) The term to be for seven years, determinable by either party upon six months' previous notice; (*b*) the Council to pay the cost of removing and fitting up the whole of the lamps not required in the electric lighting area; (*c*) the Council to pay the additional expense of extinguishing the Westminster and 12ft. lamps at midnight in consequence of their distribution over a larger area. It was reported on the 23rd ult. that the Electric Lighting Committee had been authorised to spend £1,650 for the installation of the electric light. I find that 33 of the new Denayrouze high-power five-light clusters, together with the necessary standards and lanterns, similar to that now in use at the High-street end of Bedford-street, would cost £956. 3s. 6d., and the supply of gas, mantles, and maintenance for 12 months would be £663. 14s. 3d., making a total of £1,619. 17s. 9d. In other words, this company can supply the whole of the new gas plant of equal lighting power, and make the Council a present of the first year's gas, for a smaller sum than they are going to spend on the installation only of the electric light, without reference to the cost of the light itself. But a much graver question for the Council, as the representatives of the ratepayers, to consider is the future annual cost of the electric light. I looked in vain in the Electric Lighting Committee's report for any indication of the probable amount of this annual charge, and it would not at all surprise me if after taking all expenses into consideration, including depreciation and interest on capital, it works out at three times the cost of gas. In a letter to me dated the 5th inst. the general manager of the Denayrouze Light Syndicate points out that in London the cost of the electric light per unit varies from about 5d. to 8d., but taking the cost at 6d. there is an enormous advantage gained by using their lights, which practically work out, with gas at 2s. 10d. per thousand, at about 1¼d. per unit. You are, of course, aware that we are already supplying these large lamps at 2s. 6d. per thousand, which would make the comparison still more in our favour. In many instances these lights are taking the place of the electric light. Over 6,000 are in use in Paris, and are giving the utmost satisfaction. At the new Real Ice Skating Rink at Brighton over 150 burners are now installed, and this was done after all arrangements had been made to light the rink by electricity, but on seeing the new burner and studying the question they decided to put the contract for lighting in the hands of the Denayrouze Syndicate. Mr. Williams, the manager of Niagara in London, on seeing what could be done with these burners in Brighton, has recently invited the syndicate to tender for the lighting of the building, in lieu of the electric light which is now installed there. I enclose you a copy of a letter recently received by the syndicate respecting the lighting of the Bournemouth arcade by these burners, which shows that they compare most favourably both as regards light and cost with the electric light. Under these circumstances, and looking at the question from a ratepayer's point of view, in which we ourselves are deeply interested, perhaps it may be worth while for the Council to give the matter further consideration. Awaiting the favour of your reply, yours faithfully, W. A. PADFIELD." After a lengthy discussion, a resolution was adopted to the effect that the Council give a general approval to the conditions of the contract suggested by the gas company, and that the letter be referred to the Lighting Committee to settle the details. The Electric Lighting Committee in their report recommended that the tender of Messrs. Francis Parkin and Son, to supply 33 arc lamp-posts, with lamp bracket and incandescent brackets, ladder arms, etc., for £10 each, and lowering gear at 30s. each (the latter if required) be accepted; the first instalments of the posts to be delivered by the middle of August, and the balance one month later. They also recommended that the city surveyor obtain prices for the supply of street arc lamps. Mr. Domville, in moving the adoption of the report, said the primary reason for lighting the proposed area with arc lights was because, at the present moment, the machinery they had could quite easily run the whole of the arc lamps without any additional cost. All they would have to do would be to transfer the portion of the light which was now supplied to private customers to the incandescent circuit. In the course of a year or two they would be able to bring up to the Council a report as to the actual cost of the working. At the present moment, if they chose to take advantage of the Council, they could say it cost nothing, because the power was already at work, but it was proposed to charge the Council £20 a lamp per annum. That would amount to a total cost for arc lamps of £660 a year. At the present time the cost for gas was £500, so that the increased cost for electric lighting was £160 per annum. He hoped the increased advantages given by the better light would be sufficient compensation to the citizens. At the same time it was fair to say that the lamps suggested by the gifted engineer of the gas company were extremely good, and they were obliged to the gas company for the way in which they had supplied them at various points of interest in the city. He was glad to know they had an opportunity of having them at other points of large traffic; but if the 33 new lamps suggested by the gas engineer were supplied in place of the electric light they would cost £663. 14s., or a little more than the electric light. The six months that had passed since the Council had charge of the electric light undertaking had resulted in a very considerable profit. At the end of the year he did not anticipate that any claim whatever would be made upon the Council either for wear or tear or for interest or sinking fund, which would be paid for by the undertaking; and in addition to that they hoped to have a small balance in hand. The undertaking had been carried on under the able supervision of the surveyor and Mr. Munro, the engineer, and had been an unqualified success ever since the Council took it over. So far as he was personally concerned, the contract submitted by the gas company and the terms agreed upon were very satisfactory, and it would be wise for the Council to accept the terms as to the length of period of the contract. The Shoreditch Vestry were now solving the problem of disposing of street refuse and making light at the same time. He inspected their works last week, and he looked forward to the time when Exeter would be able to offer electric motive power to houses of business, etc., at a very low rate. Mr. Wreford seconded, and the report was adopted.

PROVISIONAL PATENTS, 1897.

JULY 5.

15906. A new and improved apparatus for writing and drawing by telegraphy. Henry Charles Braun, 19, High Holborn London.

15933. Combined electric battery and headlight. William Mills, 60, Queen Victoria-street, London. (Complete specification.)

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15939. Improvements in the manufacture of protective coverings or envelopes for zinc plates of electric batteries and for other purposes. Ernst August Jahncke, 78, Fleet-street, London.

15940. An improved liquid-tight trough or receptacle for use in connection with electric batteries and for other purposes. Ernst August Jahncke, 78, Fleet-street, London.

15941. Improvements in or connected with electric batteries. Ernst August Jahncke, 78 Fleet-street, London

15982. Improvements relating to telephone transmitters and receivers and like apparatus. Justus Waldthausen, 45, Southampton-buildings, Chancery-lane, London.

JULY 6.

15993. Improvements in or relating to electric lighting. Charles Emile Sohn, jun., 22, Southampton-row, London.

16007. Improvements in or connected with electrical ceiling roses. Frederick John Borland and Edwin Moorhouse, 89, Albion street, Leeds.

16054. Improvements in electric controllers. The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. (Alexander F. Macdonald, United States) (Complete specification.)

16065. Improvements in incandescent electric lamps. François Gabriel and Henri Angenault, 45, Southampton-buildings, Chancery-lane, London.

16068. Improvements relating to the construction of rails for electric railways and to bonds therefor. Samuel Houston Harrington, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

16069. Improvements in electric batteries. Leon Wilbur Pullen, 45, Southampton-buildings, Chancery-lane, London. (Complete specification)

16073. Improvements in safety switch apparatus for systems of electrical distribution. Eustace Oxley, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

16092. Improvements relating to electric lamps for cycles. Thomas Gidley Howden, 22, Southampton-buildings, Chancery-lane, London.

JULY 7.

16108. Improved means of intercommunication by telephone. John James Mann, 4 St. Ann's-square, Manchester.

16134. Incandescent electric light decorations. Alexander Abercrombie Pollock, 70, Wellington-street, Glasgow.

16139. Method and apparatus for electrical signalling by means of split or divided currents, more particularly applicable to cable transmission. Charles Denton Abel, 28, Southampton-buildings, Chancery-lane, London. (La Société Industrielle des Téléphones Constructions electriques Caoutchoucs Cables, France.)

JULY 8.

16220. Improvements in electrically-illuminated signs, advertising mediums, or the like. William Thompson Bell, 111, Hatton-garden, London.

16225. Improvements in or connected with telephones. Jules Ernest Othon Kumberg, Bernard Felvert Krantz, and Charles Nigel Stewart, 27, Southampton-buildings, Chancery-lane, London.

JULY 9.

16255. Improvements in apparatus for administering mist or vapour and electric baths for internal purification, and for ventilating, heating, and cooling purposes. Charles Junge, 75, Chancery-lane, London. (Nils A. Renstrom, United States.) (Complete specification.

16259. Automatic distributor of gas and electricity. Viscount Eugene Pierre de Fouquier, 8, Rue des Princes, Brussels.

16279. Improvements in electromagnetic and dynamo-electric apparatus. Reginald Wood, 35, Nightingale-road, Harlesden, London.

16304. Improvements in electrical tumbler switches. Henry Charles Gover and Charles Faraday Proctor, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

JULY 10.

16325. Improvements in submarine cables. Sebastian Ziani de Ferranti, Hollinwood, near Oldham.

16339. Improvements in dynamo-electric machines. George Cheffey-James and Harry Percy Ward, 25, The Nook, Barber-road, Sheffield.

16350. Improved coil for electric instruments. William Thomson (Baron Kelvin), 154, St. Vincent-street, Glasgow.

16361. Improvements in or relating to accumulator plates for secondary batteries. Ernst Waldemar Jungner, 322, High Holborn, London. (Complete specification.)

16362. Improvements in or relating to the electrodes of electric accumulators. Ernst Waldemar Jungner, 322, High Holborn, London. (Complete specification.)

16405. Improvements relating to electric telegraphy. Oliver John Lodge and Alexander Muirhead, 323, High Holborn, London.

16407. Improvements in incandescent electric lighting systems. Charles Ormsby, 45, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1896.

9667. Electric arc lamps. Fox.

13080. Electric meters. Lotz.

13688. Electrical apparatus for the treatment of air gases and vapours. Bonna, Le Royer, and Van Berchem.

14064. Central battery telephone exchange system. Sinclair and Aitken.

15677. Electrical counter. Dixon.

16373. Junction boxes for use in the distribution of electricity. Illingworth and Smith.

16445. Apparatus for controlling electrically-actuated railway point apparatus. Siemens Bros. and Co., Limited. (Siemens and Halske.)

16475. Electric arc lamps. Jones, Jones, and Kynoch and Co., Limited.

16566. Electric bells or signals. Rendell.

16644. Means of attaching metal contacts in electrically-controlled and other gas burners. Boardman.

16771. Method for obtaining porous metals by electrolysis. Hoepfner.

18220. Meter or apparatus for registering the consumption of alternating electric current. Johnson. (Hartmann and Braun.)

18364. Electric motor or dynamo-electric machine. Knowles. (De Thierry.)

18580. Electrical ceiling roses, switches, and the like. McGeoch.

18632. Holders for incandescence electric lamps, also applicable to the holding of the shades or reflectors thereof. Hirst and Fletcher.

21236. Electric regulator. Emmott.

1897.

4064. Electric insulators. Deléry.

4487. Electric arc lamps. Buchholtz and Spies.

8439. Phonographs. Liddle. (Smythe.)

10755. Electrically-driven cranes. Craven.

10767. Phonographs. Obelt.

12090. Self-locking electrical signalling instrument. Siemens Bros. and Co., Limited, and Forreet.

12210. Means for supplying current to electric railway and tramway vehicles. Demeuse.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	9½-9¾
Brush Company, Ordinary	3	1½-1¾
—— Non. Cum., 6 per cent. Pref.	2	1½-1¾
—— 4½ per cent. Debenture Stock	100	105-109
—— 4½ per cent. 2nd Debenture Stock	100	98-97
Callender's Cable Company, Debentures	100	108-113
—— Ordinary	5	6½-7½
Central London Railway, Ordinary	10	9¾-10½
——	6	5½-6½
Charing Cross and Strand	5	13-14
Chelsea Electricity Company	5	9¾-10½
—— 4½ per cent. Debentures	100	110-113
City of London, Ordinary	10	23½-24½
—— 6 per cent. Cumulative Pref.	10	17-18
—— 5 per cent. Debenture Stock	100	129-134
City and South London Railway, Consolidated Ordinary	100	62-64
—— 4 per cent. Debenture Stock	100	137-139
—— 5 per cent. Pref. Shares	10	15½-16
County of London and Brush Provincial Co., Ordinary	10	12½-13½
—— 6 per cent. Cum. Pref.	10	15-15½
—— 4½ per cent. 2nd Debenture Stock	10	14½-15½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1½-2
—— 5 per cent. Debentures	—	88-93
Edison and Swan United Ordinary	3	2½-2¾
—— 5 per cent. Debentures	5	3¾-4¼
Electric Construction, Limited	2	1¾-2
—— 7 per cent. Cumulative Pref.	2	2¾-3¼
Elmore's Copper Depositing	1	¾-1
Elmore's Wire Company	2	2-2½
W. T. Henley's Telegraph Works, Ordinary	10	18½-19½
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	106-113
House-to-House Company, Ordinary	5	8½-9
—— 7 per cent. Preference	5	10-10½
India Rubber and Gutta Percha Works	10	20½-21½
—— 4½ per cent. Debentures	100	105-108
Kensington and Knightsbridge Ordinary	5	12¾-13½
—— 6 per cent. Pref.	5	8-8½
London Electric Supply	5	1¾-2
Metropolitan Electric Supply	10	16½-17½
—— 4½ per cent. First Mortgage Debenture Stock	100	118-122
National Telephone, Ordinary	5	6½-6¾
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	15-17
—— 5 per cent. Non. Cum. Third Pref.	5	6-6½
—— 3½ per cent. Deb. Stock	100	103-107
Notting Hill Company	10	15-16
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8½-8¾
—— £4½ shares	4½	7½-7¾
Oriental Telephone and Electric Company	1	¾-1
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	102-104
St. James's and Pall Mall, Ordinary	5	15½-16½
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	37-40
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	8	10¾-11½
Westminster Electric Supply, Ordinary	5	15½-16½
Yorkshire House-to-House	5	8½-8¾

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NOTES.

Lightning in Quarries.—A short note in the *Engineer* says that a blast was fired by lightning at Rockland, Maine, U.S.A. on June 28, killing one man and badly injuring two. Eight loaded holes were being connected for firing when lightning struck the battery wire, thus prematurely firing the charges. The possibility of this, which it is believed is hardly ever taken into account, is worth noting.

Food Preserving.—We understand that a Mr. Pinto, of Rio Janeiro, has developed a method of preserving food by electricity. It seems that a process of electric tanning originated the idea, and that the inventor hopes great things from his new method. This consists of putting the meat in brine and passing a heavy current—say 100 amperes—through it. After a course of from 10 to 20 hours the articles are said to be perfectly preserved. We trust there is no toughening as well as a tanning action in the process.

Paris Exhibition (1900).—In the House of Commons last week, in answer to Sir S. Northcote, Mr. Curzon said that arrangements for the participation of Great Britain and the Colonies in the Paris Exhibition of 1900 were in a forward condition; and it had been proposed at an early date to constitute a Royal commission. But a report having reached her Majesty's Government that a material reduction was contemplated in the space which had been provisionally allotted to the British exhibit, enquiries were being made in the matter before any further steps were taken.

The "Fuji."—As will be remembered by our readers, a full description of the electrical work on this Japanese warship appeared in our last issue. There were two mistakes in the article in question, which the author has kindly pointed out. The first is that the fourth illustration is misnamed a "wire tube arrangement" instead of a voice-tube arrangement, and the second is that the block in question was printed upside down. The large number of connections, both electrical and mechanical, crowded into the small space, was perhaps the reason for our mistaking the top for the bottom of the block.

Faraday House.—We have received a revised prospectus and illustrated description of this electrical standardising, testing, and training institution. The pamphlet is well got up, and will be most attractive reading to the guardians of would-be electrical engineers. We think that the system is well organised. Although the theoretical course is rather a short one, it prepares the student to take advantage of his future opportunities in the affiliated workshops. Perhaps the fact that by this method the students are not standardised, but have to develop individuality, is the best means of making engineers rather than thinking machines.

Dielectric Hysteresis.—The publication of Mr. Richard Threlfall's investigations on the conversion of electric energy in dielectrics, which have been already noticed at some length, is continued in this month's *Physical Review*. Mr. Threlfall has examined ebonite, glass, sulphur, paraffin, selenium, resin, various mixtures, liquids (in this case with no result), and also the effect of very high frequencies. The conclusion has still to come. With ebonite spheres, Mr. Threlfall gets the theoretically paradoxical result, that with a sphere of 1·5cm. (48in.) the law is $W = 0{\cdot}017\ F^{a}$ ($a = 1{\cdot}85$), with a sphere a little under half the size it is $W = 0{\cdot}003\ F^{a}$. The coefficient charging wildly while the index remains exactly the same.

Jubilee Addresses.—The deputation of the Royal Society to present to the Queen an address of respectful and sincere congratulations on the happy conclusion of the sixtieth year of her reign, consisted of the following members: Lord Lister (president), Sir John Evans (treasurer), Prof. Michael Foster and Prof. Rücker (secretaries), Prof. R. B. Clifton (vice-president), Sir William Huggins (vice-president), Mr. W. T. Thiselton-Dyer (vice-president), Sir Joseph Hooker (past-president), Lord Kelvin (past-president), Sir George Gabriel Stokes (past-president), and Mr. Robert Harrison (assistant secretary). Among the other addresses was one of congratulation to Her Majesty forwarded by the German colony of London. The Queen replied to this in German in a letter addressed, "Herrn Alexander Siemens, Hochwohlgeboren, London."

The Railway Magazine.—We have received the first number of the first volume of this new venture in technical journalism. The aims of the production are not explained in this its first number, and hence the contents must speak for themselves. A well-illustrated interview with Mr. J. L. Wilkinson, the general manager of the Great Western Railway, commences the issue, and is followed by articles on the following subjects: "Fifty Years of Railway Engineering," "Recent Work by British Express Locomotives," "Some 'Racing Runs' and Trial Trips," "The Flying Welshman," "The New 'Great Central' Railway Extension to London," "The Royal Jubilee Train," "The Vacuum Brake," etc. The magazine also has one story of the order found in most popular monthlies, which may find favour with its technical readers.

Electric Heating of Steel.—The *Electrical Review* of New York refers in an editorial article to some interesting experiments being carried on by the Carnegie Steel Company at its Homestead works in heating steel billets by electricity. The advantages said to have been achieved are economy in fuel, a saving in time required to heat the billet, and also that the billets are heated from the centre to the outer surface, insuring equal heat throughout the mass. This last is said to be of prime importance. The steel thus treated is reported to be of better quality, from the fact that the exact temperature required may be obtained without overheating. It is said that billets up to 12in. in length have been successfully treated in this manner. The president of the company, Mr. C. M. Schwab, who is the originator of this new method, hopes to develop it to a still greater extent. We should like to see figures as to the saving of fuel.

A New Combination.—We are always hearing of new and profitable undertakings where combination is to be the source of profit. Perhaps the latest in this respect is another attempt to defraud the water companies. This is nothing less than the use of a small dynamo and turbine to be driven by water supplied by the house mains. The idea is American, and we are not very sure if our English water companies would consider water so used to come under the category of "domestic consumption." We remember a somewhat similar scheme on a larger scale proposed many years ago by Dr. W. Garnett in Newcastle. He pointed out to the water company that their main supply reached the town at a pressure much above that which it was wanted for distribution. He therefore offered to take off the superfluous head for nothing and to use the power so obtained for technical educational purposes. His kind offer was not accepted.

The Thames Embankment.—There are two schemes at present before the County Council dealing with the Thames Embankment. The first is to provide a system of arc lighting, which is to turn the Embankment into a favourable evening promenade; the second is to provide a tramway from Westminster Bridge to Blackfriars. These two schemes should clearly be connected and electric

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traction adopted. The poles for the overhead wires would not be noticed amongst the trees, and would not there be in the way of the fire-escapes. Again, as such wires would not be appreciated on the Westminster Bridge, this small section should be run on the Hanover accumulator system. The arc lamps on the poles along the Embankment would complete the scheme, and do much to popularise electric traction in and around London. The combination of the two schemes would tend to economy, and hence we hardly think it will find favour with the powers that be.

Paris and the Electric Light.—The *Revue Industrielle* gives figures as to the progress of electric lighting in Paris since 1893. Even then we gather that the comparisons are only made on the totals for 1893 compared with those of 1895. In that time the number of consumers has increased from 4,488 to 6,865, the number of arc lamps from 5,557 to 6,518, and the number of incandescent lamps connected from 201,807 to 335,759. The total units sold, which in 1893 reached a total of 4,858,569, in 1895 reached a grand total of 7,231,993 units. The gross receipts increased from £225,707 to £332,798. The editor concludes that the Parisian stations are now a financial success, and that the public are firm supporters of the electric light. Comparing the above total with those of London, we see that the electric supply in London is not behind in the matter of output or revenue. Thus for the same year our London stations sold some 17 million units, which produced a total revenue of about £450,000. It is interesting to note that the receipts at Paris divided by the units sold gave an average price of nearly 10¾d. per unit, while the corresponding figure for London comes out at only 6¼d. per unit.

Diamonds Converted into Graphite.—We know that the great wish of the scientist is to perform the inverse of the above, and to change graphite into Kohinoors. Still, the following abstract from the *Journal* of the Chemical Society of Mr. H. Moissan's observations will be of interest to our readers, as throwing some light on the action of the discharge in a Crookes tube. He found that diamonds which had been subjected to molecular bombardment in a Crookes tube were completely blackened on the surface, and after prolonged treatment with nitric acid and potassium chlorate yielded graphitic oxide, which when heated changed into pyrographitic acid. The graphite was very slowly oxidised, and in this respect behaved like graphite formed at a high temperature. After four treatments with the oxidising mixture, the diamonds were still covered with a maroon-brown film of finely-divided carbon. Since diamond is not converted into graphite in the oxy-hydrogen blowpipe, it is clear that the molecular bombardment must produce a temperature which exceeds 2,000deg. The behaviour of the graphite, in fact, indicates that it has been formed at a temperature similar to that of the electric arc, or about 3,600deg.

Transcontinental Beyond Mazoe.—The *Financial News*—and nowadays financial papers are nothing if not South African—says that a new way of utilising telegraph wires has been discovered by the Rhodesian native: "Until recently he no doubt regarded the poles and wires as a kind of fetish [the Matabili and their brethren don't have fetishes], which pleased the white man and did not hurt him; but as a means of receiving or transmitting news, he utterly failed to recognise their advantages. The quotations of Rand mines did not interest him, and even a boom in Chartereds would not move his dusky face. Recently, though, his utilitarian mind has found a use for the wires, as officials of the Transcontinental telegraph have found to their cost. He has discovered that the wires make excellent bullets, and he accordingly lost no time in securing the whole of the available raw material. The result is that the expedition which has been patrolling the country north of Mazoe found no vestige of the Transcontinental wire left, and recommends that if the telegraph work is to be continued two forts should be established on the road. If the ingenious native is left alone for a while he will probably find a use for the poles as well." This, of course, explains a certain sentence which appears monthly in the list of telegraph interruptions.

Rontgen Radiations.—Mr. R. W. Wood, in an article in the *Physical Review*, refers to some experiments which gave results which give a clue to the many and discordant observations of diffraction effects with Röntgen radiations, all of which have so sadly lacked confirmation. His results would not be explicable by diffraction alone without penumbral effect. Mr. Wood says: "The images of the slits on the photographic plate give evidence of a maximum darkening on each edge. With a slit 0·05mm. wide at a distance of 25cm., the image was uniformly dark, but there was a very faint trace of a light border followed by a faint shadow. This looked more like true diffraction than any of the other results, and for comparison a plate was made under similar conditions with light. A rough calculation based on these two plates would indicate a wave-length of about 0·00004 for the X-rays, a trifle less than one-half that of Schumann's shortest light wave. I place very little confidence in this estimate, and, in fact, am not yet at all sure that we are dealing with true diffraction. There seems to be very strong evidence, however, that the rays do not pass by the edges of obstacles in rectilinear paths without suffering any change, although there remains a good deal of work to be done before any very definite statements as to just what happens can be made. It does not seem to me to be unreasonable to suppose that there may be some action which is not identical with the interference of light and heat waves."

Efficiency.—The use of thermal units in rating the efficiency of an electric plant does not seem to find favour with our American contemporary *Power*. If the pounds of coal per kilowatt-hour be taken, the question immediately arises, "What kind of coal?" and on substituting the calorific value of the coal, and making the unit of comparison thermal units in coal per kilowatt-hour, it is found that a thousand heat units in one kind of coal are more available than in another, so that the question, "What kind of coal?" still remains. The money cost per kilowatt-hour is not a correct basis for comparison of efficiencies, except among stations which are similarly situated with regard to cost of fuel. Prof. William S. Aldrich's proposal, the kilowatts per million thermal units in the steam supplied to the whole station on a basis similar to that in vogue for pumping plants, is, however, approved with reservations. This is an admirable system for specifying the efficiency of a pumping engine, and would be equally good for a steam dynamo, but aside from the difficulty of determining accurately the heat units supplied to a station which will always define the heat unit as a scientific rather than a popular method, there is the fact that such a rating leaves out of account altogether one of the principal features of the station, the steam generating plant. Probably the most satisfactory popular expression of the efficiency of a station is the pounds of coal per kilowatt-hour, with a statement as to the class of coal used. (That would be tiresome in comparing American results with English, say.) In reporting a test, of course all the data should be given, so that the reader may select that unit in which he is accustomed to think, and so that the reason for the result may be apparent. In truth, there are no facts more misleading than figures.

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Electrical Central-Station Economies.—Mr. I. H. Babcock puts the facts as to the duties of a central-station engineer in respect to economies very strongly and concisely in our New York namesake. Thus he says: "The business of the central-station manager is, not only to 'keep the wheels moving,' but out of the material furnished him to develop results which will pay the investor a fair income upon the capital invested. If he cannot do this, either the enterprise with which he is connected is unworthy of prosecution, or else he is lacking in the skill and ability to utilise the elements of profit which are in the materials placed at his disposal. To throw away products which can be turned to profitable account and made to pay dividends is an evidence of lack of thrift which admits of no palliation. The manager of an electric lighting company who possesses the technical skill to produce the most perfect light and yet has not the business ability to turn his waste products to practical account, cannot be said to worthily fill the position he occupies." He goes on to point out the need for working the station regularly at a good output, and says that while the day current should be sold at a profit, it must be so cheap as to meet the competitive demand for outside power. One solution of this problem of cheapening the supply is by utilising the by-product of exhaust steam, and making the lighting station a heating and power station as well. This added profit will enable the manager to increase his day work at a lower price. The more day work, the more steam produced, until soon the station is carrying a fair load at a profit during the entire 24 hours. This course has not been attempted yet in England, but the author says that many American stations are making profit, and one, at least, all its profit, from the sale of exhaust steam.

A Novel Use for Electricity.—One great feature of the electric motor for power purposes is the ease with which it can be attached to its work, and with which the necessary connections to the source of power can be made. The flexible pipes, which in the case of steam and hydraulic engines can be made to give a certain lateral movement, cannot be extended to any great range. The application now before us is that of the use of electricity to that new seaside monstrosity, the Observation Tower at Great Yarmouth. This permanent addition to the seaside attractions of Great Yarmouth has been erected on the north beach, near the Royal Aquarium. The structure is 125ft. in height, and is built entirely of steel on concrete foundations. Including the machinery, it weighs about 125 tons. A circular platform built round the tower, and constructed to accommodate about 160 passengers, is raised to the summit and lowered by means of steam power. As it ascends, the platform is caused to revolve by electric motors at the rate of one revolution in three minutes. There is another platform at the summit, to which access is obtained from the revolving apparatus, and which is hoisted to an additional height of about 20ft. At night the structure is illuminated by 50 incandescent electric lights and by three arc lights. At the base of the tower are spacious bars and dining-rooms. A company of nearly 200 guests were invited to the opening ceremony this week. The proprietor of the tower, Mr. T. Warwick, presided, and was supported by the Mayor of Yarmouth, several members of the Corporation, and many of the leading residents of the borough. The party were invited to make the first ascent, which was very satisfactorily accomplished. The Mayor then declared the tower open, and in the course of the afternoon and evening hundreds of visitors ascended it.

An American Tale.—The following tale is given as it is told in the *Electrical Journal*, which is published in Chicago. The editorial comment is simply that the "younger generation, men and women . . . make it a point to store away a little electrical knowledge for use on call." It would, perhaps, have been a little better for our contemporary to have made the young lady twist the platinum leads together, or made a short somehow else. Again, the other four lamps in series on the 500-volt circuit (it is presumed) might have proceeded to glow with unwonted brightness in recognition of the services of the fair repairer. These are possibilities; but, as we have said, we give the tale as it stands, and on the authority of our Western contemporary: "Trolley car No. 318 of the Bayonne, N.J., line was on its way to Jersey City when its incandescent lights went out. Conductor Miller jumped for the trolley rope, but to his surprise the trolley had not left the wire. Only the feeble rays of two oil lamps at either end of the car saved the vehicle from being in utter darkness. The conductor tried in vain to ascertain the cause of the difficulty, and had about given up trying, says the New York *Journal*, when a neatly-dressed young woman, urged by a female companion, went to the rescue. Advancing to the centre of the car, she detached one of the bulbs and, taking it to the end of the car, examined it carefully by means of the kerosene light. She shook her pretty head dubiously as she replaced the bulb. One by one she removed the bulbs until she reached the one at the rear end of the car. 'This is the one,' she exclaimed triumphantly, as she examined it. 'See, the carbon film has burned out. Smash that globe and I will fix your lights for you.' The conductor, after some hesitation, complied. When the globe was returned to her the young woman deftly twisted the broken carbon ends together, explaining to the conductor meanwhile that by so doing the circuit was again connected. Taking care not to allow her fingers to touch the joined filament, she sprang the stub back into its place, and, lo! all the other lights were instantly illumined. With blushing face the young woman returned to her seat followed by the admiring glances of the other passengers. When a reporter, who was on the car, tried to ascertain her name she refused to give it, and added: 'I have studied electricity in Jersey City, and the trouble seemed so easy to remedy that I could not resist the temptation to repair it.'"

Theory of Accumulators.—The July number of the *Journal* of the Chemical Society contains two abstracts on the above subject which are culled from the *Zeit. Elektrochem.* The first is by Karl Elbs, whose reasoning is as follows: "The source of the E.M.F. of a secondary battery is to be found, according to Le Blanc, in the change of quadrivalent into bivalent lead ions; whereas, Liebenoff and Löb assume the presence of the ion $\overline{PbO_2}$ in the solution, which, on abandoning its charge, is deposited as lead peroxide. The author is led, by his observations on the electrolysis of solutions of the acetates, to support the first view. The acetates are divided into three groups: (1) Those yielding, at the anode, mainly ethane and carbonic anhydride; (2) those yielding mainly oxygen; (3) those from which no gas is evolved. Group (1) includes the acetates of metals of constant valency; group (2) contains the acetates of metals which are bi- or trivalent, and whose higher oxide yields less stable salts than the lower; group (3) contains metals of valency between two and four which form comparatively stable peroxides. In the last two groups, it is supposed that the $CH_3 \cdot CO_2$ group liberated at the anode combines with the salt in the solution to form the acetate of the higher oxide. These salts are readily decomposed by water; cobalt triacetate, for example, would give cobalt acetate, acetic acid, and oxygen, whilst lead tetracetate yields acetic acid and lead peroxide.

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From this point of view, the formation of lead peroxide in an accumulator is preceded by the formation of the salt, $Pb(SO_4)_2$, containing quadrivalent lead." The second one, by Walther Löb, disagrees with the above, as may be expected of accumulator experts. He argues that, according to the views put forward by Elbs, equivalent quantities of lead and lead peroxide should separate at the electrodes when a solution of lead acetate is electrolysed. The author's experiments show that this is not in general the case. By using a large anode the greater part of the lead may be deposited as peroxide. To explain this anomaly, Elbs supposes that lead tetracetate diffuses from the anode to the cathode and there dissolves the lead. The author rejects this explanation, because if lead tetracetate were distributed through the whole solution lead peroxide should not separate only at the anode. The author thinks that the phenomena are most readily explained by supposing that the solution contains the ion $\overline{P}bO_2$, which need be present only in very small quantity, and which may be produced by the hydrolytic decomposition of the lead salt.

Electricity in the Workshops.—Dr. Louis Bell has a second article in the *Engineering Magazine* on the cost-reduction and labour-saving in workshops by the application of electricity. He goes into several very small matters, as, for instance, an electrically-heated glue-pot. Some of his views, which obviously arise from giving special attention to points which are usually dismissed as unimportant, are decidedly new, and, at first sight, somewhat startling. He looks upon electric portative devices as the most direct method of lessening the labour cost—a method which may advantageously be coupled with general motor service, even if no further special applications are contemplated. In investigating a concrete case with reference to the adoption of electric power, this is one of the first points to be considered. If the shop examined is one where artificial light has to be used to any extent, there is a strong added reason for using electricity, unless a lighting circuit has already been installed. The next step is to examine into the matter of special machines. The merits of the case depend largely on the class of work being done, and the extent to which the machine tools are systematically used. If a given machine, when in use, is turning out a routine product at a uniform speed, electric driving from the labour standpoint has no particular reason for being. If, on the other hand, it is being used for a large variety of purposes and at all sorts of speeds, it may well happen that merely the matter of speed regulation, enabling the tool to be worked at its most advantageous rate of cutting all the time, will show good reason for electric driving. Again, in cases where a single man tends several semi-automatic machines engaged even on uniform work, the use of electricity may render it possible by automatically changing the feed or speed, or even by automatic stopping on the completion of certain work, to lessen the attention required, and so give a single man command of more machines, or at least quicken the work of those already in use. This line of improvement has not been followed far in general machine practice, and deserves much more attention than it has received. With plenty of automatic machines for special purposes but comparatively few can be turned to a variety of purposes. Again, the question of portable tools has a very various degree of importance in different shops. In most shops doing heavy work it has great weight, while in those turning out a light and uniform product it can hardly be considered of much importance. The electric drill has already been discussed, and, while even now considerably used, would really fill a very useful place in most large machine shops. In some cases portable metal saws and milling tools, emery wheels, and buffers, would prove exceedingly convenient, and would save a great deal of work now done with cold chisel, scraper, and file. To all such devices electric power lends itself with extraordinary facility, and there are few shops where portable tools of such a kind would not prove highly economical of labour. It is a field that can profitably be explored by the inventor as well as the engineer. Finally, we come to a class of electrical applications which have to do not so much with an improved application of existing tools as with the convenience of the skilled workman, whose time is far too valuable to waste. Such are in themselves often apparently trivial, like the electrically-heated soldering iron, or even a magnetised screwdriver to facilitate certain assembling work, but they do save time; and time is money, if anywhere, in manufacturing processes requiring much manual labour.

The Telephone Trouble.—There has been a long letter in the *Times* over the signature "A. D. Provand," relating to the Post Office management of telephones: "The Post Office was first in the telephone field. They have had advantages which the companies never possessed. They have not required to provide separate premises for the service, and consequently have paid no extra rents or rates, have had no directors to pay or shareholders to satisfy with dividends, have paid nothing for patents, either by purchase or royalty, and have paid no license fees for which the companies give the Government 10 per cent. of their gross earnings. They obtain wayleaves at nominal rates compared with what the companies pay, and have had whatever sums they have asked voted to them by Parliament. The Post Office have therefore enjoyed a position which should have ensured them success against private competition, handicapped as the latter have been by the above as well as other onerous conditions." Notwithstanding all these advantages the Post Office charge subscribers a higher rate than the companies for distances over half a mile. The National Company's rates are from £5 to £10 per annum everywhere except in London, whereas the Post Office rates are £8 for a quarter of a mile, £10 for half a mile, £12 for three-quarters of a mile, and £14 for one mile. That the Post Office ever really competes with the Telephone Company is scouted. "The character of this so-called competition can be judged by the following particulars: The return shows that the Post Office have established 37 telephone exchanges; 27 of these are gradually expiring and have now only 152 subscribers amongst them, or less than an average of six per exchange. Four exchanges have each now only two subscribers. While the subscribers to the National Company's exchanges are everywhere increasing, in no instance is there any increase taking place to a Post Office exchange. Five of their exchanges in important towns have actually died out altogether. In Derby the Post Office opened their exchange in 1885, the National Company opened in 1889. The Post Office exchange is now extinct, while the National Company have about 370 subscribers. In Plymouth the same result has befallen the Post Office exchange, while the National Company have about 475 subscribers. In Londonderry the Post Office started eight years before the National Company, but never obtained more than six subscribers, while the latter have 120; the Post Office exchange has now lost its six subscribers (naturally) and no longer exists. Where extinction of a Post Office exchange has not yet followed the opening of a National Company's exchange, it has very nearly reached that point. In Leicester the Post Office exchange started in 1881, and obtained 135 subscribers; it has now nine (American papers, please do copy). The National Company opened 10 years later and have about

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750. In Hull, the Post Office exchange from having 163 subscribers has now only 28; the National Company have 970. In Cork the Post Office have seven, the National Company more than 400. Limerick tells the same story." There is much more which cannot be even summarised. The end of it all is to advance the definite charge that the present backward condition of telephony in the United Kingdom is directly the result of Post Office mismanagement of the business. This, the leading commercial country of the world, offers from its geographical configuration unequalled opportunities for supplying good telephone service. "The Treasury should in the public interest deal promptly with the position." In response to a resolution passed at their annual meeting, the Association of Trade Protection Societies of the United Kingdom have received the following letter from the Postmaster-General: "Sir,—In reply to your letter of the 4th ult., conveying to the Postmaster-General a resolution passed at the forty-ninth annual meeting of the Association of Trade Protection Societies of the United Kingdom on the subject of the telephone service, I am directed by the Duke of Norfolk to inform you that a very large number of additional trunk lines have either been recently completed or are in course of construction, and that so far as his Grace is aware the service is now satisfactory, except in a few cases where difficulties have prevented the erection of additional trunk lines with such speed as he could have wished. If, however, you will be so good as to specify any particular case in which the trunk wire accommodation appears to be inadequate, he will be glad to consider the matter. As regards the question of charges for the hire of telephonic instruments, I am to say that his Grace is giving careful consideration to the whole question, and he will be glad if he should find it possible to meet the wishes expressed in the resolution.—I am, Sir, your obedient servant, JOHN ARDRON." In regard to this question it is urged by the association that the present rental charged for telephones is excessive, and that the service would pay quite as well at reduced rates, owing to the probable increase in the number of subscribers.

The Rotary Converter.—Mr. Carl Hering gives a good abstract of a lecture in the *Sib. Jour.* by Mr. Steinmetz, in his digest of current literature for the *Electrical World*. He concludes that the lecture in question is the best we have had on the question of transforming alternating into direct currents. The following is a brief *résumé* of the above lecture as arranged by Mr. Carl Hering. In such machines the alternating and continuous current pass through the same armature, and their respective voltages therefore have a definite relation; in most cases additional step-down transformers will therefore be necessary. Mr. Steinmetz compares rotary converters with a combination of a motor and a generator, the former requiring transformers, as do also the latter between 10,000 and 1,000 to 6,000 volts; in reliability of operation and first cost a single machine is preferable; the rotary converter with transformers will give an average efficiency of 90·7 per cent.; a direct-current generator, synchronous motor and transformers, 82·5 per cent.; and without transformers, 84·6 per cent. The rotary converter has the advantage that no transference of mechanical energy takes place. The theory is briefly discussed, and formulas are given for calculating the voltage and current when two, three, and four equally distant points are connected to as many collector rings; a table gives the alternating voltages and currents, using the continuous voltage and current as a unit; this is given for single, 3, 4, 6, 12, and n phases. The question of armature resistance and heating is discussed, and he shows that for the same energy loss in the armature, the current in the rotary converter can be increased in a certain proportion over that of the direct-current generator; on this basis, the figure for a continuous-current generator being 1, the figure for a single-phase is 0·85, three-phase 1·34, four-phase 1·64, and for infinity phases—that is, as many collector rings as there are commutator segments, thus forming the Le Blanc rectifier—2·31. The armature reaction is the resultant of the generator and motor action, and it is therefore equal to zero—that is, there is no armature reaction except that due to the small amount of energy to rotate the machine; there is no magnetic reaction if the current is in phase with the impressed voltage; the armature reaction is demagnetising with a leading and magnetising with a lagging current; with a lagging current the field magnetisation must be lower and with a leading one higher than for coincidence of phases; by increasing the field excitation a leading current or, by lowering it, a lagging current can be produced; with a leading current the self-induction of transformers and lines supplying the rotary converters increases, and with a lagging current reduces, the voltage below that corresponding to a non-inductive load; thus the field excitation offers a means of controlling and even of raising the voltage with the load; the increase of field strength with increasing load is insignificant compared with that of the same machine used as a direct-current generator. Owing to the absence of distortion a much greater armature reaction can safely be used in rotary converters; the field excitation can be varied through a wide range without noticeably affecting the voltage at the commutator brushes; with high armature reaction and relatively weak fields a full and overload can be carried without any field excitation whatever—that is, by exciting the field by the armature reaction of the lagging alternating current; such converters without field excitation are similar in construction in their magnetic fields, but allow no control of the alternating system, cannot be compounded, and must be run with a lagging current; the polyphase converter is self-starting, running up to complete synchronism, which is indicated by beats in a lamp or voltmeter; the field circuit must be opened at starting; the starting is essentially a hysteresis effect; excessive voltages may be induced in the field, reaching frequently 4,000 to 6,000 volts, which must be taken care of; when synchronism is reached, the field circuit is closed and the load put on; while starting, the continuous side must be open; polyphase rotary converters can also be used as generators delivering continuous or alternating currents; the armature reactions are then additional and the field excitation or compounding is the sum of the compounding due to the continuous and alternating currents generated; in general, such use of the alternator is undesirable; when the rotary transformer is used to transform from direct to alternating currents, the armature reactions equalise each other, but attention must be paid to the nature of the alternating load on the machine; when a heavy inductive load is put on suddenly, the converter will rapidly speed up the more the lag of the load increases, and when not checked by strengthening the field excitation the accelerations may be serious. Most of the preceding discussion applies only to polyphase converters; in single-phase rotary converters the continuous-current and synchronous-motor armature reactions do not neutralise each other, as the latter pulsates with double the frequency; thus the armature polarisation oscillates, giving a very unfavourable condition for sparkless commutation and making the continuous current pulsating; the single-phase converter is not self-starting; it is preferable, therefore, in general to use direct-current generators driven by alternating-current motors instead of single-phase converters.

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MUNICIPAL ELECTRICAL ASSOCIATION.

SECOND ANNUAL CONVENTION, MANCHESTER, JUNE 30.

(Continued from page 79.)

Distributing Systems.

BY JOSEPH A. JECKELL, A.I.E.E., BOROUGH ELECTRICAL ENGINEER, SOUTH SHIELDS.

(Concluded from page 79.)

This brings us to consider the loss in distribution of the various systems. This is very hard to arrive at, since it is very difficult to obtain reliable figures on this point; engineers cannot, or do not care to, give accurate figures, but let us assume, as somewhere near the mark, that the losses with a low-tension direct-current system are 10 to 15 per cent., those with a high-tension direct-current system 25 to 50 per cent., and those with an alternating high-pressure system and with street transformers or sub-stations are 20 to 25 per cent., and if house transformers are used from 25 to 50 per cent. The question now to consider is how much this current which is lost costs to produce. In the case of the low-tension direct-current system this loss will be in the batteries, if there are any, and in the mains. This latter loss will be on for only a short time, being at the period of heavy load, and may amount to, say, 20 per cent. at that time. This means that the greatest loss occurs at the time when it costs most to generate current, and that 20 per cent. more plant has to be installed to overcome this, and a corresponding amount of interest and redemption incurred. With a high-tension direct-current system, the loss, though in the aggregate greater, will not occur to so great an extent at the period of maximum load, because at that time the transformers are in use, and there will not be so much loss on the mains. A great part of the loss will occur in the batteries and low-tension mains when the batteries are supplying the current; therefore it is possible, and even probable, that the lost energy in this case does not cost so much to produce as it does in the former case. With a high-tension alternating system the loss will be about a constant, but the percentage will vary inversely as the load. This loss may be taken as 2 per cent. of the capacity of the transformers installed if they are of a modern type and of a reasonably large size. This loss is probably an iron loss at the times of light load and copper loss at the times of heavy load, and is a constant factor; therefore the percentage loss will be very high when the load factor is very poor. The cost of this energy so lost will, however, be small, seeing that so large a proportion is lost during the hours of light load, when it costs very little to generate current. Moreover, the extra plant required to be installed to overcome this loss will be only 2 per cent., and therefore the extra interest and redemption will be very small. As the percentage loss becomes less as the load factor improves, it will be seen how very important it is, where a high-tension alternating system is used, that everything should be done to induce consumers to burn their lights for a long time during the day; though this is important on every system, it is much more so in the case of this system, which has the disadvantages already referred to. There is one high-tension alternating system where, according to published figures, some 97½ per cent. of the current generated is sold; this almost seems too good to be true.

We now come to that very vexed question—*i.e.*, the mains required to convey the current; and if any part of the system should be the very best procurable, these certainly should be. We may divide these up into three classes: (1) bare conductors in conduits; (2) insulated conductors in ducts; (3) insulated conductors buried direct. The first is in many ways the ideal system, but the opportunities that it affords for accumulations of gas and water are, of course, its great drawback. It is generally used where large conductors are needed, but at Norwich, where ordinary sanitary drain-pipes are used to form the culvert, it is used for quite small sections of conductors, and the author is informed that the price compares favourably with any other system of laying cables. Certainly, the gas accumulations seem to be the greatest drawback to this system, which, if adopted, should undoubtedly admit of the insulators being readily examined. The second system can be carried out in various ways, cast-iron pipes, stoneware casing, and Callender bitumen troughing being the most general. Prices doubtless differ in various parts of the country, but from recent experience in the North of England the author finds that for one duct or two ducts cast-iron pipes are much cheaper than stoneware casing, and where three ducts are required the price is exactly the same. This is if the stoneware casing is laid with the cheapest kind of joint, for if it is laid with a better kind of joint the expense is, of course, increased. There is no need to mention the many points in which cast-iron pipes seem to the author, at any rate, superior to stoneware casing, setting aside the question of price. The best known methods of laying cables on the solid system are the armoured cables laid direct in the ground, and unarmoured cables laid in a trough and run up solid. It is not the intention of the author to draw comparisons between the various kinds of cables, etc. He has laid almost every kind, and has been fortunate in not having experienced the wonderful faults that are so often reported. He has found that a cable, however good, may be irretrievably damaged by being badly laid and badly handled, and many of the faults which are put down to faulty manufacture are really due to bad laying. Gentlemen who have not had much experience in cable-laying seem generally to think that anybody can lay a cable; everyone who has had a wide experience, however, knows that this is a very erroneous idea, and a good cable badly laid may be worse than a bad cable well laid.

The author has avoided mentioning anything about prices because they are so uncertain, especially when there is sometimes 100 per cent. difference in the tenders sent in for such a simple thing as laying a 3in. cast-iron pipe. In conclusion, he would suggest that there are three states of the mind—disbelief, conviction, and that vast interval between the two which is not belief but suspense of judgment—and he ventures to think that suspense of judgment is very advisable when the various reports about faults and breakdowns are heard, and that engineers would do well not to make up their minds until the full circumstances of the case are known; if this is done, there will be less liability to condemn material which may not have been so bad after all.

Distributing Systems.

BY J. R. BLAIKIE, A.I.E.E., CHIEF ASSISTANT ELECTRICAL ENGINEER, BRISTOL.

Blaikie, J. R., A.I.E.E., gained his first experience at the Finsbury Technical College, where he took a two years' course. He then passed one year at the electricity works at Bath. He afterwards passed two years with the Taunton Electric Lighting Company. After that he was with Mr. F. M. Newton, and then became charge engineer at Bristol. One year only was spent by Mr. Blaikie in that capacity, as he was afterwards appointed to be chief assistant engineer in the same station. He has held this latter position for some three years.

The most economical and efficient means of transferring electric energy from the generating source to indefinite points, in indefinite quantities, and at variable times, is beyond human calculation. The result of each experiment, and the experience of each year, tends to narrow the limits of speculation, but at the best there must always be a considerable element of uncertainty. The first cost of a system and maintenance, the capability of subsequent development and the probable dissipation of energy, whether in ohmic resistance, iron losses, or simple leakage, are not the only difficulties of the problem. There are certain other little considerations graced by Acts of Parliament concerning uniformity of pressure, and such devices and alternative methods of supply as the engineer may think desirable for securing the reliability of the service. To the practical engineer the last two points are of vital importance, and having secured these, he may then proceed to the luxury of cutting down the costs of distribution.

Considering various systems on broad lines, with special regard to the more pressing requirements, one cannot help regretting (with all due deference to the Board of Trade) that aerial lines are no longer permitted. It does seem a little hard when overhead tramway conductors, 600 volts, bare copper (!) and an "earth" return (!) are encouraged to increase and multiply

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Since the high-voltage lamp has been produced, the idea becomes still more practicable. There is no other system so readily capable of extension, and the rapidity with which alterations can be made is a great convenience, both to the undertakers and to the general public. The difficulties of insulation were fairly well overcome five years ago, and no doubt there would be perfections forthcoming to-day, if demanded. The mechanical difficulties are less than those involved in tramway systems. Happily, the Board of Trade does not issue regulations on the lines of the Medes and Persians, so there may come a day when small country towns and straggling districts will be able to support the cost of an electric current service. It would take too long to trace the true historical development of underground systems. The first stage appears to be conductors strained from point to point on insulators in culverts. It speaks well for the perseverance and ingenuity of electrical engineers, to find that a system with so many obvious difficulties can still hold its own. It is almost mysterious to find high efficiencies when one considers the probability of leakage and the cost of running ventilating fans, etc. The dangers of electrolytic action and the chances of explosion seem to be greater with a culvert system than in any other, and may have a powerful influence in the future in condemning it as safer methods are brought forward and proved. The construction of culverts in ground already full of gas-pipes and water-mains, to say nothing of telegraph and telephone lines, pavements undermined by coal-cellars, or an occasional church crypt, must necessarily be a very laborious undertaking. If the area to be supplied is of an undulatory character, and the difference of level extreme, the difficulties of drainage become more serious. Indiarubber-covered cables drawn into pipes have been and still are very successful for high-tension work. Manholes receiving the ends of the pipes are not very nice, and are liable to fill with water, but the main point for criticism is the rubber. Whether it is possible or not to make rubber that will not perish is perhaps only known to manufacturers. Competition with less expensive dielectrics may be responsible for research work that is not altogether in the interest of the user. Cables insulated with cotton or similar material drawn into pipes full of heavy oil have been used in a few cases. Such a system does not commend itself on account of complications involved in glands and fluid tight joints. Bitumen casing eliminates many of the objections to culverts and pipes, but it does not appear to have been very generally employed. Perhaps the cost is excessive, or the friction on the cables drawn in is a a disadvantage. All the above systems are capable of development as the demand increases, and enable the outlay in copper to be efficiently controlled. Solid systems mean laying in copper for the ultimate supply. More of this hereafter.

The Callender solid system, mains covered with bitumen and braid, laid on wooden bridges in iron troughs, and filled in solid with bitumen, appeals to the engineer as a sound mechanical job and easy to manipulate. Still there is a tendency for a gradual flow to take place in a substance like bitumen, which might cause trouble. The light cast-iron covering used would not be much protection from a pick in the hands of the average navvy. In the case of alternating currents, there may be a fair amount of energy wasted in eddy currents in the iron troughs. By far the most popular solid system is the lead-sheathed armoured. There are at least 56 undertakings in Great Britain using these cables in some form or other. The table following is compiled from data published by the *Electrician*. In some cases the description of mains given is somewhat incomplete, as, for instance, "Insulated cables drawn into pipes." These have been taken as rubber covered. Stations having two or more kinds of mains have been counted to each variety. The date of the opening of the station is given, but that of the inauguration of new kinds of cable is unfortunately omitted:

Year of opening.	Bare copper.	India-rubber.	Bitumen casing.	Solid bitumen.	Lead and armoured.
1882	—	1	—	—	—
1885	1	1	—	—	—
1886	—	—	—	—	1
1887	—	—	—	1	1
1888	1	—	—	1	1
1889	1	1	1	1	4
1890	2	4	2	1	2
1891	4	1	—	—	3
1892	2	5	1	—	3
1893	6	8	1	1	8
1894	2	5	2	2	11
1895	2	7	1	1	12
1896	—	2	—	—	4
High tension	1	26	4	4	31
Low tension	21	12	4	4	25
Total	22	38	8	8	56

There can be little doubt as to the reliability and cheapness of a system so largely adopted. It may be of interest to this association to dwell more particularly on the details of this rapidly-increasing means of distribution. The majority of lead-sheathed cables are entirely dependent on the watertight protection of the lead casing for the maintenance of the insulation. The quality and uniformity of this casing is therefore the most questioned and the most keenly watched. The percentage of foreign material or use of an alloy may or may not be advantageous. Some makers put the casing on hot. Variations in temperature may be of importance to the insulating material. Others prefer to use hydraulic pressure and put it on cold. What the chances are of getting porous places through dross, oxidation, or crystalisation by one process or the other is a matter of opinion. (With a view to discovering porous places, it might be well to put on a thousand volts or so continuous current for a few hours while the cable is under water, the positive pole to the tank and the negative to the core. As is well known, the passage of a current alters the surface tension of fluids, and by this means the water would percolate rapidly and produce the results that might occur in the course of a few years, or by similar accidental conditions in practice.)

The ductility of the metal is of great importance, as the latter processes of manufacture and the laying subject the whole cable to a good deal of bending. The differences in the diameter of the cores of the drums used by various makers is rather noticeable. The jointing and tapping of these cables can be made perfectly reliable and simple. Of course, some methods are better than others. In general there appears to be room for improvement in ensuring the continuity of the lead and armouring, or the connection of either to junction-boxes for the purpose of making a certain "earth." The extraordinary differences of potential that have been found to exist across a few feet of ground, point a strong necessity. The use of "wiped" plumbers' joints from the lead sheathing to a lead sleeve, or from the sheathing to a brass collar from a box, is not very satisfactory. It requires a specially skilful plumber to make a thoroughly sound joint in the awkward positions that occur. It is difficult to say whether a joint is sound, and it may get damaged as the box settles into its final position. It is also awkward passing the end of a cable through a collar and making connections inside the box. A box split into two halves to fit on after the internal work is complete, is far more convenient. The two halves are made with a tongue and groove; a bit of thin lead piping laid in the groove makes the joint quite tight when bolted up. With jute cables, the box can be filled with oil, in which case a small compartment at each end is filled with melted compound to make the ends tight. In house boxes, if rubber is used for the lead in cables, the whole box must be filled with compound, as the oil attacks the rubber. It is generally better, however, to make all joints with compound. The internal fittings should have rings vulcanised in position and ebonite caps on any portion that could possibly come in contact with the box through violent mechanical strains. Some jointers are not sufficiently careful to see that there is solid ground or a large stone underneath the box, the result being that when the earth is filled in and pounded down, the fittings are liable to very severe strains, or the box may slide along the cable a little, and bring one end in contact. "Dead ends" require attention with regard to these strains. It is common enough to tape the end, slip a lead socket full of melted compound over it, and then a piece of iron pipe. In the course of time the lead gets forced down till at last the tape cuts through and causes an "earth." Some makers impregnate the insulating material with a heavy oil, which has the advantage of healing a slight puncture in the lead, and possibly makes the cable more flexible by allowing the layers to slip slightly when bent. Whatever this may be worth, it is obviously safer to get the most perfect lead sheathing as well. Other makers have non-hygroscopic insulating material, which is also more or less independent of the lead. The two latter varieties have one great advantage—viz., if by accident the cable should get pierced, there is less chance of a great length being spoilt, as with the ordinary jute cables moisture may run up any distance if it once finds an entrance.

The armouring applies to all makes and might be improved. There are three usual methods: (1) iron or steel wire in long spirals; (2) wire with special sections that locks itself; (3) two steel tapes, breaking joint. Round wire spirals offer very little resistance to pointed tools as the wire easily spreads. The other two are perhaps equal in resisting, but hardly enough. It might be better to provide more elasticity, by putting a serving of jute between the layers of tape, or perhaps wire, between them. Provided that the armouring cannot buckle and pinch the lead when the cable is bent, it would be well to have it of such a stiffness that the cable could not be bent too sharply, and thereby gain extra resistance to penetration; the additional weight would not be a great drawback. So much for cables, arrangements for disconnecting sections; transformer pits or sub-stations are leading features.

The first difficulty is to make such receptacles or chambers watertight, the next step to ensure their being free from gas, either coal-gas, which may accumulate from the soil charged continually by small leakages, or the explosive product of

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COST OF BUILDING CONSTRUCTION OF SUB-STATIONS.

Internal dimensions.	Wages.	Carting.	Tiles.	Cement.	Girders.	Roof slabs.	Covers and ventilators.	Total.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
11ft. 6in. × 4ft. 9in. × 5ft. 6in. deep	5 12 6	3 9 0	6 1 0	2 12 6	1 4 6	0 15 0	4 19 6	24 15 0
11ft. × 5ft. × 6ft. ,,	5 14 8	1 16 6	5 17 0	2 11 2	1 4 6	0 15 0	4 15 6	22 14 4
14ft. × 5ft. × 5ft. 9in. ,,	5 4 11	1 7 0	7 7 0	3 4 9	1 4 6	1 0 0	5 7 6	24 15 8
11ft. × 5ft. × 6ft. ,,	8 16 9	1 6 0	5 17 0	2 11 2	1 4 6	0 15 0	3 14 6	24 4 11
11ft. × 5ft. × 6ft. ,,	5 9 0	1 2 0	5 17 0	2 11 2	1 4 6	0 15 0	3 13 0	20 11 8

Roof slabs—old paving stones—at 2s. 6d. per yard super. Tiles, cream glazed, 3d. each. Cement, 4s. per bag. Concrete, 1 to 6. Labour, 4d. per hour. Bricklayers, 6½d. per hour.

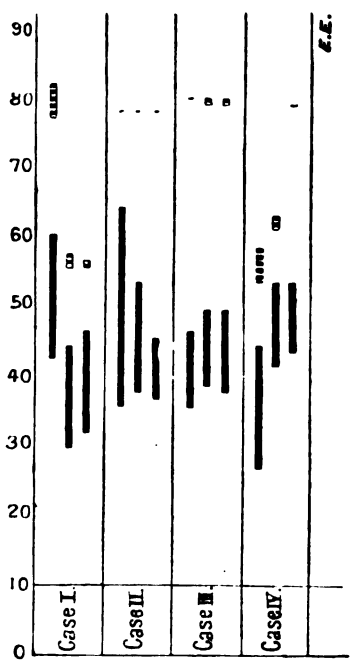
electrolysis, and the third, how to prevent hygroscopic insulators or walls from falling below the temperature of the enclosed air. Moisture in the air does not matter unless it deposits. Small boxes and transformer pits can be made of metal, with sound mechanical joints and glands; they can be quite water-tight and gas proof. With regard to moisture depositing, the simplest plan is to exclude the air altogether by filling them up with oil, but this of course prohibits the use of rubber cables. A cleaner and still satisfactory way of making junction-boxes reliable is by having the detachable links or fuses carried up to one level, as near the top as possible, and then filling in compound up to the level of the links. By this means the enclosed air space can be reduced almost to insignificance. A rubber joint can then be used, which, if of good material, will last for several years. Of course, either gunmetal studs or nuts, or both, should be used for the inner cover. A cast-iron tray filled with limmer makes about the best outer covering. A great objection to all outdoor boxes is that they are more or less inaccessible in wet weather. They necessitate having a tent or similar protection, which means time, and there are occasions when time is everything in a lighting station. Where transformers are used, a large number of capacious dry sub-stations are invaluable as disconnecting junctions and branch fusing points.

Various modes of construction seem to have been employed in the building of underground chambers. Of course, a lot must depend on the natural drainage of the ground. The commonest plan is to build double walls, having a space from 1in. to 2in. in between, filled with hydraulic cement, bitumen, or pitch. In some instances these walls are 4½in. and in others 9in. Chambers about 7ft. by 7ft. by 6ft. inside of this type, cost from £50 to £60. Puddled clay outside the walls has been used, but the cost is not given. Cement concrete, having asphalte lining, costs about £70. Cement concrete, heavily faced with cement, only £28. Good dense bricks, laid in cement, 18in. thick, cost about £65. One of the latest methods, and the cheapest, is the use of concrete with glazed tiles, having an L-shaped section. A glazed surface, with fine joints in cement, makes an ideal watertight structure. The cost is about £25. Fortunately an engineer using these sub-stations has sent full details, so that the cost in districts paying different rates of wages can be estimated very accurately.

The roofing is a very important detail. The changing differences of temperature between the inside and the outside tends to make the roof "sweat." The brick arch has the advantage of running this condensed water down the sides, instead of allowing it to drop on the apparatus. Rolled joists and concrete is more efficient as regards space, and cheaper to construct. It also affords a better means of attaching the manhole frame. A variety of this roof consists of old paving stones with rolled joists. A little cement in the joints makes it very waterproof. It is economical as well, and the suggestion of utilising the waste material from the corporation yards will generally meet with unqualified approval. With a view to keeping the roof dry, independent of ventilation, some roofs have been constructed in the following manner. One inch flooring boards treated with creosote are laid on 2in. by 3in. wood joists. Over this is laid sheet roofing lead with soldered joints quite flat, and the edges well over the outside of the walls. Sand to a depth of 2in. is laid over the lead and then the iron joists and concrete. The wood being non-hygroscopic keeps the inside dry. It could not do any external damage if by any extraordinary means it should take fire. As an extra precaution the woodwork can be painted with asbestos paint if thought desirable. It is very convenient to have chambers that will keep dry without ventilation, as many ventilating systems are not very positive, and where relying on the heat of transformers, an independence that will allow of cutting alternate feeding points out altogether in the summer months is a consideration. Ventilation is, however, often of the greatest importance in keeping sub-stations dry, and may be necessary in some cases to ensure the chamber being free from gas. The means taken to render a chamber waterproof often make it gas-proof as well; in such cases, if no pipes leading in cables, etc., are left open, it is practically impossible for trouble to arise from this source.

In a few isolated cases fans are used; the cost of this mode must be greatly against it. When transformers are employed in a system, the heat generated is sufficient to make a very fair circulation either through special covers or pipes. With covers, the necessity of providing a drip pan makes the arrangement rather clumsy. With pipes it is very hard to discover the most advantageous position and size. There is nothing to be gained by carrying the up-cast pipe any distance up a wall or a post, as the pipe itself dissipates the heat so rapidly. Pipes taken into a small well in the pavement are not much use either. Good results have been obtained by pipes 3in. by 4½in. ending in a grating standing against a wall about 6in. to 8in. above the ground. The two pipes, in one casting, go down vertically about 2ft. 6in., the one with a right-angle bend runs horizontally about 2ft., and enters the chamber near the top; the other with two bends, is taken to within a foot of the bottom. With a ventilator of this sort the flame from a match is drawn in well by the downtake pipe, and repelled by the up-cast.

In illustration of some of the above remarks, the following experimental results are interesting: A maximum and minimum recording thermometer was placed in a sub-station, and a similar one outside. Readings were taken at the end of about three days on both instruments. It would, of course, be far more accurate to register the relative temperatures simultaneously at short intervals, but the ends to be gained would hardly justify the necessary expense. In the diagram the thick lines represent



the range outside, and the dotted lines the range inside the sub-station.

I.—Redcliff.		II.—Victoria-street.		III.—Victoria-street.		IV.—Woodland-road.	
Outside.	Inside	Outside	Inside	Outside.	Inside.	Outside.	Inside
				Ventilator	Blocked		
43°-61°	78°-83°	36°-65°	79°-79°	36°-47°	81°-81°	27°-45°	54°-59°
30°-45°	56°-58°	38°-54°	79°-79°	39°-50°	80°-81°	42°-54°	62°-64°
32°-47°	56°-57°	37°-46°	79°-79°	38°-50°	80°-81°	44°-54°	80°-80°

The first case is a sub-station, with a roof of cement concrete and iron joists and stone flagging, but no wood, the inside being faceed with neat cement. Ventilation by means of two 2in. pipes into a well in the pavement; this chamber contains two 25-kilowatt transformers; the roof sweats a good deal. It will be noticed that the mean temperature inside varies pretty much

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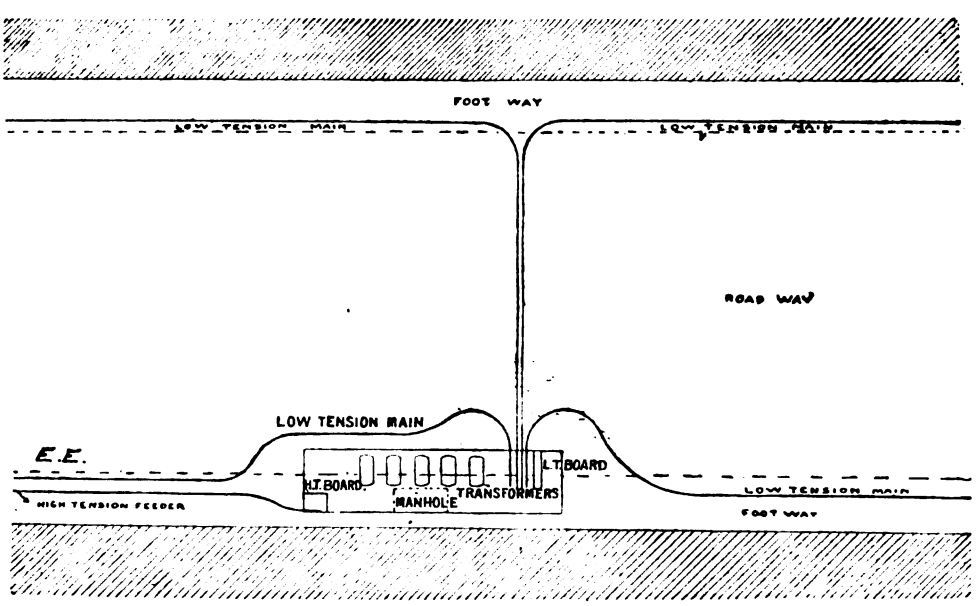
as the mean temperature outside. The ventilation being poor, this result is due to the conductivity of the roof. The next case is a similar chamber, but having wood in the roof, and 6in. ventilating pipes, also into a well. Here the temperature remains constant inside. The condition of this chamber is always first-rate. There is a little ventilation, as is shown in case III., which is the same chamber with the ventilators blocked; a slightly high temperature is reached. The last case is a later sub-station, having wood in the roof, but a ventilator, as before described, standing a few inches above the pavement. This shows the mean temperature inside to be more or less proportional to the mean temperature outside. This chamber having a non-conducting roof, owes its varying temperature to ventilation, and is always dry.

Manhole covers are usually designed for special requirements. A large tray filled with limmer, and having a lip to fit into a groove filled with tallow and a little white lead, is in every way satisfactory. A small manhole near one side of the tray should be fitted for ordinary use. The inner cover of the small manhole can be drawn up tight on a rubber joint by a bolt and crossbar, the outer cover being a loose tray filled with limmer. This arrangement is quite weather-proof, can be opened very rapidly, and gives a comparatively clean entrance. If the cover is over any apparatus, it should be lagged inside with wood to prevent "sweating." The floor, above the concrete foundation, should preferably be of Limmer asphalte; this material is quite impervious to water, and has considerable insulating properties. Although the floor should never be trusted, it might save an accident when handling fuses. The provisions of a reliable "earth" appear to be a serious consideration. As a suggestion it might be a safeguard to bury a large metal plate under the foundations, and carry up a copper rod, which could be also connected with the armouring or lead of cable, or pipes containing cables. A thoroughly systematic way of connecting metal cases, "earth shields," etc., to "earth," seems to be wanted.



A word with regard to the shape of sub-stations. It is generally more convenient, from the constructional point of view, to form a long, narrow excavation along the street, as it can be better accommodated in a network of pipes and other services. In solid systems, if the mains are brought in at the side near one end, space can be economised. A neat arrangement is shown in the diagram. From data collected from a number of members of this association with reference to the spacing-out of sub-stations there appears to be such a diversity of arrangement that one cannot draw any definite conclusions. They vary from 100 yards to 970 yards. Probably the want of confidence in the working conditions of underground chamber or the cost of construction has influenced some engineers who prefer to have them "few and far between." The advantages of using sub-stations as junctions are most likely the strongest inducements to those who favour short distances and large numbers. About 200 yards is generally recognised as the efficient distance for three-wire distribution, consequently one would expect to find sub-stations with a 200-yard radius, or 400 yards apart, and this does happen to be the distance given in three or four instances. In outlying districts it may be doubled with provision for an intermediate station half-way.

For purposes of regulation and alternative methods of supply, it is obviously best to have as many independent feeders from the central station as possible. The original pressure can then be varied to compensate for the individual losses and irregularities of any particular district. The development is often contrary to expectation, so that some means should be provided for correcting the original scheme. For example, three or four feeders having different sections could be taken to a distributing sub-station, and connected there to the outgoing cables in the manner best suited to the actual demand. A pipe laid from such a distributing centre to the station at the same time as certain armoured cables would be convenient for establishing additional circuits or augmenting the section of any existing feeder, by drawing in rubber cables when such alteration should be found necessary. The number and size of the feeders can only be arrived at from a study of the geographical and commercial characteristics of the area of supply, and modified to suit the personal opinion of the engineer who is responsible for the maintenance. With the actual distributing mains it might be different. Two or three standard sizes might be arrived and only the feeding points located, or the pressure raised to accommodate the inequalities demanded. It would no doubt be a convenience to the users if manufacturers were able to stock such cable, instead of having to make up each variety to order. From information received from two large firms as to the usual sizes supplied, one can only be astonished to find such a large range. One station alone uses 15 sizes (!) of low-tension distributing main, others nine, eight, seven, six sizes. Another station eight sizes, from ·3875 square inch to ·325 square inch. There are several large stations only using three sizes, and some one or two. One firm says, "Generally speaking, it is not usual for alternating-current stations outside London to use a larger size than ·2 square inch, or a smaller size than ·1 square inch." For the sake of the convenience of only storing a limited number of sizes with their joint-boxes, etc., one can afford a little margin on the copper. Possibly some attempt at uniformity would decrease the cost of manufacture. From replies received from 14 provincial stations, the average number of 8-c.p. lamps connected per yard is from 1 to 2·21. Perhaps further data of this kind would enable standard to be determined.

In conclusion, the author desires to thank all those gentlemen and firms who have so graciously responded to enquiries, and to state that he will be glad to add as an appendix any further information he may receive with regard to the cross-section of distributing mains, or of lamp density per yard of frontage, if any members feel that such figures would be of interest to this association.

Discussion.

Mr. Stewart (Derby) said in the matter of cables, engineers seemed to have been playing a game of follow-my-leader without considering specially the merits of the cable. One difficulty he found with rubber cables was from rats. Rats got into the consumers' premises, and there would be trouble with them and they sometimes actually destroyed the cables. The manner in which lead-covered cables were drawn into the conduit was important. In practice, you would get so many men on a rope and let them haul. That was very crude. As a matter of fact, he had found that in cases the lead was considerably drawn. He suggested the use of a winch which could be adjusted not to pull beyond so many hundredweight.

Mr. Boot (Tunbridge Wells) said Mr. Jeckell had been doing a good thing in calling attention to the importance of the cable part of the engineer's work. It was very little use having central-station machinery which was perfect and never broke down, and then having faults in the cables. Manufacturers must understand that their cables must be turned out so that they would be a success, without having to be laid by the manufacturers' men. In cities, where the roads were constantly being taken up, it was not found that the gas and water companies took great care in ramming the ground where they crossed the electric mains, and

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from this cause the copper might sag between the boxes after it had been laid. Another point was that further protection was wanted than for a gas-pipe. Cables were very well when they were laid and left alone. Faults were the result of someone opening up the ground and not filling it in properly. Mr. Jeckell avoided mentioning anything about price. That was absolutely suicidal. One could make a cable last 100 years if there were no bounds to the expense of it. It might, for instance, be put in an iron pipe an inch thick. Sub-stations were a great advantage for alternating current, and would be a good thing if they could be built at the price Mr. Blaikie mentioned. There was a possibility of danger about a pit, and it was not convenient to work in. The Hampstead accident would never have taken place had it not been in an underground chamber.

Mr. Tittensor (Dundee) had been using indiarubber cables for 4½ years, and had never had a single fault. As to bare conductors and copper strip, he had thought of a plan for inspecting them. It consisted of a box camera with an incandescent lamp drawn through the culvert. He knew the suggestion was practical, because he had worked it in other cases.

Mr. W. E. Heenan (Northampton) had had culverts for nearly seven years, and very little cable. They were now adding the third wire, and having taken tests all through their system at 500 volts, they had not been able to get a reading on the ohm-meter. The insulation was absolutely infinity. A looking-glass was used to inspect the culverts. As to water in the culvert, they had put in drains and had not had the slightest sign of it. Nor had there been any trouble from gas. Where there was any doubt about it, upright pipes were put up the sides of the houses. As to the cost of culverts in comparison with cables, they had gone into the question for a 150 yards extension, and found that they saved £8 on the 150 yards by using the culvert. Lead-covered cable had broken down in their streets because furnace slag was put on the top of the cable to keep it from mechanical damage. In reason he would prefer a culvert wherever possible.

Mr. Snell (Sunderland) thought they should keep to one system, either the direct or the alternating current. The Oxford system was available for continuous-current systems to meet the needs of the outside districts. In most cases the time would come when these would be combined with the central distribution and motor-transformers dispensed with. Mr. Murray said he had alternating-current motors which ran well. He (Mr. Snell) would like to hear the experience of other engineers as to the single-phase motor, because the ability to supply motors was always a great point for the direct-current. Mr. Jeckell had said the transformer loss was only 2 per cent., but surely it was not constant. Hysteresis loss was constant, but the $C^2 R$ loss increased with the load. Mr. Blaikie expressed surprise that bare copper strip could continue to hold its own. His (the speaker's) experience was at Notting Hill, at St. Pancras, and at Kensington Court, and he hardly agreed. The trouble at St. Pancras, as everyone knew, was because the insulators were put in such a position that they could not be inspected. In the Crompton strained copper system, one could examine the insulators for oneself. He had never had a single fault in his 20 miles of bare copper strip—with one exception at Notting Hill, and that was when a water-main burst. With the Crompton culvert the percolation of gas might be reduced to nothing. With cables the tendency was to a hygroscopic dielectric and lead sheathing. He considered the essential point was that the conduit should be dry. Laid in cast-iron pipes with lead joints, there should be no faults. He had had much trouble with armoured cables. At St. Pancras there were many miles of it. In one new street, which had been made up with ash, after 15 months the cable had to be withdrawn. There was nothing left of the armouring but a little rust. If bricks were put above to mark the cable, when the gas company crossed it, they did not put them back. Then the next time they came they dug a hole into the cable. He would very much like to know where Mr. Blaikie got bricklayers at 6½d. per hour.

Mr. Mountain (Huddersfield) thought the question should be discussed whether a town should be supplied upon one network. He thought it almost criminal that a single fault should be liable to put out the whole town. With sub-stations it was not difficult to arrange the feeders to feed from both ends. He rather wanted to find out why low-tension engineers used concentric mains for distribution. He did not think it was right even for alternating mains, but simply the result of fashion. The professors had pointed out in the old days that concentric was the better for theoretic reasons. In his opinion it was all wrong. They saved in one way, and as a result got the capacity effect, and were unable to make a joint. Any joint in the ground was more or less a point of risk. Mr. Jeckell was rather hard on alternating-current motors. He thought their continuous-current friends might be a little more generous, and go back a couple of years or so. It was nothing in those days to find their lights dance about all over the place whenever a motor was put on. The engineers took the matter in hand, devised water resistances, and now the coming on of the motor could not be noticed. The alternating motor would improve with use in a similar way. The efficiency they need not bother about. He was surprised at engineers giving up the problem of single-phase motors, instead of facing and overcoming it. With conduits or pipes, if there was a heavy frost and a skin of ice over the top of the ground, you get gas in them; and it was absolutely impossible to be always sure of keeping water out.

Mr. Tremlett Carter asked if Mr. Mountain would have the feeders in parallel on the machines or each isolated on a separate machine, which made it impossible to get a good load factor. In London they practically had a number of distributing systems working independently, but now one of the western stations was metering current from one of the eastern—*i.e.*, Chelsea was taking current from Deptford for the evening.

Mr. Mountain would keep the machines separate, instead of parallel, as far as possible, falling back upon smaller plant as required.

Mr. Barnard (Hull) said he had tried three-core cables at Hull. He had given an alternative in his specification fearing that the cable would prove the dearer, but he was agreeably surprised to find that the difference was comparatively small. He found great advantages in using such cables. He was putting down a high-tension generating plant at Hull with 440-volt transformers to serve the residential districts.

Mr. Nesbit (British Insulated Company) said he thought the present low tension would have to become ultimately high tension, and that should be considered in designing a distributing system. Many stations supplied less than 2 per cent. of the ratepayers, so that the extensions to be looked for in the natural course were very considerable. In fact, electricity supply would increase enormously. Doubling the voltage gave some relief—*i.e.*, four time—but at the present rate of increase the problem would face them again in five years, and unless in that time something higher than a 220-volt lamp was on the market high-tension feeders would have to be put in. Armoured cables seemed just now to be the fashion. These were cheap and gave satisfaction. Cast-iron pipe was very expensive. A good protection was a wooden trough filled in with an asphalte composition. The trough perished, but that did not matter, as it was really only used as a mould. Engineers should ask for a good thickness of lead and see that they get it. Generally speaking, he did not see why they should have less than a plumber would put in a water-pipe. Originally 53 stations used indiarubber. There were now 23; 30 had been converted.

Mr. Callender began by half humorously referring to the rapid alterations in electrical practice as the area supplied increased. He thought the right thing to do was to stick to either the alternating current or the direct, and not have a mixed station. A continuous current did not preclude the supply of outlying districts. At Birmingham (continuous) they were supplying a quantity of motors for the jewellers' quarter, and he was surprised that so little was known about that station. At Berlin, where the incandescent lamps had been taken up more than anywhere else, they were continuous. When railways were started, engineers thought they could do with one line of metals. Soon they found they must have two for all mains, and now between Manchester and London they had four. They would have to do the same thing with their electricity mains. He was impartial in the matter, because the manufacturer had rather a better chance of getting something out of an order for high-tension than low-tension mains. The table on page 5 of Mr. Blaikie's paper gave a lot of information, but it took no account of the size of the stations. For small towns lead-sheathed cable might be the best, and small and large were counted equal in the table, but it did not follow that it was the proper system for large cities; and it was hardly fair to pair off Liverpool, and Manchester, and Birmingham, with their miles of cable, against three small towns. One case of trouble from rats was worth mentioning. It was near the Thames-embankment, and they made the conduit a regular thoroughfare. Two met in the middle, fought it out, and both died. He did not think lead-sheathed cables should be pulled into pipes under strain, and the best way to do it was by a winch, where the lusty navvy would not feel the strain. [A **Member**: My point is that the winch should be constructed to stop when too much weight came on.] If the member would bring him one of those winches he would buy it, as he would very much like to have a good look at it. He was glad to see his embedding system was being taken up by some of his competitors. [**Mr. Nesbit**: Our solid system is not yours.] As to damage from outside, the engineer had power to insist on notice from the gas companies, and should use it to keep an eye on them. In Liverpool they had an inspector who did nothing but go round and see what was being done. It had a most wholesome effect on the future action of a gas or water company to make them do their work twice over.

Mr. Gray (Silvertown) said that the question of alternating or continuous current hardly concerned cable manufacturers, except that with the alternating current cables were subjected to a higher strain. With the continuous current, where people simply put a dynamo on to the arc lighting circuit and one of the lamps went out, there was an enormous rush of current and a temporary high E.M.F., which was unfair to the cable. In America, they put lightning arresters in on high-tension cables. Much of the disappearing of the armouring off armoured cables was due to chemical action, and would not take place if the lead was not present. No experience was required as to the preference of Doulton's conduits or iron pipe. The Post Office used iron with very good results. The cost should not be an objection. People would spend money on machinery in their station, which was constantly under inspection, but a cable in the street was necessarily out of sight, and therefore out of mind, and nothing was known about it until there was a breakdown. It was, therefore, good policy to have one that would not go wrong. The rat difficulty could be overcome. A well-conducted rat did not get into their pipes, unless it came up a drain, and castor oil was an excellent thing to protect the cable from their attentions. Mr. Nesbit's remark that rubber cables were generally being replaced, he did not think quite exact. His firm had orders, and he supposed that other manufacturers had also.

Mr. Cousens congratulated the authors. Different soil had a very different effect on the armouring of cables. Down his way (Taunton) they had had cables down from two to four years, and found that the tape over the armouring was not even gone. One

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never seemed to know exactly what a rubber cable would do. There was such a delightful uncertainty as to what the manufacturer would put into them. He preferred transformer sub-stations to pits. In the West Country they were not troubled with trades unionism, and could get bricklayers at the price mentioned.

Mr. Quin (Blackpool) noted that the papers were at variance as to transformer chambers or sub-stations. Anyone who had laid on his stomach on the pavement, and dived down into a transformer pit, would have no doubt about it. With sub-stations, transformers were banked; with street boxes it was easy to get one end of the circuit overloaded before the other was on full load. He supposed that he had at Blackpool about the worst load factor in England. His maximum load last year exceeded the plant installed by 20 per cent. It was impossible to get a satisfactory works' cost like that. He was not troubled by a demand for motors, so the efficiency of alternating-current motors did not affect him. He had had a number of house transformers, but they were not there now. As to having a reserve, the safest policy was to duplicate everything. He had found steel armouring which could be pulled off as dust in 12 months. The gas department had a similar experience with its pipes.

Mr. Wilmshurst (Halifax), as a fairly large user of rubber cables, wished to say he had had no trouble with them. It all depended on how the cable was laid. He thought it improper to put more than one cable in one pipe.

Mr. Chamen (Crompton and Co.) would speak only of bare copper. His point was to have the insulators always accessible. It was really quite easy to ventilate and drain the culverts. Mr. Tittensor's interesting arrangement with a camera might tell if anything was wrong, but how were you to get at it to remedy it? On the Crompton plan, with a lady's back-hair glass, one could see from one box to another. Putting in a box for every two houses made it unnecessary to break the pavement a second time. It could be altogether avoided in most cases by driving a gas barrel through the ground. Some of the most serious explosions had occurred with cables in the City system. He quoted Northampton and Harrow as successful examples of the Crompton system. There was no dielectric system to get out of order. The life of rubber and paper and that sort of material must be much smaller than bare copper. It was distinct advantage to have no insulation to deteriorate. He was not aware of there having been any trouble from vermin.

Mr. Hawley remarked that at Oswestry they got earthenware pipes which were glazed with salt, which proved injurious to the lead. Rubber was such a good insulator that you might find a 110-volt house wire stand 3,000 volts and take no harm. Things were done with rubber cables which ought not to be done. For instance, it was easy to put extra protection on the ends or any exposed part. Ten or twenty years hence there would be 10 or 20 times as much energy distributed. They might expect much to be done in electrical traction. The question was not so much the minimum cost of cable for the momentary demand, but what would be the cost of increasing the mains by 50 per cent. Again, excavating must be considered, as it varied from 3s. to 7s. per yard, and exceeded the cost of the cable.

Mr. Fedden (Edinburgh) said they had about 40 tons of copper laid down in Edinburgh on the Kennedy system, and saved a great deal in the way of opening streets. They had had no trouble from gas in the culverts. He had never seen any deposit in the mains [electrolytic] upon the insulators. They had 2,800 boxes and three sets of inspectors.

Mr. Sutherland agreed with Mr. Quin that it was wrong to run separate machines upon separate mains. The machines should be run in parallel, and the mains interconnected, with a separate low-tension plant for the arcs. He did not think concentric mains presented such difficulty in making joints as had been alleged. He disliked road-box transformers. Mr. Blaikie seemed to want to get back to overhead mains. Most of them were agreed that it was a good thing the overhead main was put a stop to. He agreed with Mr. Nesbit that ultimately the low tension would all become high tension. The low-tension men, beginning with 110, had already got up to 440.

The Chairman said, as the paper touched upon a highly controversial subject, he would not as president say anything.

Both **Mr. Jeckell** and **Mr. Blaikie** reserved their replies for the *Proceedings* in order to save time.

The Localisation of Faults in Underground Mains.

BY ROBERT C QUIN, A.I.E.E., BOROUGH ELECTRICAL AND TRAMWAY ENGINEER, BLACKPOOL.

R. C. Quin, A.I.E.E., obtained his first experience with central-station work at Bradford during the construction of the works there, and afterwards during the running of the plant. From 1891 to 1896 he acted as assistant at the Brighton Corporation works, and was appointed engineer at Blackpool in May of the latter year. He has patented several electrical devices, amongst others, in conjunction with Mr. Arthur Wright, of the combined alternating and continuous current system in use at Brighton. Mr. Quin claims to be second in respect of the length of time he has served as a municipal electrical engineer, Mr. Sydney Baynes, his former chief, taking the premier place in this respect.

The mileage of cable laid under streets has increased rapidly within the last few years, and more especially does this increase show itself in the area and complexity of distribution networks. Whether the cause be electrolytic, chemical (internal or external), electrostatic, or mechanical, with the ageing of the cables come the troubles of the station engineer's life—cable faults; and the increasing complexity of the network renders more difficult the task of their localisation. It has been the lot of the writer (fortunately or otherwise) to have had more than his fair share of cable trouble, and if the results of his experience help to lighten the burden of brother engineers, the recompense will be ample. Many methods of localisation have been suggested, the readiest undoubtedly being the antiquated "cut and try." Of the remainder, the majority consist of some modification of the loop test; but by all methods previously suggested, with the exception of the "telephone and induction coil" and compass methods, the resistance of the cable is measured directly or indirectly. When we consider the very low resistance of the average distributing main per yard, it is easy to see the impossibility of accurately locating the fault by any method which takes resistance into account. Furthermore, accurate methods of testing are not possible in a crowded thoroughfare, and standing at a street corner in a blizzard is not the most delightful situation in which to solve an abstruse mathematical calculation.

MR. R. C. QUIN.

When a fault appears on a network the first step necessary for its removal is, obviously, to locate the section or district in which it exists; and for this purpose the "Berlin" system of automatic signalling is one which recommends itself. But the cost of installation, especially where the network is already laid, practically prohibits it. A somewhat similar system however is within easy reach of all. Property in "earth" does not exist, but it behoves electric lighting authorities not to interfere with the due and proper working of telephone companies' apparatus. Many hard words have been said as to the National Telephone Company's use of earth returns, but it will be a bad day for the "trouble" man when these "earths' give place to metallic returns. If the "Berlin" system cannot be afforded, arrangements might be made with the local telephone exchange, to allow connection to be made (say at 7 a.m. or some other time when the telephones are not generally in use) from the mains, through a suitable resistance to their exchange "earth." It is quite as efficacious and not nearly so expensive. It protects the telephone company from undue interference, by enabling the sections in which faults exist to be located before the faults become serious. It requires only a comparatively small current to drop the indicaters when connection is made direct to the exchange "earth," but a very much larger current is required when the central is not (if the term may be used) one of the "spheres of influence." Once the numbers of the fallen indicators have been ascertained, it is not a difficult matter to plot the positions of the telephones on the map, and thus find the whereabouts of the second "sphere of influence." It is possible there may be more than one faulty section, but the numbers of the telephones will soon show this. Where direct feeders are used and voltage pilot wires are laid down, these latter can be employed for localising faults; but as their number is generally far short of that of the telephones, this method can take only a secondary place. The method of using the pilot wires which the author would suggest is as follows: Assuming the fault to be on the negative, earth the negative 'bus bar at the works, and take the potential between the negative pole at any feeding point, by means of the negative pilot wires, and "earth" at the works. The feeding point having the least D.P. to earth, is the one nearest to the fault. A high-resistance voltmeter should be used, otherwise the resistance of

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the pilot wire has an appreciable effect. Should the fault be on the + pole, then that pole must be earthed.

Another method, which consists of the insertion of small fuses in the feeders, has given very good results, but it necessitates the use of a comparatively large current to earth, and also

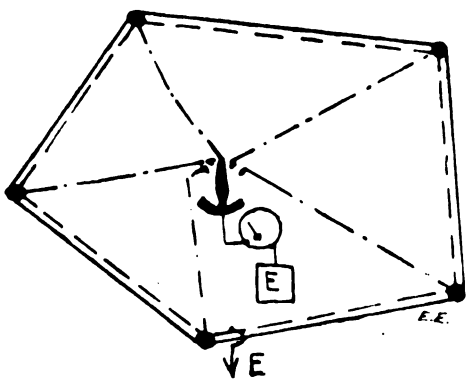

FIG. 1.

is applicable only where direct feeders are used. The *modus operandi* is as follows: Fuses are inserted at the time of light load between the 'bus bar and the feeders on the pole on which the fault exists of such a capacity that if two or three blow the remainder will safely carry the load. The insulated pole is temporarily connected to earth at the works, and the order in which the first two or three fuses melt is noted. The diagram (2) shows generally the scheme and the order in which the fuses would blow. Should any doubt exist as to the correctness of the order it is as well to repeat the test, but the writer has not at any time found this necessary.

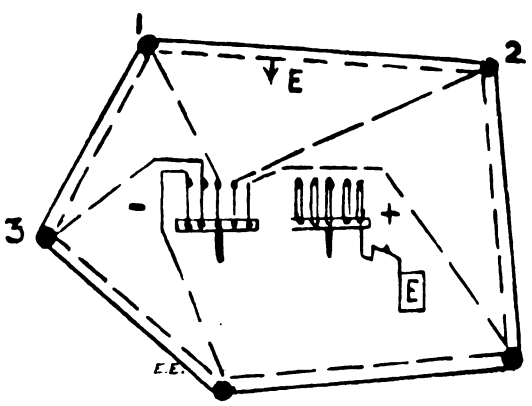

FIG. 2.

One other method, applicable only to continuous-current systems, deserves mentioning. It is, the writer believes, in use at Liverpool. Around each feeder is placed a small annealed iron ring, wound as shown in Fig. 3, the network being divided in such a way that a portion is fed separately by each feeder. It is quite clear that a steady current will have no effect upon the indicator, and therefore in testing for faults the insulated pole is intermittently connected to earth, and the throw of the needle on each feeder ascertained. It is said that with a leak as small as one ampere the throw is quite perceptible.

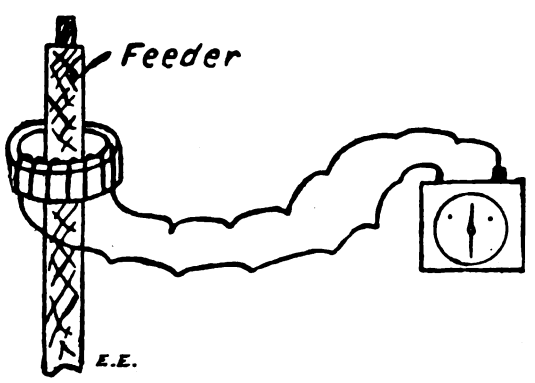

FIG. 3

A passing word may not be out of place as to the lamp-signal method (Fig. 4) generally in use for notifying the presence of a fault on the mains. Such a method is good when it has been adopted from the commencement, and care has been taken to remove immediately every fault which has developed. But even then there is considerable risk of faults developing slowly and simultaneously on both poles. Under these circumstances the apparatus is not reliable. What does it tell us? Simply that the potential difference to earth is equal on both sides of the mains, which, as far as insulation resistance

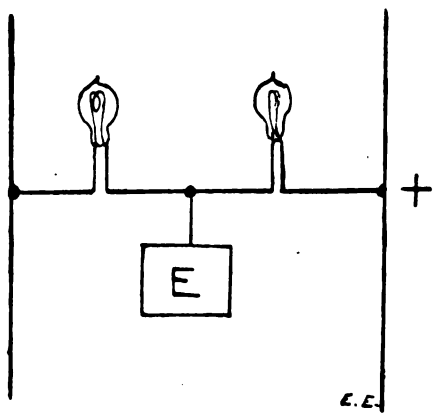

FIG. 4.

is concerned, means nothing. There might even be a short-circuit, but so long as the resistance to earth is the same on both poles, the lamps will be equally bright or dull.

Some time back the author designed an instrument, really a differential ammeter, for the purpose of finding the sections in which these small leaks were, and he was very much surprised at the number found, and of which no evidence existed at the works. Fig. 5 is a diagram showing the way this instrument is used. As will be seen, it is inserted in the network, and forms the feeder from the main network to the section

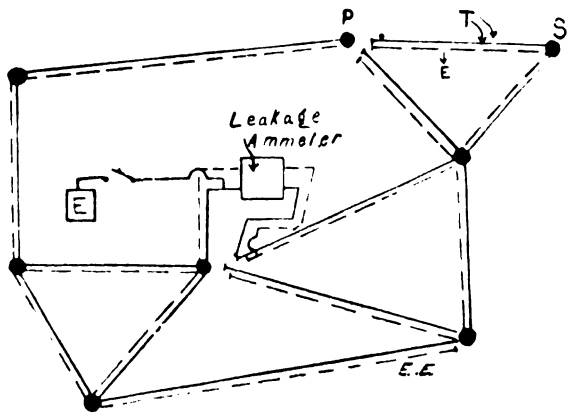

FIG. 5.

or district to which the fault has been localised by any of the methods previously described. It is essential that the whole of the current required for the isolated network should pass through the instrument. When the connections to the ammeter are completed, the faulty district should be separated, but not before. The main network is then temporarily earthed, and the deflection of the instrument needle noted. Should the leak be in the isolated district, the instrument will read the leakage current in amperes, but if not there will be no deflection, the reason being that all circuits, other than earth, are completed through the instrument, and therefore their algebraic sum is *nil*. Assuming that the fault has shown itself to be in the isolated network, connect the branch T (Fig. 5) to the main network at P, and then disconnect at S. Again earth the main network at E, no deflection will be obtained, showing that with removal of branch T the fault has been transferred to the main network, and that therefore the fault is in branch T. It will be seen that continuity of supply has been maintained throughout the whole time of test. The instrument was made to the writer's instructions by Mr. G. Alderton, of 45, Clifton-street, Brighton, and is now in use by the Brighton Corporation. It is a three-wire one, as will be seen by the number of leads, and has a carrying capacity in each conductor of 300 amperes, and a range of reading from three amperes to 100 amperes. Of course the range and carrying capacity can be varied to suit any requirements. It is applicable to alternating as well as continuous-current networks. Several methods of arriving at the location of a faulty branch in a network have now been shown, and the author must leave his readers to select the one which appears to suit the special local conditions to which they wish to apply it. Personally, he has a predilection in favour of the telephone signal system, following this up with the leakage ammeter.

Dealing now with faults on alternating high-tension feeders: an electrostatic voltmeter certainly appears to be the best and most serviceable fault indicator. To locate the feeder having

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the fault is not a difficult matter where entirely separate feeders on separate alternators are used. When alternators are paralleled on to a common 'bus bar, it is as well to parallel an additional machine on to the 'bus, then to connect this alternator by jack cords to the hospital terminals of any one circuit (most switchboards allow of this or similar connections being readily made), and finally, by disconnecting the extra machine from the 'bus bar, leave it supplying only the particular feeder required. The electrostatic voltmeter can then be applied, and if necessary the extra machine paralleled back again to the 'bus, and then withdrawn on another circuit. These complications apply only to systems in which separate feeders are used to supply independent networks, and when the engineer considers, as the author does, that continuity of supply is an important factor in the problem of commercial electric lighting. Where the feeders supply into a common network, they can of course be disconnected individually without stoppage of supply and tested by the ordinary methods. The tendency, however, at present, is towards the use of concentric or twin cables for high-tension feeders, and with either of these a fault means a short-circuit, and this is very promptly indicated by the fuses.

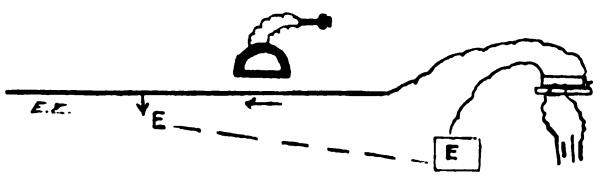

FIG. 6.

We now come to the crux of the whole problem. Given a length of main in which a fault (say an "earth") exists, by what method and in what manner shall we be able to accurately locate its position? The loop test offers a fairly good solution when the resistance of the conductor is high, but when dealing with low-resistance conductors (say with 50 yards of ·3 distributor having a resistance of ·00008 ohm per yard), it is well nigh impossible to accurately test its position—especially when we consider the conditions under which the test must be made are not conducive to superfine methods. So often has the loop test failed in practice that the author has been forced to abandon it, and seek a test more reliable.

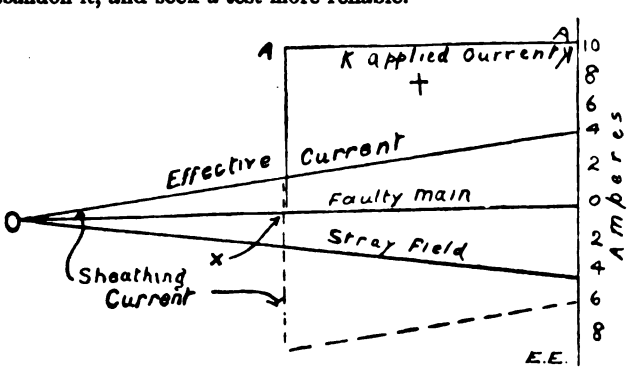

FIG. 7.

But before dealing with the method which the writer now adopts and recommends, mention will be made of one or two others which he has tried with varying success. The first of these non-resistance methods is the "telephone and induction coil," shown in Fig. 6; when the supply is alternating, the "induction coil" can be dispensed with and a connection made to the mains. This appears beautifully simple and reliable on paper, but unfortunately it has serious drawbacks. Theory—at least, laboratory theory—says "from induction coil to fault, hum; beyond, silence." You travel along the line of main, carefully tracking the cable with the search coil, and listening intently at the telephone receiver; presently, silence—the fault! no, only the telephone diaphragm jammed. You travel still further, and further, until you arrive at the end of faulty branch; but still that maddening hum continues with scarcely diminished vigour. This method might have been a good one before the days of metal-sheathed conductors, of conductors drawn in iron piping, of gas and water mains, and sundry other things; but these things do exist now, and consequently the method must take a back place. A little consideration will show us the reason of the continual hum, and consequent failure to locate the fault. Fig. 7 is a diagram of the currents and circuits obtained by this method—the applied current, A A, being taken at 10 amperes, 0 0 is the faulty main, X the fault. The cable is assumed to be either lead covered or drawn in iron piping. It is contrary to common sense and Ohm's law to expect that the applied current, when the point X is reached, would complete the circuit either entirely by the sheathing or entirely by stray earth—*i.e.*, by gas and water mains out of the search coil field.

(To be continued.)

THE MECHANICAL CONSTRUCTION OF ELECTRICAL MACHINERY.

BY F. M. WEYMOUTH.

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THE DYNAMO.

(Continued from page 84.)

NOTE.—The writer desires to call attention to the fact that owing to error in the designs shown in Figs. 237 to 239, these do not correctly represent the practice of Messrs. the India Rubber, Gutta Percha, and Telegraph Works Company, Limited. Bearings designed by this company will be shown on a later page.

Bearings.—A method of pouring melted white metal into a bearing with the shaft in place is illustrated for a simple case in Fig. 244. This is a plain, solid bearing, used merely

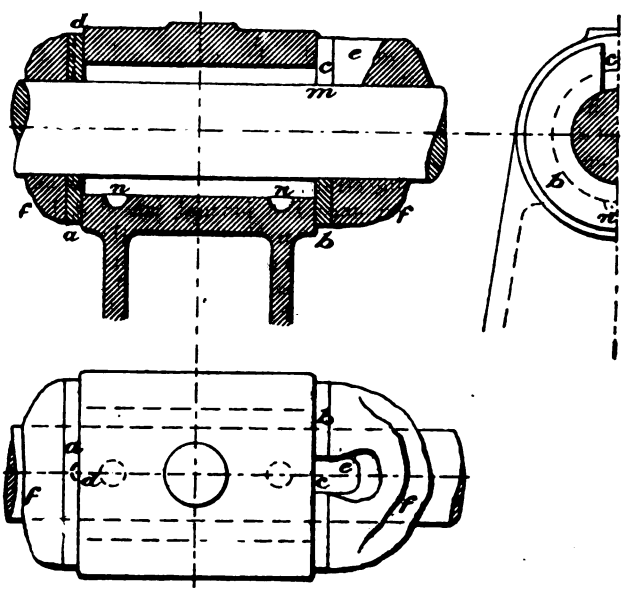

FIG. 244.

to carry the shaft without regard to end play. To prepare for the operation two wrought-iron or steel washers, *a* and *b*, are first made: these are bored to fit the shaft, and one of them is gapped as shown at *c*, and they are arranged one at each end of the bearing as also depicted. The washers are then kept in place by fireclay, *f f*, which latter, where adjacent to the gapped washer, is formed into a funnel or gate, *e*, for the purpose of running in the melted metal. It is necessary, however, that all the parts should be hot before pouring in the metal. They may thus be warmed up separately by a stove, or what other means may be convenient, before putting together: or else, having been put together with the shaft truly lined up and rigidly held in its correct position, the whole may be warmed up by hanging on lumps of hot iron. The heat attained should be about just too much to bear the hand on. A very necessary precaution is to oil the journal beforehand, as there may be trouble otherwise in removing it from the white metal after the latter has cooled and set. The inner sides of the washers may also be oiled. Though the bore of the bearing needs not for this reason to be oiled, yet a little within will not hurt. The bore must not be machined, as the original rough skin of the casting will afford a better hold for the white metal than a smooth surface. An additional precaution, however, already alluded to, for preventing any subsequent shifting of the lining is to cast hollows in the sides of the bore as at *n n*: the white metal pouring into these will form snugs. Everything thus being ready, all the parts hot, and the journal oiled, a final precaution just before running in the melted white metal is first to pour in a little additional oil.

Without this last precaution a "blow-up" is apt to occur. Such an eventuality is, of course, due to the fact that as the melted metal goes in, the air has to come out. The little oil at the last moment poured in, falling as it does just where the stream of white metal will fall, makes it

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additionally easy for the metal further to pursue its course inwards, by reduction of friction between itself and the top of the shaft, and it therefore enters the bearing at the point *m* from the bottom of the funnel, *e*, in a quickly-flowing stream which is also shallow, or thin in vertical dimension. Hence there is space above the stream for the air to come out. Otherwise, with the passage at *m* blocked by the metal entering, the enclosed air heated by the hot metal will expand, and thus blow out the metal at *m* and in *e*. It would seem, however, as though a vertical groove cut in the inner face of the washer, *a*, as shown dotted at *d d*, would form an efficient passage for the escape of air, and the metal forming in this as the bearing fills up could easily be subsequently chipped away.

After the operation, and when the metal is set, which may take about two minutes, all the parts should be dismounted, and the bearing pulled off the shaft. The shaft and the bearing will thus cool separately. Otherwise, if allowed to cool *en bloc*, there will be the risk, if not certainty, that the journal, being in the centre of the mass, will cool latest, and will still be warm after the cast iron has become comparatively cold. The cast-iron bearing will thus have become contracted while the shaft is yet expanded with its warmth. Between the two, therefore, the white metal will be squeezed to a thinness less than its proper dimension, which is assuming that the bearing does not crack under the bursting strain to which it will be exposed; and as a further consequence, the journal, when at length cool, will have then contracted in diameter, and so become a loose fit in the white metal instead of the proper working fit required. By allowing the parts thus to cool separately, they all contract freely, and so their mutual working fit will continue when cold.

The arrangement shown Fig. 244 is taken from actual practice. As stated, it shows only a simple case. It is sufficient, however, to illustrate and exemplify general precautions that need to be taken to ensure a successful result. With varying designs of bearing it may be necessary to think out and perhaps in some degree elaborate the methods to be pursued in detail, though this trouble would, of course, mostly occur only with first attempts. In the case of bearings having oil-catching hoods, the washers may be placed inside the hoods, though more especially when the white metal is to have flanged ends as was shown in Fig. 228, or plain butt ends as in Fig. 244. When dealing with cap bearings, wherewith the upper and lower halves of the lining must be separated by thin iron or steel plates, as was mentioned in connection with Fig. 240, the two halves should be fed by separate streams of molten metal, separated, that is, within the casting; as otherwise, when the metal is set, the cap may be held down by a solidified stream of metal inside, where it cannot be got at to cut it, unless special means for doing so have been provided. The flow of the two streams from one funnel outside would not create this difficulty, inasmuch as their union in the funnel can easily be severed.

The cost of this method in any particular case is to be set against that of boring the lining; though, of course, in all cases the metal has to be run in. With corrugations on the journal requiring annular grooves in the lining to fit them, the cost of boring would, of course, be much increased. But with the boring method there is the further subsequent trouble and expense of lining up and fixing the bearings on the bed-plate true with the shaft, which do not occur with this method under discussion, wherewith the shaft is simply fixed rigidly in its required position with the bearings bolted down, before pouring in the metal, and there is no further trouble as regards alignment.

We now approach the subject of "self-oiling" bearings. By this term is meant those kind of bearings which carry no lubricator: but they are provided in their design with a well or recess immediately below the journal, which is kept always full of oil. A chain round the journal, or more commonly, perhaps, a plain metallic ring of about one and a half times the diameter of the journal, hangs from the latter, so that its lower side dips into the oil. Thus, as the shaft rotates, the ring or chain always become wet, so to speak, with the oil, and so conveys it to the top of the journal. The oil is then retained so that it works through and lubricates the bearing, and, exuding from the ends, descends by oil-ways to the well once more. Another method is to add to the journal a collar of large diameter which dips into the oil, and, rotating at a high speed, flings the oil upwards, where it is caught in troughs or recesses at a level above the journal. Channels leading from such recesses conduct the oil then into the bearing, from which it also finds its way to the well again, as in the previous case. Not infrequently a gauge glass is added on the outside of the bearing, within which the oil rises so that the attendant can see at a glance the height of the oil within, and to some extent note its condition. At intervals the well will be drained by a tap supplied at the bottom for the purpose, and new or freshly filtered oil poured in at the top.

Advantages attending this method are that as much oil may pass through the bearing as it will take, being brought up by the ring or collar, which would be a quantity such as, if fed from an ordinary lubricator, would require constant attention for re-filling, or, indeed, would empty a lubricator in a few seconds. This will depend much on the oil-ways usually cut in the liner which conduct the oil to near the ends of the bearings. It will, of course, also depend on the number of rings used: in some designs there being only one, in others two, and in others three. The "self-oiler" thus admits of a free flow with but little attention. As regards speed, it is, of course, to be observed that the higher the speed the greater will be feed agreeable with the quicker passage also of the oil through the bearing.

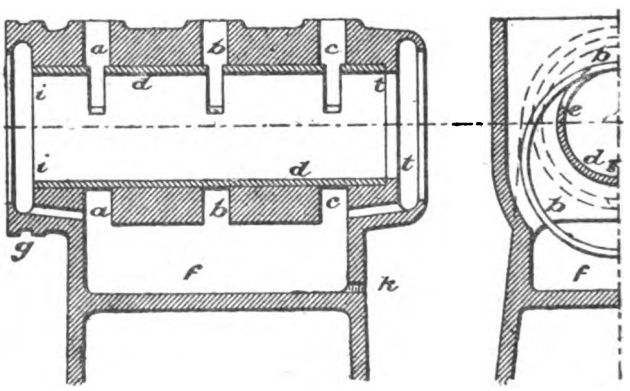

FIG. 245.

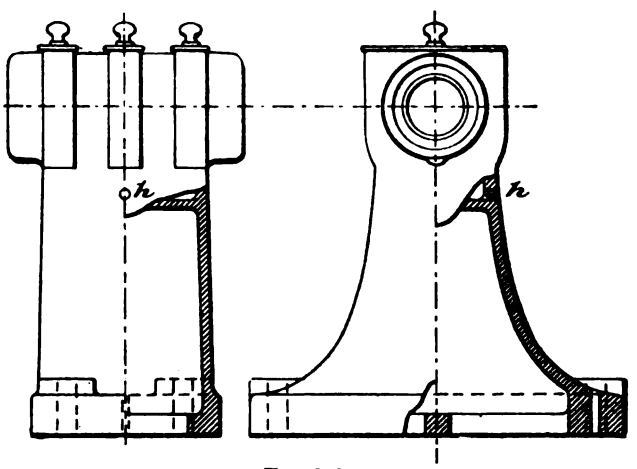

FIG. 246.

To consider now some special examples, we may commence with a design by Mr. Wilson Hartnell, of Leeds, to whose courtesy we are indebted for drawings and a photograph of which Figs. 245 and 246 are a reproduction. The former shows a longitudinal section and a half transverse section through the head of the bearing only: while the latter shows two outside views to a smaller scale, partly in section, of the whole of the same bearing. This design will be observed to be of the solid type, requiring to be slipped over the end of the shaft. It has three oiling rings, coming in the spaces *a*, *b*, *c*: the rings themselves are not shown in the longitudinal section, but one ring is visible at *b b* in the half transverse section. Their lower edges thus dip into the oil-well, *f*. A very noticeable feature in this design is the extreme lightness of the gunmetal bush or

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liner, *d d*, this being, in fact, no thicker than the ring, *b b*, which is, of course, a distinct economy in metal, besides that it conserves towards general compactness. It will be noted that while the shaft rotates round a centre at *r*, the ring will turn round a centre at *s*, and their speeds will be inversely proportionate to their diameters. The liner has to be gapped at three places on the top, as shown, to take the three rings; and a special feature to be noted is that the lower edges of it are cut so as to slope inwards, as represented at *e*. It will thus be seen that with the shaft and ring revolving in the direction of the arrow (Fig. 247), oil will always be retained at *e*; and similarly on the other side, with the shaft revolving in the opposite direction. For if instead the gap were made straight across with a file, or still worse, if the slope was in the opposite direction to that shown, as at *x* and *z* respectively in Fig. 247, the oil would not lodge, and would practically, indeed, be scraped off; and thus the efficacy of the method would be considerably diminished.

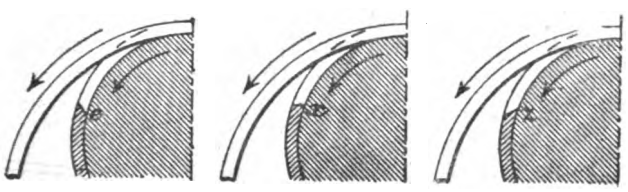

FIG. 247.

The bearing shown in Fig. 245 is for the commutator end, and the brush-carrying neck will be seen at *g*, and may be noted as being very similar to that depicted in Fig. 228. This neck alone distinguishes this bearing from that used at the pulley end, which latter is illustrated in Fig. 246, the dimensions and other particulars being the same for each.

To enable the rings to be got in, each space, *a*, *b*, *c*, is carried its full width to the top, as shown in the cross-section Fig. 245, where it is covered by a loose cap, as may be observed in Fig. 246. Oil can be poured in by removing either of these caps, and may then be drained off when necessary by a tap, which may be in the side, as at *h*, or at the end, as at *k*.

It will be noted that the shaft is steadied endways by these two bearings between them. For the liner being forced in at the one end is stopped by a lip, *t t*. Its other exposed end at *i i* can take against a shoulder on the shaft. The lower half of the casting, as will be seen, is of the inverted box type with the metal well placed, and the base spread across the width of the machine, so as to resist well the side pull of the belting or driving ropes.

MOTOR-STARTING SWITCHES.

With the growth of the uses of motors for domestic purposes, the need for a reliable starting switch has also grown. Such switches can be now obtained from almost all makers of electrical machinery. There are, however, other requirements besides those of being able to start a motor without damaging it that may at times be needed. Thus, if, say, a motor is running against a constant load and the supply fails for a few seconds, the motor will stop. If the switch is left on, the supply, when again put on, will find the motor dead on with no added resistance interposed to check the rush of current. In such a case the collecting gear is likely to be damaged, and, in large-size motors, it may be that the armature connections may also suffer before the rise of speed reduces the abnormal current. To guard against such defects, the Cutler-Hammer rheostats with automatic releasers were devised. These instruments, of which there are many types, are being supplied in England by the Sturtevant Engineering Company, of 75, Queen Victoria-street, E.C. We have chosen to illustrate two rheostats in which the automatic release is, so to speak, highly developed, as from them the simpler types can be readily understood. Thus, Fig. 1 shows a rheostat which in starting is used in the ordinary way. In the handle of the switch there is a coiled spring, which tends to keep the contact bar always in the off position. When the handle is put hard on, thus cutting all the resistance out, the iron keeper on the end of the handle bar comes against the poles of the upper electromagnet, and is held there. This magnet is wound with a fine-wire circuit connected in series with the shunt of the motor. Now, if the supply is discontinued, this magnet loses its attractive force and the

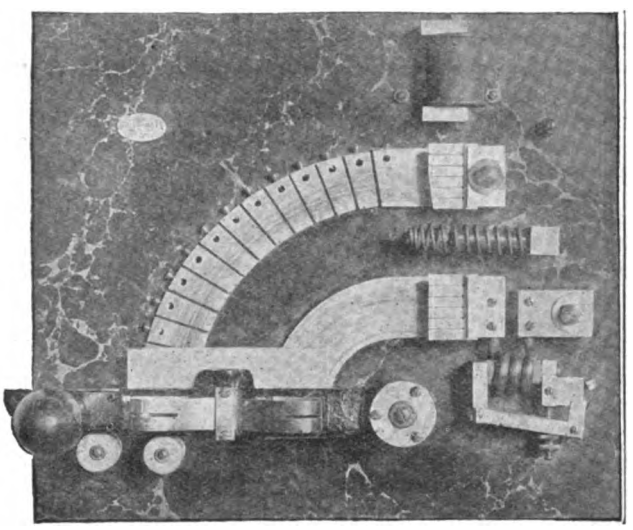

FIG. 1.—Motor-Starting Switch, with Automatic Release for Excess Currents or for Discontinued Supply.

switch flies back, giving the safety referred to above. Another fault will also release the switch, for if due to some accident the shunt-circuit of the motor is interrupted the release will also be effected, and the armature saved. The lower magnet is for excess current, and its armature acts by short-circuiting the upper magnet coil, if the current in the armature of the motor exceeds a certain definite limit. This limit can be fixed by altering the nuts on the screwed spindle, seen in the illustration, on which the armature of the magnet rests. The other features of the switch are the use of contact jaws for the "on" position, which give a large surface, and the throw-off spring, which helps the contact bar out of these jaws when the electromagnet gives the release. In the more simple, and hence cheaper, type, one electromagnet in the shunt circuit only is used.

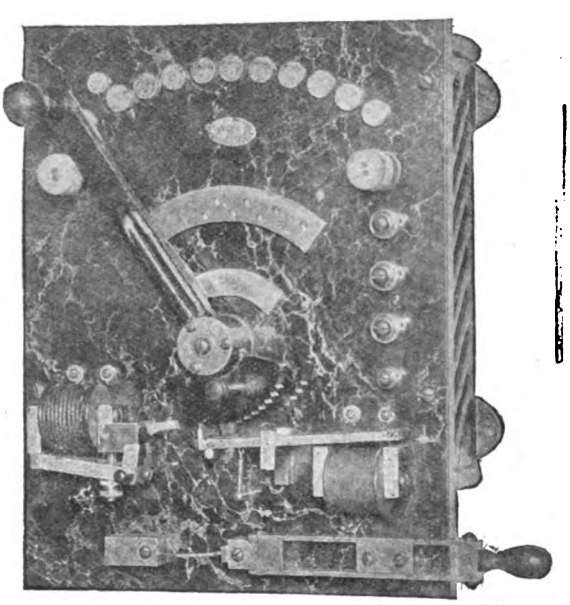

FIG. 2.—The Universal Rheostat to release from any position.

The next illustration, Fig. 2, is called the "Universal Starting-Box." This contains all the apparatus described above, but the magnets are arranged somewhat differently. This is to allow of the rheostat being used to regulate the speed of the motor, and to give the release from whatever position the contact handle may be left in. In addition to this, a main fuse and switch are also provided on the same base-plate. In all these instruments the resistance wire is placed at the back of the switch-gear.

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C Anonymous communications will not be noticed.*

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Vol. XVIII. of new series of "The Electrical Engineer" can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.

LEICESTER AND THE ELECTRIC LIGHT.

Two of our contemporaries have seen fit to write leading articles on the above subject, and have also seen fit under a cry of patriotism to condemn the action of the Electric Light Committee in ordering new alternators from abroad. The leader of the *Engineer* is particularly scathing in this respect, and says distinctly that "a machine which was not made in Great Britain was probably not worth making at all." This logical argument is followed by the writer, whose consistency and technical knowledge are equally good, alternately believing and disbelieving statements made by Alderman Lennard. Thus Alderman Lennard says "he had no fault to find with the existing dynamos;" hence we are led to infer that Alderman Lennard is right, although further up in the leader the town councillor has been referred to in far from complimentary terms. Again, afterwards we are told that Alderman Lennard's "patriotism is about level with his knowledge." We say distinctly that the writer of this twaddle knows nothing of the subject he is handling, and that both the articles in question were written without weighing the biassed information from which they were compiled. A brief review of the facts of the case, even if the facts are bitter ones, would be far more to the point, and these we propose to give briefly. Mr. Colson, when laying out his scheme for an electric lighting plant, visited Cologne and saw there some horizontal engines with flywheel alternators which, as a mechanical engineer, he preferred to quick-running engines. He was informed, and correctly informed, that these alternators worked well and worked in parallel, and he consequently asked for tenders for a similar type of plant. We believe that his action inaugurated this type in England, as the Portsmouth alternator design by Ferranti and Co. was first submitted to the Leicester Corporation. Since that date the idea of building the alternator up on the flywheel of the engine has been extensively used. We could from memory point out flywheel alternators made respectively by Ferranti, Siemens Bros. and Co., Johnson and Phillips, Fowler and Co., and others, which have given every satisfaction, showing that the type was a possible one. Mr. Colson can therefore be congratulated on having introduced a new type of machine which has found favour in the sight of English designers and consulting engineers. Unfortunately, the alternators at Leicester were not a success, and this is the disagreeable fact not referred to by our contemporaries. We remember that at the opening ceremony even the contractor fought shy of answering questions as to the parallel running of the machines. Hence, due, not to the lack of electrical efficiency, but of mechanical strength, it has been necessary to replace the alternators. Need we wonder if, in selecting the new type, the engineer has paid special attention to the question of mechanical strength. Perhaps, as the *Engineer* says, Mr. Colson may not be an electrician, but he is a most capable engineer, and his knowledge of the requirements of his station is certainly better than that of his critic. Of this no greater testimony than that

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of Mr. Mordey's could be deduced, in that the designer of the plant condemned is introducing into England the very type to be used to replace it. That Mr. Mordey is the original inventor of the inductor alternator is well known, but the fact remains that the Continental makers developed the type into a practical machine before he took the design up at all. Hence we do not think the committee at Leicester are to be blamed for giving the orders for their new alternators to a firm who has for several years manufactured the type they wanted. We are sorry that such a large order should go abroad, but we do not see how in the special case blame can be placed anywhere except on the contractors whose machinery had to be replaced. As regards our other contemporary, who also sets up Alderman Lennard as a technical expert, it commits itself only to the wise dictum that "in the design of the Leicester works some very grave errors must have been made." It would have been more fair to those responsible at Leicester if our contemporary, who has praised flywheel alternators elsewhere, had said at whose door the errors lay. It might also at the same time assure the Leicester ratepayers that their station was, with the exception of the error in question, one of the best alternate-current stations, as regarded the cost of production, in England. It might go further and say that for the forty thousand pounds spent they have more to show than any alternate-current station opened during the past few years. To return to the cry of patriotism, it is laziness, not patriotism, that causes the editor of the *Engineer* to hide his head in an inkpot and cry, "We are the people." If the Continental engineers have excelled in one branch of electrical machinery, let us learn of them, even as they took their first principles for the design of continuous-current dynamos from England.

REVIEWS.

Electric Railways and Tramways: Their Construction and Operation. By PHILIP DAWSON. Offices of *Engineering*, 35 and 36, Bedford-street, Strand, W.C.

Chapter IX. deals with speed regulators, and we are glad to notice the credit given to the late Mr. Anthony Reckenzaun in this department of traction work. The advantages of the series-parallel controller are most clearly shown by figures from actual experience, and some useful tables of results as to the starting and running power required by different cars on grades are also given. The figures showing the influence of the state of the track will be useful, as indicative that the cleansing of the rails must not be neglected. The chapter on car wiring and equipment deals with the various accessories other than the controller required on the car. The connections diagrams, when compared with the view of a set of made-up cables for connecting two motors and two controllers, show the advantage of preparing the wires in the shop. The information following on motor trucks is introduced by the statement that electric traction has revolutionised the construction of running gear. The cars used for horse or mule traction were often supported by single springs carried on the boxes. The first electric cars were constructed by bolting a motor on to the floor of a car body of this old type, and, as need hardly be mentioned, the result was not a success. The need of having all the mechanism independent of the car body was soon seen. The author lays down eight essential features to be observed in designing motor trucks, and then proceeds to describe with illustrations a number of the best forms now in use. Chapter XII. deals with the car bodies as distinct from the trucks. The author compares the practice of England and America in this department, and says that as a rule larger and heavier cars are used in America. We note, however, that in very few cases are double-decked cars used in America. Hence the seating capacity of English cars is higher per unit of weight or length. Some views of American cars, with crowds of people hanging on to every part and also seated on the roof, must raise the envy of our English directors of tramways. Fortunately on this side such dangerous practices are not allowed. The two following chapters deal with other details of electrical cars, such as the best type of wheel to use, the question of the brakes and braking power required, the guards for the wheels and for the front of the cars to mitigate the damage done when a foot-passenger is run down, sanding gear, trolley construction, etc.

We then come to Chapter XV., which commences the description of "the power-house." The section is opened by some useful tables for ascertaining the power required in maintaining a given schedule at a given speed with a certain length of track. The author recommends large units in the power-house as being best able to cope with the fluctuating load. Another important consideration is that of the flywheel energy to be provided by the engine. The author recommends that the engines should be designed to give their best efficiency at three-quarters of full load, and that large flywheels be added, which should be capable of dealing with momentary peaks in the load curve. The next item to the engines is naturally the dynamos, and in this department the author recommends multipolar machines as the best in every way. Illustrations of several of these machines are given, and many working drawings. These include the machines of the three large American firms, but none of any other make. The details and connections of switchboards are carefully gone into, and then follow some useful hints on the running of the plant. Having by some few pages on boilers and coal-handling gear, and also on the repairing shed, disposed of the various items of an electric tramway system, the author proceeds to describe a series of completed lines. In this branch of the book will be found a compilation of most useful facts and figures, and the illustrations do much to add interest to the engineer in reading it. We are glad to see that the English lines get a full share of attention. We then get a chapter on the combination of lighting and power plant as instanced by the works at Hamburg, Altona, and Rome. The three chapters following deal with the open conduit, surface contact, and storage battery systems respectively. These receive careful attention from the author, who says that, after all, it is the mechanical details in all these systems that makes or mars the scheme. This we endorse, and also his views as to the promise of success attending the Hanover system of combining accumulators with the trolley system. The last chapters of this book deal with the working of an electric traction plant after completion, and cover all the necessary ground, such as the question of accounts, management, and organisation of men. Statistics of working expenses on various lines are given in the last chapter. We must finally congratulate the author on the complete nature of his production.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

METER PATENTS.

We have been asked to insert the following correspondence between the Bradford town clerk and Messrs. Chamberlain and Hookham:

[COPY.]

"4, New Bartholomew-street, Birmingham,
"July 15th, 1897.

"DEAR SIR,—We are informed that you are using on your electrical circuits the Thomson-Houston meter. We are advised that such user is an infringement of our patent

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rights, and renders you liable to damages for the past and an injunction for the future.

"We should be glad to hear at your earliest convenience whether you admit this, and, if so, what arrangements you propose to make with us. On the other hand, if you are not prepared to admit our rights, we shall be obliged to appeal to a competent court.

"Please understand that we are exceedingly sorry to have to address you thus, but our duty to our shareholders compels us to vindicate the company's rights.

"Yours truly,

"For Chamberlain and Hookham, Limited,

(Signed) "ARTHUR CHAMBERLAIN,

"The Town Clerk, Bradford." "Director.

[COPY.]

"Town Clerk's Office, Bradford,

"July 17th, 1897.

"DEAR SIRS,—I duly received your letter of the 15th with reference to the use of Thomson-Houston meters. In reply, I can only refer you to the British Thomson-Houston Company, Limited.

"Yours faithfully,

(Signed) "FREDERICK STEVENS,

"Deputy Town Clerk.

"Messrs. Chamberlain and Hookham,

"Limited, Birmingham."

[COPY.]

"4, New Bartholomew-street, Birmingham,

"July 20th, 1897.

"DEAR SIR,—We have your favour of the 17th, and note that in answer to our complaint you refer us to the British Thomson-Houston Company to justify you for using on your circuits their meters.

"In reply, we beg leave to say that we are exceedingly sorry if we cause you any inconvenience, but the legal position requires that we should deal with you direct, and we have therefore instructed our solicitors to ask you to be kind enough to accept service yourselves of a writ in this matter. "Yours truly,

"For Chamberlain and Hookham, Limited,

(Signed) "ARTHUR CHAMBERLAIN,

"The Town Clerk, Bradford." "Director.

THE TRAMWAYS INSTITUTE OF GREAT BRITAIN.

The annual general meeting of this institute was held at the Frascati Restaurant yesterday, the chair being taken at 11 o'clock by Mr. John Fell, J.P., the president of the institution.

In opening the proceedings, the CHAIRMAN made a brief statement as to the work of the past year, which he characterised as in every way satisfactory. The only point with which some discontent might be felt was that the balance-sheet showed a deficit of about £80 for the year's working. This was clearly proved to be due to the increased number of *Journals* printed and circulated. The council adopted the policy of increasing the influence of the society by circulating the *Journal* amongst all municipal men. Thus a copy had been sent to every mayor and district council chairman, as well as to every town clerk and borough engineer. They had also endeavoured to extend the influence by other means, and had amended their articles of association so that the officials of a municipal tramway could become members. They now proposed to increase the council from nine members to 15, and he hoped that representative men would be selected.

The election of officers for the following year was then proceeded with, and the following gentlemen duly elected:

President.—Mr. John Fell, J.P.

Vice-Presidents.—Messrs. J. Carruthers Wain, W. Turton, R. Whittaker (Mayor of Oldham), and W. Mason.

Council.—Messrs. J. Waugh, J. Coomer, W. Stansfield, Graham Harris, J. H. W. Rosenthal, J. E. Waller, E. Pritchard, T. Parker, S. Sellon, and E. Garcke.

Mr. FELL, in thanking those present for re-electing him, said that he had pleasure in again accepting office, although he held that a new president each year gave more life to a society. He hoped next year to come to the general meeting with a good report of work done and with a financial balance on the right side. He hoped that the institute would be able to help forward the tramway interests and the interests of the travelling public, and thought a tramway company was too often treated by the local authorities as a milch cow. He thought, however, that the new Light Railways Act would change that view of their position.

The following paper was then read:

Light Railways.

BY STEPHEN SELLON, A.M.I.C.E.

Reading a paper to the members of this institution, amongst whom the author can count so many friends, on the subject of tramways and light railways, is an agreeable task. You may also be sure that so far as the knowledge of the author can carry him, it has been carefully considered; as he is aware he is dealing with a subject with which most of you in this room are familiar, and as he believes the best compliment that can be paid to a paper, and the basis on which it should be valued, is by the discussion invoked. The author is therefore anxious that you should not spare him, so long as your president will assure him he will not meet such total dismemberment as will unfit him for a prompt exit if necessary.

It is said of an Oxford undergraduate, who, for the purposes of his examination had applied his whole powers to the enunciation of the binomial theorem, was horrified to find in his paper no question relating to this subject. With visions of failure in front of him, he again carefully read through the examination paper, and finding the question, "Explain the working of the common pump," he recklessly seized on this, and begun his paper thus: "Before you can properly understand the working of the common pump, it is necessary you should be first thoroughly acquainted with the binomial theorem," and he promptly proceeded to enunciate the same. Having only concluded this when the time was up, he left a note, saying he regretted that time prevented him from pointing out its application.

I have been carefully examining for the last fortnight the agenda of your secretary. I have also made an attempt to bribe him, and have discreetly sounded his views on this point, but I find he is either too respectable or that his price is too high for me. My plot was to get in a lunch somehow before this paper, and then, like the Oxford undergraduate, I could have shown you easily that before you can properly understand the working of tramways or light railways it is necessary you should first have an intimate knowledge of good gastronomy; and I had hoped that the proposed visit to the Waterloo and City Railway at 2.30 would have spared me the necessity of showing the application, but I was informed in that coarse and brutal *vox humana* tone of the secretary, "No light railways, no lunch."

Through the courtesy of the Board of Trade in 1894, your late president and myself were permitted to take our seats amongst Gog and Magog, and we listened whilst statesmen and railway magnates tried to define the words "light railways"; and as they failed I do not intend to try, beyond expressing my opinion that our American cousins in the words "street railways" adopt a nomenclature which requires no definition.

For the purpose of this paper I include, under the head of "light railways," any railway or tramway in a street or road. You are all familiar with the word "tramway," and have tasted the sweets of the 1870 Tramway Act, an Act as insulting to the intelligent mind as it is unjust to the investor. But if this can be said of the 1870 Act, what shall I say of the Tramway Act, 1897? Not heard of it! Oh, yes, you have. I refer to the Tramways Act, 1870, plus all the numerous protective and insolent clauses demanded at the present day by town clerks under the advice of their parliamentary agents, who crowd in penalties upon penalties

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on the top of conditions which, if it does not ruin the undertaking, goes far towards making the words in the preamble of the Bill a mockery—namely, "that the same will be for the public benefit." It is quite time that one should be bold enough to speak out and say that capitalists will prefer in the future to spend money, if it has to be spent, in sweeping away from private Bill legislation the touting parliamentary agents rather than pay their costs. We all know them—by their clauses do we know them—the same stereotyped form so excellently considered that they are perfectly suitable for either the urban, suburban, or rural line, and adaptable for all conditions of traffic. What more proper parliamentary enquiry could be held than on these parliamentary agents who advertise themselves and say: "Retain my services, all ye that want to oppose, and I will show you how to do it; and the promoters shall pay our expenses." If the 1870 Tramway Act is unjust, it is the agent on the one side, and the irresponsible promoter on the other, that have made it so. "Get an order—workable if you can, but get it," is the motto of the latter.

To those among my audience who have not of late years had much to do with the promotion of tramways, it may be interesting to them to know that in addition to the conditions of the Tramway Act, 1870, wayleaves are now generally demanded; a percentage of the profits after payment of a certain dividend; an extra width of road to be paved; the engineer's specification to be supplied to the borough engineer, who is to be paid by the promoters to see that the former does not vary from it; abolishment of the arbitration of the Board of Trade; and although the promoters have to maintain their permanent way, the materials to be to the approval of the borough engineers.

A case has lately come under my notice in respect to a small tramway I am constructing under a set of clauses which are issued by some parliamentary agents of the name of Baker, Lees, and Postlewaite, as proper protective clauses for a corporation, in addition to the clauses in the Tramway Act. The borough engineer now has a resident, who is paid by the promoters. Everything has to be done to his orders, though no responsibility is incurred by him. Approximate levels are given to work to, but are not guaranteed as correct. The paving has to be made to a template, and a variation in regularity of surface of more than $\frac{1}{8}$in. is condemned. Hardwood paving to be laid opposite all churches and chapels, and 50 yards on each side; and it is considered the proper thing to float the granite paving after laying with $\frac{1}{2}$in. of asphalte and finish off with granite screenings, and this construction is considered reasonable for a small town of 40,000 inhabitants, having at the present moment macadamised roads. This is only an illustration of the public-spirited way in which the promoter is met, and of the senseless demands of some borough surveyors.

With these remarks the author passes with much pleasure out of the world of Bumbledom to the consideration of the Light Railway Act, and what it may do to improve the present position, for it is now established that an urban tramway comes within the scope of the Light Railway Commissioners. In the first place, the once all-important frontager has disappeared. The mode of procedure is economical, and is much facilitated by the local enquiry. Consents are not necessary before the enquiry, thus sweeping aside the blackmail and private agreements of the past to obtain them. Clauses are considered by the Commissioners, and adjusted by them in case of dispute between the parties. There is no purchase clause, this being a matter of agreement if demanded.

It may be interesting to my hearers to know that so far the author has arranged for purchase at the end of 35 years on a valuation as a going concern. The settlement of the first draft order was of some difficulty, but having four schemes in the first session different parliamentary agents and counsel were consulted by the author, and the result was a model order which might be well followed by others.

The author hopes he will be forgiven if, at this stage of his paper, he points out what immense service to the tramway interests it would have been had there been at that period a strong representative tramway organisation which could, in the interests of the industry, have appointed a committee of tramway experts to assist in drawing up a model order as a guide for all; such concerted action would have been gladly hailed by promoters, and all clauses and demands from local authorities and others would have been submitted to the committee before acceptance or otherwise.

It is the author's view that the apathy on the part of the tramway industry in guarding their interests in the past is responsible for many of their difficulties in the present; and it is possible, should this continue, that the Light Railway Act may become as useless a piece of legislation as the 1870 Tramway Act. Look at the railway companies, what a power they are in this country; the reason is solely due to organisation, and though they have many conflicting interests, which tramways have not, they guard their general interests, and therefore those of their shareholders, sinking their petty differences and leaving matters of principle to the judgment of the Railways Association. Then look at the Tramways Institute, and you find it gallantly struggling against odds because it appears impossible to make the average tramway director understand the advantages of combination.

Your secretary can tell you more accurately than I can how much of the £15,000,000 invested capital in tramways is represented by your institute; but perhaps the best object-lesson you can have to prove how far my views are correct would be not only to know the capital of each tramway company attached, but how much the directors put aside annually for the funds of the institute, and how much the treasurer has at his disposal for the protection of their common interests if required. The author has travelled over a wide ground purposely. He has, he hopes, without offence, assumed a somewhat dogmatic tone in the sincere hope that such a discussion may be raised as will convince those that are at the helm of the industry that it is wiser to steer through the deep water of unity and security than over the shoals of division and danger.

DISCUSSION.

Mr. Alfred Dickenson was asked to open the discussion. He said that he was sorry Mr. Sellon had met with an accident which had hampered him in writing the paper, as he did not think the present production did him credit. There was, in Mr. Dickenson's opinion, too much introduction, and not enough about the real subject of the paper. Again, he deprecated Mr. Sellon's condemnatory remarks about the borough engineers, as from personal experience he had found them reasonable and easy to get on with. No doubt some local authorities had acted in a somewhat arbitrary manner, but, as a whole, he considered them to be as just as they could be. He favoured rather a policy of conciliation than that of the active opposition of the author.

Mr. R Whittaker said he had interests on both sides, as he was a director of the Southport tramways and Mayor of Oldham. He considered that in dealing with borough surveyors great tact was needed. All men were liable to make errors of judgment at times, and it was not well for the tramway company to rake up any such faults against a borough surveyor. If certain matters pressed a company very hardly, the committee of town councillors should be approached. Thus although they had suffered some hardships at Southport under the 1870 Tramway Act, they had got a new lease on as favourable terms as possible. In his second position as Mayor of Oldham, he had had to advise on tramway companies, and even, remembering his experience at Southport, had had at times to check the demands of strangers wishing to get powers to run tramways in the town.

Mr. Platt asked the author for definite information as to how far new tramways could be passed under the Light Railways Act to the neglect of the 1870 Tramways Act.

Mr. Sturgeon did not think the rough-and-ready way of dealing with the opposition proposed by Mr. Sellon was good.

Mr. Pogson (Huddersfield) said that the borough engineer was certainly the most important man the tramway people had to do do with. The municipal tramways under his charge were a distinct department, and from experience he would say that no difficulties need arise where the borough engineer was a reasonable man and was approached in a proper manner. He, however, thought 21 years too short a time to yield a fair return on the capital expended, and should be sorry to have to manage a line on that basis.

The **President** here interposed to ask the members to widen the basis of their remarks beyond the action of certain borough engineers to the real subject of the paper. He thought that all those gentlemen acting for the towns should be made responsible for the instructions they gave to the tramway officials. Thus, in one place, he had been directed to lay wood blocks in such a way that, as pointed out, there was no room for expansion. When this occurred the whole of the kerbing was upset, and the borough engineer denied all liability. Another case of arbitrary treatment by the Council at Worcester was that in 1893 the Corporation decided to do the repairs to the roads, and the tramway company

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to pay £100 per annum for the relief so granted. They had, however, to pay a large sum down to put the roads into good order to start with. Now, suddenly the agreement had been terminated, and they wished to again transfer the repairing to the company without first making the necessary repairs. He hoped that the model order referred to by the author would be drawn up for the benefit of all members of the institution.

Mr. J. Carruthers Wain then proceeded to obey the president, and widened the basis of the discussion by explaining how he and the author were the joint authors of the Light Railways Act. He gave many instances of the need for the joint efforts in this respect, but modestly asked the meeting to be thankful to Mr. Sellon for what had been passed. The Light Railways Commission had distinctly decided that suburban tramways did now come under the Light Railways Act. Perhaps the greatest advantage of the new procedure was the abolishment of the right of the single frontager, who under the 1870 Act was a great nuisance. About 300 miles of line had already been sanctioned under the new Act, and notices of some 300 more miles were already posted. He contrasted the progress made in light railway work on the Continent, and hoped that in spite of the opposition of the railway companies good progress would be made in Great Britain. As regarded the best method of procedure when dealing with obstinate authorities, he advised, perhaps, a middle course. Cardinal Richelieu had said. "First try all your power to conciliate, but failing that, use all your powers to crush." Mr. Sellon had evidently been exasperated past the conciliatory mood.

Mr. Bradley (Wolverhampton) said he spoke as a representative of the borough engineers. He would suggest that after the model order had been carefully drawn up, it should be submitted to the Association of Municipal Engineers for their comment, so that, if possible, a general agreement on most points might be obtained.

The **President** said this should be done as it was the intention of the council even before Mr. Bradley had spoken.

Mr. S. Sellon, in reply, said he was glad to hear that Mr. Dickenson had no trouble when dealing with the authorities, and wished he would communicate to the meeting his method of obtaining such satisfactory results. Of course, a large number of engineers of towns were reasonable men, but the odd ones were most unreasonable. He had passed four different schemes under the powers of the Light Railways Act this last session, of which the one for Crewe was for a tramway right through the town. In this case the London and North-Western Railway had objected to it being treated as a light railway, but the Commissioners had replied that they were quite capable of dealing with the matter. Again, at Wolverhampton they had opposition from the Corporation, but only on the question of what was to be the charge for the electric energy supplied. He then instanced difficulties he had experienced from the treatment of engineers who declined responsibility for information they gave and whose demands called for wholly unwarranted expenditure. He asked the members to seriously consider the question as to whether the institute should not have greater financial support. As it was at present, they stood a great risk of a company in want of funds allowing actions to be decided against them, which decisions would be used as precedents afterwards. He urged that an industry which every year carried half as many passengers as the railways do should have a powerful organisation which could take up matters of common interest.

After this, a few desultory remarks were made as to the cost of procedure under the new Act. **Mr. Dickenson** said the cost was greater and the results less satisfactory than under the 1870 Act. This was due to the cost of getting counsel to attend the enquiries held in the country, and to evidence being sprung on the promoters at the last moment.

Mr. Sellon said he had got four orders through, and never in either case had had counsel, although counsel were retained against him. His experience as to cost was exactly opposite to that of the last speaker.

The usual votes of thanks terminated the proceedings, and after lunch the members were shown over the works of the Waterloo and City Railway by Mr. Graham Harris.

TRAMWAY HAULAGE.*

BY E. J. SILCOCK, A.M.I.C.E., F.G.S., BOROUGH ENGINEER, KING'S LYNN.

The question of establishing or rearranging tramways has recently been before several municipalities in this country, and the present therefore seems an opportune time for the Association of Municipal Engineers to discuss the relative merits and demerits of the various systems of tramway haulage now in the field. Until a few years ago only two systems of haulage were in practical operation—viz., by means of horses and steam-engines—but these alternatives were first increased by the cable system, and more recently by compressed-air motors, oil-engines, gas-engines, and electric motors, the electricity being either carried in the car in accumulators or conveyed to it by an overhead or an underground conductor. It will be therefore seen that the engineer of to-day has a much more complicated question to deal with than he had some years ago, and the object of the present paper is to bring out the points which must be considered in order to enable him to select the best system for any particular case.

With regard to horse and steam traction, it may be said at once that their defects are great, otherwise there would not be so many competitors endeavouring to oust them from the position they once held. Independently of the question of cost, it is pretty clear that the days of both these systems are numbered. At the present time, when cruelty to animals of all sorts is so strongly condemned, it seems an anomaly that horses should be allowed to be used for the purpose of pulling tramcars on heavy gradients, and therefore sentiment alone is sufficient to prevent the system from continuing in vogue for many years longer. In addition to this, horses occupy, wear, obstruct, and foul the streets, and the speed which can be attained by horse-cars is so low, and the saving of time over walking is so small, that there is very little inducement to the public to patronise horse-cars. Further than this, it is impossible to keep a sufficient reserve of horses to deal with the traffic of special occasions, and the number of workmen employed is so large that this system is more liable to suffer from strikes than any other. The steam-engine, too, has a bad reputation: it occupies as much space on the road as horses; it wears the rails by an extra set of wheels travelling over them, carrying a load of about 15 tons; and its steam, smoke, smell, dust, and noise together form a great nuisance, not only to the passengers, but even in a greater degree to other persons using the roads and living in the houses abutting on them; and from an æsthetic point of view, this system is probably more objectionable than any other, for of all the vehicles in common use a steam tram-engine probably carries the palm for ugliness. Taken altogether, therefore, steam traction will be condemned whenever any other form of mechanical traction is available—excepting possibly the gas-engine, which is very near akin.

Of the systems already enumerated, the oil-engine, gas-engine, and compressed-air engine have been put on the market, and the makers have claimed that they are practicable, but, so far as the author is aware, none of these systems have yet been adopted in any town in England for regular everyday work for any length of time. The only oil-engine yet introduced is the "Connelly" oil-motor. An engine on this principle was run for a short time in South London to Deptford. The engine was a separate vehicle from the car, and as the oil used gave off an offensive smell, it met with no encouragement, and it has since been converted into a gas-engine. The weight of this engine to draw a car carrying 40 people at eight miles an hour is said to be about six tons. The objections to this system are the double wear on rails, due to a separate engine; the noise of the machinery, which counts against this system equally with all systems involving locomotive engines; the space occupied in the street by the separate engine; and the fumes from the gas. Another gas-engine on the market is known as the "Lührig." This engine was run experimentally for some time at Croydon, and there is a complete installation of this system at Dessau in Germany, where there are nine gas-motor cars on a tramway 2¾ miles long. These motors are combined with the passenger cars, so that there is only one vehicle; and the gas is stored in the body of the car at such a pressure as will run the car two double journeys, or 11 miles. The car weighs six tons empty, and when loaded with a full complement of 27 passengers, driver and conductor, it weighs 7½ tons. The gradients on the line are easy, and only a 7-h.p. engine is required. There are two gas-cars on this principle running on a line between Blackpool and Lytham. The cars weigh seven tons, and carry 40 passengers. They cost £750 each. The gas is stored at 150lb. pressure. The route is a fairly level one, and the motors in this case, as at Dessau, are of 7 h.p. This form of gas-driven engine is not so objectionable as the "Connelly," on account of its being a combined motorcar; but the noise and the smell of gas fumes are still present, and the cars run unsteadily.

Compressed-air motors have been tried, but hitherto the success attained by this system has not been very great. The first tramway engine propelled by compressed air in this country was built by Messrs. Hughes and Lancaster, the car and motor being combined in one vehicle. The air was compressed to a pressure of about 170lb. per square inch, and at that pressure it is impracticable to provide sufficient storage room on a motorcar to propel the car for any great distance. To obviate this difficulty an iron pipe was laid along the tram route, and this main was kept charged with air at working pressure. The reservoirs of the car were then replenished from time to time as required, and much ingenuity was displayed in devising automatic arrangements for making the connection between the reservoirs and the air-main. It was expected that the charging could be accomplished in one minute, and, as the operation was to be carried out at regular stopping points, this would involve no loss of time. This motorcar was publicly tried by Prof. Unwin at Chester, and his report was of a favourable nature, but in spite of this the system has not been developed in England. Probably this is

* Paper read before the annual meeting of the Incorporated Association of Municipal and County Engineers.

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due to financial considerations, as it appears probable that power supplied by compressed air could not compete for price with horse or steam haulage. The compressed-air system without a charging main is in operation at Nantes, with a working pressure of 450lb. per square inch. The weight of the car and motor in this case is nine tons when loaded. Compressed air is also in use on a line from Paris to Nogent-sur-Marne, with extreme high pressures, varying from 660lb. to 1,175lb. per square inch. These high pressures necessarily involve trouble with the formation of ice in the valves, ports, and passages of the engines, and in order to overcome this difficulty, the air has to be superheated at considerable expense. The large and heavy reservoirs required with this system and the heating arrangements and other apparatus bring the weight of the motorcar when empty to 15 tons, and when loaded to 18 tons. The wheel base of these cars is very short, and this produces a see-saw rocking motion, which is very destructive to the rails and unpleasant to passengers. A newer system of compressed-air propulsion, designed by M. Conte, is in operation at Vienna. This system has a charging main, as in the case of the Hughes and Lancaster cars tried at Chester, but the method of making connection between the air-reservoirs and the air-main is different. The pressure used is about 300lb. per square inch.

The ultimate success of any system of tramway haulage by means of compressed air appears to the author to be extremely problematical. The well-known inherent defect in such a system, due to the loss of power by loss of heat in compression, is certain to militate against any system using air as its motive power. This loss of heat increases at a very rapid ratio after the air has been compressed beyond three and four atmospheres, so that there must be a very substantial loss of power when working to such pressures as 1,000lb. per square inch or over. One is therefore on the horns of a dilemma; either the car must carry a large supply of air at high pressure, with a consequent large loss of power through loss of heat, or the power must be distributed along the route by means of pipes charged to a lower pressure; and this method of power distribution has been proved to be a failure by the experience of the Birmingham Compressed-Air Power Company. It would, therefore, appear that there are not great hopes of making a compressed-air motor commercially successful. This is to be regretted, as the absence of all smell from the products of combustion, present in all other forms of heat engines, is a very encouraging feature in the application of air to motorcars.

Turning now to the cable system of traction, we find nearly all the objections which have been urged against the motors already considered have disappeared, and practically a new set of conditions obtain. The weight of the cars is less than on any other system, as there is no machinery of any kind to be carried; there is, therefore, less wear and tear on the rails, due to dead-weight, than on any system, and, more important still, there is no grinding action between the wheels and rails, to propel the car, or to check its speed in descending steep gradients. This system is especially applicable where severe gradients are encountered, and it has been found in practice that any gradient can be negotiated without difficulty by a cable tram. There is very little noise on the road, such as is given by the hum of a motor or the rattle of gearing. A large number of extra cars can be put on to meet special traffic at a very slightly increased cost. As compared with overhead electric haulage, it has the further advantages of having no poles and overhead wires, and there is no danger from falling wires. And, as compared with any electric system, it scores on the ground of having no sparking at motor brushes or car wheels. The disadvantages of the cable system are, that the cable has to be hauled whatever the amount of traffic may be, and this forms a large proportion of the power required when few cars are running; it follows, therefore, that a quick service and large traffic are necessary for economical working. The cable system involves a central rail with slot, and this is a very strong objection, as it means, practically, that the portion of the road occupied by the tramway track is, to a large extent, useless for ordinary traffic. The inconvenience caused by a broken cable is very considerable, as it generally necessitates taking up part of the track; and in any case, if the cable becomes blocked or broken, the whole of the tramway traffic on the route is entirely suspended, and it is even necessary to use horse traction to take the cars to the depôt. This is a strong objection to the cable system. As affecting the cost, it may be mentioned that the hauling station must be placed near the route, and if the system to be worked is a radiating one—*i.e.*, one on which the roads radiate from the centre of a town—the hauling station must be placed near the centre of the system, and this usually entails the establishment of large works on a very expensive site, and one which has not the facilities of water for condensing purposes and easy coal delivery, to say nothing of the nuisance which may be created by smoke, noise, and vibration.

Electric traction, hitherto, has been mostly developed in the direction of overhead conductors. The accumulator system, although, perhaps, the most ideal method of applying electric energy, has not attained any great degree of success, chiefly owing to defects in the accumulators. These include nuisance to passengers from the escape of fumes and the spilling of acid solutions; the loss of power due to double conversion of the power from the dynamos into the batteries, and from the batteries to the electric motors; buckling of battery plates and short-circuiting due to the great variations in the rate of discharge and the mechanical strain on the plates caused by the vibration of the cars when running; great weight of accumulators to be carried; and inconvenience caused by cars having to be taken to the depôts to have accumulators replaced by fully-charged ones. The conduit electric system has the advantage over the accumulator system on nearly all the points previously named, but it is objected to on the following grounds: the slot in one rail is liable to cause accidents to cyclists, and by horses' shoes catching in it; the slot is liable to become filled with dust, mud, and snow, especially when situated in exposed positions, as at the sea-front at Blackpool; the liability of leakage of electricity in the bare underground conductors; liability of stoppage of cars by short-circuiting, due to some metal or other conductor falling through the slot on to the underground conductor; and the inconvenience caused by the breaking open of streets to effect repairs to the electrical portion of the track. The Westinghouse underground system gets over most of the above objections to the conduit system, except the last named, of breaking up the streets. Contact, in this case, between the underground conductor and the motor of the car is made through a sliding bar as it passes over a series of bosses placed along the centre of the track, and these bosses are automatically put in circuit with the underground conductor by the car as it approaches, and automatically put out of circuit after it passes them. This system promises to give good results, and has achieved a certain amount of success in America and Paris; but, so far as the author is aware, it has not yet had a practical trial in this country.

The overhead electric, as already stated, has been the most successful of the methods of applying electric power to tramway haulage; and, taken all round, it undoubtedly meets the requirements of a tramway service more than any other. The chief objection to the system is the unsightliness of the overhead wires, which no doubt at first sight do offend the eye; but this is one of the many things met with in large towns, which, although ugly, soon become unnoticeable by reason of their great utility. This objection was largely accentuated by the method adopted in the early examples erected in this country of having the trolley wire carried by span wires running from one side of the street to the other, and these were especially objectionable at curves in the track, where they formed a perfect network overhead. The feeder wires, too, were carried above ground on poles along the side of the track, and they, being heavy insulated cables, were very noticeable. The form of construction now in vogue of putting the feeder wires underground, and carrying the trolley wires on the projecting arms of poles placed along the centre of wide streets or the kerb of narrow ones, has reduced the overhead work to a minimum, and the ornamental character of the poles and brackets has rendered them no more objectionable than ordinary arc lamp-posts. Exception is also taken to the overhead system on the ground of danger from falling wires, but this has been largely exaggerated, and in practice it has been found that there need be no apprehensions on this score. As a set-off against these two objections, there are many points in favour of this system. On the score of first cost it has the advantage of a saving to the extent of £3,350 per mile of single line over the underground conduit. As against other than electric systems it has no central slot to obstruct the streets. A very small proportion of the total current generated is absorbed in transmission. The cars can be run at varying speeds, so avoiding ordinary vehicular traffic, making up for lost time, and giving a quick service on suburban parts of the routes, and they can be moved backward if required. The power station can be placed at any moderate distance from the centre of the route without appreciable loss of power, thus giving the choice of cheap and convenient sites and the possibility of utilising power from refuse destructors. The cars can be lighted by electricity, which is a feature much appreciated by passengers. The weight of the cars is less than in any other system, except the cable car. It is a system which readily lends itself to extensions, and it probably has a greater field for improvements in economy of working than cable traction. Considerable improvement has already been effected in the efficiency of electrically-driven cars on which two motors are used by the adoption of the series-parallel controller, which has for its object the reduction of the large momentary current when a car is started. This device reduces the momentary maximum current by about 30 per cent., and the saving thus effected is important in two directions, as it allows the central generating plant to be run at a more uniform output, and, therefore, with increased economy, and it increases the number of cars which can be run by any given plant. A further source of improvement on large systems will probably

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result from the use of accumulator sub-stations. These have been adopted at Hartlepool, and so far have been very successful; and it appears probable that a variable connecting gear between the motors and car wheels, permitting of a variable ratio between the speeds of the armature spindle and car axle, may be the means of further reducing the excessive variations of current in starting and ascending steep gradients. There is a further field for improvement in the adoption of three-phase currents, and this method is on its trial in America.

In the present state of development of tramway haulage, it appears that the choice lies between cable and overhead electric, and as to which of these two methods should be adopted in any particular case will depend on the gradients to be negotiated and the amount of traffic to be catered for, or, in other words, the frequency of the service. In comparing these two methods of haulage the following data may be of service: Cost of ordinary steel girder rail tramway track on concrete foundation, and paved with granite setts, £5,250 per mile of single track. Cost of cable conduit, £3,500 per mile of single track, if laid at same time as rails; if added to an existing line of tramway this sum must be increased by £400 to £500 per mile. The cable itself costs £200 per mile. The electric underground conduit, including conductor, costs £4,300 per mile of single line, if laid simultaneously with the tramway line. If added to an existing line the same extra allowance must be made as in the case of cable conduit. The electrical work for an overhead system costs £1,900 per mile of double track, and £1,500 per mile of single track, if erected in conjunction with the tramway line; and an allowance of £150 per mile of single track, and £300 per mile of double track must be made for extra paving over bonding the rails for return circuit if this system is fitted to an existing line. A cable bogie car to carry 50 passengers costs £250, and an electric motorcar of the same size, either for overhead or underground conduit, costs £700.

The power required to haul the cable of a cable system is given by Mr. Clark in his book on tramways at 4 i.h.p. per 1,000ft. of cable, and every right-angled bend is to be considered as equivalent to 1,500ft. of straight cable. This allowance does not include the power absorbed by the engine and winding machinery when running empty. This estimate appears to be rather a high one, judging by the results obtained at Brixton, Birmingham, and Edinburgh, from which it would appear that 4 i.h.p. per 1,000 lineal feet, or 21 i.h.p. per mile, covers the power required to haul the cables, including bends, and the power absorbed by machinery running light. To this must be added 3 h.p. for each car running. The power required for overhead electric cars fluctuates, as already pointed out, and these fluctuations are more marked the smaller the number of cars running. For instance, on the Roundhay electric tramway at Leeds the average power per car, with only five cars running, varies from 13 e.h.p. on a bad day to 7 e.h.p. on a good day, and in very bad weather the momentary power has reached 36 e.h.p. per car. Mr. T. Hewson, jun., A.M.I.C.E., made tests on this line on January 28, 1895, after a slight fall of snow, when he found that the power per car, with five cars running, averaged 13·9 e.h.p., and ranged between 25·1 e.h.p. and 1·2 e.h.p. per car—*i.e.*, the maximum exceeded the average by about 80 per cent. It should, however, be stated that when these tests were taken the cars were not fitted with the series-parallel controller. The cars were subsequently fitted with this appliance, and the power absorbed was then much more uniform. On the other hand, Mr. K. Hedges, in his book on "American Street Railways," gives a diagram taken from the Minneapolis Street Railway with 163 cars running, showing an average of 8·34 e.h.p. per car, and the maximum demand only exceeds the average by about 20 per cent., whilst on the same line with only 15 cars running, the power absorbed per car averaged 11·33 e.h.p., and the maximum demand per car was double that figure. It will, therefore, be seen that, in estimating the horse-power required at the central station for any system, regard must be had to the effect which the number of cars running has upon the excess of power absorbed above the average power per car.

The cost of engines, boilers, and dynamos at the central station may be estimated at £15 to £17 per indicated horse-power, and for engines, boilers, and winding machinery for a cable system at £12 to £15 per indicated horse-power. The cost of buildings and land for the power station will, of course, depend to a large extent on the substantiality and ornateness of the former, and the local conditions for the latter. In estimating the annual costs, allowance should be made for redeeming the outlay on land, lines, and buildings in 30 years, fixed machinery in 20 years, rolling-stock for cable cars in 20 years, and electric cars in 10 years, and renewals of lines, machinery, and rolling-stock at the end of these terms. The cost of haulage on the Birmingham cable system, with six miles of cable, 21 cars, and a three-minute service, for the years 1891-4 inclusive, was 6·35d. per car mile on an average of 621,000 car miles per annum. Of this sum from 1½d. to 2d., representing about £4,000, is the fixed charges which cannot be appreciably reduced, however small the number of miles run. The above figures include all expenses except capital and renewal account charges. The cost of haulage on the Roundhay electric tramway, with a seven to eight minutes' service and five cars, was 5·76d. per car mile, exclusive of capital and renewal account charges. This sum includes 1·36d. per car mile for management and power station expenses, which would be reduced to from 1d. to 0·75d. per car mile on a larger installation. An estimate of the annual cost of running any proposed system can be made with a considerable degree of accuracy by using the above data, making allowances for any special local circumstances, but the result will depend largely upon the accuracy with which the requirements of the traffic to be catered for has been gauged, as on this part of the estimate will depend the total number of car miles per annum over which the fixed charges for interest on and repayment of capital, management, and renewals can be distributed. It will be found in most cases that the cost of cable and overhead electric traction are equal at between a two-minute and a three-minute service each way. If the frequency of the service exceeds this the cable will be cheaper, but if the service is slower the electric overhead will be the more economical.

Discussion.

Mr. Pritchard (Birmingham and London) thought that steam and horse traction were doomed, though horse traction would continue for some time when the roads were easy and the loads were light. He referred to the Birmingham tramways, and stated that the engines constructed by Kitsons were excellent examples of tramway engines, and lighter than competing engines by Peacock, the former weighing 8·5 tons as against the latter 13·5 tons. Any extra weight acted detrimentally upon the roads. The opinion at Birmingham was that steam would be replaced by electricity. Indeed, a syndicate was formed to purchase the tramway undertaking and work it electrically by an overhead system, but the city engineer advised against this system, as did also a deputation that visited various Continental and English tramways and the syndicate would not carry out the project because of the excessive cost of electrical working by means of a conduit. Thus, steam and horse traction must be continued at Birmingham for a time. After giving his experience of American practice, he said that from this experience his conclusions as to the value of the overhead and conduit systems were not in accord with those of the author of the paper.

Mr. Price (Birmingham) supported the views adopted in Birmingham. He had visited the Continental and English tramways with the deputation, and had been struck with the good points presented by various systems. At Paris, steam had favourable points; at Hanover a mixed system of trolley and accumulators had been examined, but he understood that the mixed system was to be given up. With regard to a self-contained system, it meant that out of 9·5 tons, 3·5 tons were accumulators, which seemed a large percentage of dead-weight to carry. Birmingham had offered special facilities for the purpose of obtaining electric traction, but it would not have an overhead system. It was engaged now in getting all other wires underground, so it was not likely to accept a return to overhead wires. Another point has troubled them whenever they had examined the question; that was the electrolytic action of the current. As they had interest in gas and water mains, he would be glad of some proof that electrolytic action was not too damaging. He would like to know the cost of Mr. Silcock's proposed conduit. When the association discussed this question at Dover he gave the cost as £10,000 a mile.

Mr. Cockrill said that he had advised his Council to adopt an overhead system of about four miles at an estimated cost of £39,000.

Mr. Lobley said that before he went to America he was prejudiced against overhead wires, but 24 hours' experience rendered the system more or less unnoticeable. Besides, there had been improvements in this direction, as elsewhere He thought a gauge of 4ft. ought to be a minimum, that electricity could deal with steeper gradients than steam, the latter just managing 1 in 13·5, while he knew of a case where the former worked over 1 in 8. The two-pole overhead system with span wire was not obsolete—in fact, it was being installed in his district—but he preferred the one-pole with overhanging bracket. The network in either case had been and could be simplified so as to be less objectionable.

Mr. Eayrs pointed out that arguments could be used for and against every system, and that the special system to be adopted in any place depended upon local circumstances. No doubt the conclusion of the Birmingham Council was the right one for Birmingham, but the smaller towns could not adopt a conduit system because it would be too costly. With regard to a slot, it depended entirely upon its width whether it was objectionable. At Birmingham it was ½in., and cyclists with their pneumatic tyres ran on it all right. He asked whether the slot as proposed by Mr. Silcock was central or on rails, whether the return was by the rails or a separate conductor, and pointed out that one great objection to a trolley system was the sparking both at the poles and at the rails. Certain details were also objected to, because the cars being lighted electrically from the trolley wire might at certain changing points be left in darkness.

Mr. Harpur said they ought to take each system on its merits. At Cardiff they had decided to have 12 miles of tramway, but the system to be used had not yet been decided. He feared that if an overhead system was used, it would in some parts be tolerated but a short time. The electrical question was not yet settled, nor the problem solved. He hoped for something better, but as yet had neither seen nor heard of a system which he thought unobjectionable.

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A hearty vote of thanks was given to **Mr. Silcock** for his paper, and after thanking the members for this vote, he remarked that he quite agreed with the various speakers who desired each case to be considered on its merits. He had no intention of being dogmatic. In considering any system to be adopted, such as an overhead electric, that would depend very much upon the width of the streets. He thought that many members might change their views if they could examine what was being done in this direction at Leeds. His estimate for a conduit system was about £9,550 per mile. The position of the slot was not important, the return was by the rails.

SAFETY REGULATIONS FOR ELECTRIC WORKS.

(Concluded from page 86.)

RECOMMENDATIONS.

28. For the purposes of these regulations a station where the direct current generated is at 700 volts or any higher number, or where the alternating current generated is at 350 volts or any higher number, shall be considered a "high-pressure station," and all metal conductors, whether they be on the dynamos, the switchboard, the mains, or any other part of the station carrying a current at a pressure equal to or greater than that above mentioned shall be deemed to be at "high pressure." The committee recommend that the following regulations should be applied in all those cases mentioned in paragraph 1 where electricity at high pressure is in use. It is not intended that they should be applied to low-pressure systems:

(i.) The frames and bed-plates of all generating machines shall be efficiently connected to earth.

(ii.) The rails fencing dynamos, or other generating machines, shall be made of wood or other non-conducting material.

(iii.) All terminals, collecting brushes, main connectors, parts of dynamos, motors or other appliances, to which neither Regulation No. (vi.) nor No. (vii.) applies shall be so placed, covered, or fenced with non-conducting materials, that no person can touch accidentally, either with his body, clothing, or any conducting tool, two parts differing from each other by an amount which constitutes a high pressure. This rule is to be read in connection with No. (iv).

(iv.) The floors of all places where it would be possible to make connection with metal at high pressure shall be covered with an insulating mat of suitable material and kept in a state of efficient insulation.

(v.) The material used for wiping or cleaning the commutator strips or collector rings of dynamos, motors, or rotary converters of any form shall be applied by means of an insulating handle.

(vi.) In switchrooms and on the front of switchboards, the main switches, main fuses, main terminals, omnibus bars, and all other metallic parts shall be insulated or arranged in such manner as to render it impossible for any person by accident or inadvertence to touch them.

(vii.) The backs of all switchboards shall be kept closed, except for the purpose of alterations or repairs. When such work has to be carried on either at the back or at the front of switchboards, the following regulations shall apply: (*a*) No person except a skilled electrician, or a workman under his personal and immediate supervision, shall be employed when any part is at high pressure. (*b*) No extensive or serious repairs shall be executed upon metal which is at high pressure. (*c*) Where the alterations or repairs are not of an extensive or serious character, all metallic parts at high pressure shall be covered with an insulating cap or protected by some form of insulating covering, only one part, or several at the same pressure, to be exposed at any one time.

(viii.) All switchboards erected after the application of these rules shall have, at the back, a clear space of at least 4ft. This space shall not be utilised as a storeroom or lumber-room, or be obstructed in any manner.

(ix.) Any person at work upon a cable or portion of the mains under high pressure shall wear indiarubber gloves on both hands.

(x.) All aerial high-pressure conductors in factories or workshops shall either be insulated over their entire length, and supported at such frequent intervals that, in the event of breakage, they shall not come within reach at places where persons are liable to pass or to be employed, or shall be so placed and arranged as to comply with the requirements relating to such wires in streets enjoined by the Board of Trade.

(xi.) The gloves shall be supplied by the occupier, and it shall be the duty of the manager to see that they are in a proper state of repair, and are worn by the workpeople.

(xii.) No examinations, repairs, or alterations necessitating the handling of mains, wires, machines, or other apparatus, shall be carried on except in cases of urgent necessity while such parts are under high pressure, and all such work shall be done under the personal supervision of an electrical engineer or competent manager or foreman.

(xiii.) Where operations are being conducted upon mains from which the current has been cut off, the switch shall be locked and precautions taken that it shall not be unlocked except by the person in charge of the station on his being satisfied that the danger is at an end.

(xiv.) Every vessel used for lubricating purposes shall be so constructed that it cannot act as a conductor between the hand and anything touched.

(xv.) Metal transformer boxes shall be efficiently connected to earth, and so constructed that in the event of "running to frame," the earth connection will not be broken by the removal of the fuse box or any other part of the box.

(xvi.) Transformer cases, iron ladders, and all permanent metallic parts contained within the transformer chamber, and not forming part of the electric circuit, shall be metallically connected together.

(xvii.) All holes in transformer cases, through which high-pressure conductors pass, shall be lined or bushed with suitable and effective non-conducting material.

(xviii.) All high-pressure connections within a transformer chamber shall be so protected with insulating material that it shall be impossible to touch them.

(xix.) Switches which can be conveniently operated from the outside for cutting off both the high and low pressure connections of the transformers shall be fitted in all transformer chambers erected after the application of these rules, and in all existing chambers, unless it is proved to the satisfaction of Her Majesty's Chief Inspector of Factories that such an arrangement would be attended by special difficulty.

(xx) Each post or support where series arc lighting is employed shall be provided with means for completely disconnecting the arc lamps from the mains, without disturbing the action of the other lamps.

(xxi.) All persons engaged in electrical works shall be made fully aware of the dangerous parts of the machinery, cables, and their connections, and shall be practically instructed in methods of artificial respiration—that known as Sylvester's is both simple and efficacious. Rules for artificial respiration, and for the restoration of persons apparently killed or injured, shall at all times be kept affixed in the station. All persons engaged in the works shall thoroughly understand these rules and be capable of putting them into practice. In the event of a person being rendered unconscious by an electric shock, artificial respiration shall, on the careful removal of the body from its electrical contact, be at once resorted to, and a qualified medical man immediately summoned.

(xxii.) All accidents occurring in generating stations or transformer chambers shall be notified according to the provisions of Section 18 of the Factory and Workshop Act, 1895.

29. The committee feel that any set of special rules framed for the safety of the workpeople in this industry must imperfectly realise their object if a specially qualified person be not retained to advise the Secretary of State or Her Majesty's Chief Inspector of Factories on matters requiring technical knowledge of electricity.

H. J. TENNANT. C. V. BOYS.
MAY TENNANT. H. P. SMITH.
THOMAS OLIVER, M.D.

The committee desire to express their deep sense of obligation to Mr. Boys, F.R.S., for the invaluable assistance he has rendered them in the course of their inquiries, and in the drafting of this report.—For the committee, H. J. TENNANT.

LEGAL INTELLIGENCE.

BRITISH ALUMINIUM COMPANY, LIMITED, v. SIR W. G. ARMSTRONG, MITCHELL, AND COMPANY, LIMITED.

This motion for judgment came on in the Chancery Division of the High Court of Justice, before Mr. Justice North, on Saturday last, July 17.

Mr. Graham, counsel for the plaintiffs, explained that it was a motion for judgment in default of delivery of defence. The defendants had since withdrawn the defence, and hence the case now came as if there had been no defence at all. The action was one to restrain the infringement of patents relating to aluminium, and damages were not asked for.

An injunction, the delivery up of any aluminium which the defendants may have in their possession, and a reference to the taxing master to tax the costs, were granted by **Mr. Justice North.**

DISPUTE BETWEEN ELECTRICAL ENGINEERS.

In the Westminster County Court, on Thursday, his Honour Judge Lumley Smith, Q.C., had before him the case of Salmony *v.* Lawrence and Butcher, in which the plaintiffs, a firm of electrical engineers, carrying on business at 120, Charing Cross road, sued the defendants, who are also electrical engineers, carrying on business at Stafford-street, Bond-street, to recover the sum of £36 in respect of a quantity of electrical fittings supplied to their order.

The claim was admitted subject to the return of certain of the goods which were had on approval, and the defendants set up a counterclaim for damages in respect of a quantity of electric holders which were found to be defective.

The defendants' case was that in November of last year they had a contract to fit up electric light at Messrs. Crosse and Blackwell's premises, and the fittings for the carrying out of the work were ordered from the plaintiff. A large number of the electric lamps refused to burn, however, and as a consequence they had to be replaced by others, which were purchased from the London Electrical Company at a higher price, and beyond that, there was a loss of about £25 in labour.

After hearing evidence at some length, his **Honour** said he was satisfied that some of the plaintiffs' goods were defective, and after allowing for some which were returned, he should give them a verdict for £20 on the claim, and the defendants would get £15 on their counterclaim, each party to pay their own costs.

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COMPANIES' MEETINGS AND REPORTS.

CROMPTON AND CO., LIMITED.

The annual general meeting of the shareholders of this Company was held at the Cannon-street Hotel yesterday (Thursday) afternoon. Mr. John Trotter (chairman of the Company) presided, and there was a good attendance.

The **Chairman**, in moving the adoption of the report, spoke favourably of the work of the past year, and said their prospects were more brilliant than they had been. They had made a net profit of £12,172, and after the payment of debenture interest, bankers' interest, and other fees there remained a balance of £4,180.

After a few questions had been put and answered, the report was adopted.

Mr. John Trotter was re-elected as a director.

An extraordinary general meeting was then held to hear the scheme prepared by the directors for reducing the capital of the Company. As explained very lucidly by the **Chairman**, it was this: To call up the remainder of the ordinary shares, to dispose of various properties, to reduce substantially various figures under "property and assets," such as goodwill, etc., to write off bad debts and to wipe out the cumulated dividends on the preference shares, and to put both the preference and the ordinary shares on the same footing as regards priority of right to dividends, so that the former would take seven-eighths and the latter one-eighth of available profits.

On the whole, the scheme met with the approbation of the largest preference shareholders, who spoke, and a resolution was passed adding another article to the articles of association to legalise the scheme. A second extraordinary general meeting is to be held to confirm this resolution.

A vote of thanks to the chairman concluded the meeting.

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY, LIMITED.

The half-yearly general meeting of this Company was held on Tuesday, at the offices, Old Broad-street, Sir Robert Herbert presiding.

The **Chairman** reminded them that at their meeting at the beginning of the second half of the year no formal business was placed before them, and that there was no report or statement of accounts presented to them, as these were made up to the end of the year and submitted to the meeting in January. The only object of calling them together that day was that they might hear about the condition of their property and the business that had been transacted during the past six months. Both the factories were in good working condition, and they had done a fair amount of business during the half year. The ships had also been tolerably well employed, and were in a thoroughly good condition. The state of the Company's affairs, therefore, warranted their offering to the shareholders an interim dividend of 5 per cent., or 12s per share, as in previous years, and, without prophesying, they hoped that nothing would prevent them from paying the same dividend next January as they paid last January. The construction of cable had gone on steadily by them as regarded furnishing supplies to the various companies who required their stocks increased, but they had had no great transaction to address themselves to. Some of them might have seen at the Imperial Institute a very interesting exhibition which had been placed in the north gallery by the Company, and which had attracted a great deal of attention—he referred to the admirable model of the system for communicating by telegraph without a complete connection by wire between the Fastnet Rock and the mainland—a system prepared by Mr. Willoughby Smith and Mr. Granville, showing how a message can be passed through rough and broken water from one point to another without any actual wire to convey it. They had desired to take advantage of the visit to this country of the Colonial Premiers by inviting them to inspect the company's works at Greenwich. All of them accepted the invitation, and the directors had hoped to give them an instructive view of what they were doing, which might have induced them to extend their operations in the laying of cables. The Premiers, however, received a command from the Queen to go to Windsor on the day fixed for the visit to Greenwich, which therefore had to be abandoned. Several of the Premiers expressed their regret at not being able to see the Company's works, but it was perhaps possible that one or two of them, in a quiet way, might yet be able to visit them. He afterwards alluded to the distinction which had been conferred by the Queen on Sir James Pender, and he invited the shareholders to join the Board in congratulating their colleague. He had inherited the qualities of his father, the late Sir John Pender, and they were very pleased to see that this fact had been recognised.

Mr. Croft, on behalf of the shareholders, afterwards expressed the satisfaction with which they had seen the announcement referred to.

EASTERN TELEGRAPH COMPANY, LIMITED.

The report for the half-year ended March 31, 1897, states that the revenue for the period amounted to £479,822. 0s. 6d., from which are deducted £110,109. 1s. 3d. for the ordinary expenses and £27,544. 12s. for expenditure relating to repairs and renewals of cables, etc, during the half-year. After providing £3,540. 19s. 5d. for depreciation of spare cable, £6,254. 1s. 2d. for income tax, there remains a balance of £332,373. 6s. 8d., to which is added £41,966. 16s. 11d. brought from the preceding half-year, making a total available balance of £374,340. 3s. 7d. From this balance there has been paid: interest on debentures and debenture stock, £30 112. 10s. 7d.; dividend on preference shares, £20,296. 3s 3d; an interim dividend of 2s 6d. per share on the ordinary shares, £50,000—total, £100,408. 13s. 10d.; leaving a balance of £273,931. 9s. 9d, out of which the directors have placed £20,000 to the reserve fund for maintenance ships, £10,000 to the fire insurance fund, £10,000 to the land and buildings depreciation fund, and £120,000 to the general reserve fund. The directors recommend the declaration of a final dividend for the year ended March 31, 1897, of 2s. 6d. per share and a bonus of 3s. per share, amounting together to £110,000 both payable on 22nd inst., free of income tax, and making, with three previous payments on account, a total distribution of 13s. per share, or 6½ per cent. for the year on the ordinary shares. The balance of £3,931. 9s. 9d shown at the foot of the revenue account is proposed to be carried forward to the next half-year. The revenue includes £34,024. 10s. dividends for the half-year upon the Company's investments in other telegraph companies. At the last general meeting reference was made to the loss the Company had sustained by the death of Mr. Geo. G. Nicol, a director of this Company since its formation. The directors have now to record the death of their esteemed colleague, Mr. Charles William Earle, whose loss they deeply regret. The vacancy thus created has been filled by the appointment of Mr. Clement S. Colvin, C.S.I.

CITY AND SOUTH LONDON RAILWAY COMPANY.

Directors: Charles Grey Mott, Esq. (chairman), Harrow Weald, Middlesex; Charles Seymour Grenfell, Esq., Elibank, Taplow; Sampson Hanbury, Esq., Wyvenhoe Park, near Colchester; S. Barclay Heward, Esq., 96, Ashley-gardens, Westminster; Edwin Tate, Esq, 21, Mincing-lane, London, E.C.

Report of the directors, with abstract of accounts for the half-year ending June 30, 1897, to be submitted to the twenty-sixth ordinary general meeting of the Company, to be held at Winchester House, Old Broad-street, E.C., on Thursday, July 29, 1897, at 12 o'clock noon:

The receipts from all sources for the past half-year have amounted to £28,259. 12s. 6d., and the cost of working has been £15,733. 17s. 7d., leaving a profit of £12,525. 14s. 11d. Inclusive of the balance brought forward from December 31 last, the net revenue account shows an aggregate total of £13,888. 1s. 1d. After making provision for the debenture and debenture stock interest, and the deduction of £1,000 referred to in paragraph 8, a balance remains available for dividend of £9,439. 14s. 1d. Out of this sum your directors recommend that the full dividend of 5 per cent. per annum be paid on the preference shares, and that a dividend at the rate of 2 per cent. per annum be paid upon the consolidated ordinary stock, leaving a balance of £1,034. 19s. 1d. to be carried forward to the next account. The following table shows the number of passengers, exclusive of season-ticket holders, carried since the opening of the railway in each half-year:

Half-year ended	Number of passengers (exclusive of season-ticket holders).	Receipts (including season-tickets.
Dec. 31, 1890 (11 days)	165,000	£1,568 3 9
June 30, 1891	2,412,343	19,403 6 9
Dec. 31, 1891	2,749,055	19,798 16 6
June 30, 1892	2,813,162	20,931 4 2
Dec. 31, 1892	3,117,602	22,002 17 5
June 30, 1893	3,146,656	22,458 6 9
Dec. 31, 1893	3,093,351	22,067 14 10
June 30, 1894	3,383,154	23,564 10 6
Dec. 31, 1894	3,275 649	23,540 12 4
June 30, 1895	3,113,199	23,711 5 8
Dec. 31, 1895	3,172,438	23,780 3 7
June 30, 1896	3,192,672	24,021 13 0
Dec. 31, 1896	3 368,480	25 567 7 6
June 30, 1897	3,437,810	26,403 3 6
Total since the opening of the line	40,440,571	£298,819 6 3

The locomotive, generating, and hydraulic plant have been efficiently maintained, and are in good working order and condition. Considerable progress has been made with the works of the extension to Finsbury-pavement. The shafts at London Bridge and Moorgate-street Stations have been sunk to the full depth, and the driving of the tunnels commenced. The difficulty experienced as to the settlement with the rector and churchwardens of St. Mary Woolnoth for the acquisition of the church for the construction of the station underneath, compelled your directors to apply to the Board of Trade in order to obtain possession in accordance with the Act of Parliament. By direction of the valuer appointed by the Board of Trade, a large sum having been deposited with the Paymaster-General as security, possession of the site was at length obtained in May last, and the works are now being proceeded with. In pursuance of the authority given at the last half-yearly meeting, notices to treat are being served upon the owners of the property required for the two stations on the extension to Clapham. Arrangements have been made with Sir Benjamin Baker to act as engineer, and the detailed plans for the line are now in hand. The net profit of £1,000 received from the letting of seats to view the Diamond Jubilee procession, has been transferred to a "reserve fund" to assist in meeting any dividend that might accrue on the

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preference shares created in connection with the extension, should there be any delay in the opening of the new line for traffic. The further sum of £1,800 has been paid off the 5 per cent. terminable mortgage debenture bonds during the past six months, leaving a balance of £28,300 still to mature.

Dr. Revenue Account.	£	s.	d.
Maintenance of way, works, and stations	575	0	1
Locomotive and generating power	5,921	0	0
Carriage repairs	556	17	11
Traffic expenses	6 062	17	7
General charges	1,781	13	4
Passenger duty	61	8	11
Law charges	5	5	0
Rates and taxes	769	14	9
	15,733	17	7
Balance carried to net revenue account	12,525	14	11
	£28,259	12	6
Cr.	£	s.	d.
Passengers (3,437,810)	25.123	17	8
Season tickets (523)	1,279	5	10
	26,403	3	6
Parcels, etc.	118	4	8
	26,521	8	2
Transfer fees	34	12	6
Rent of property	668	2	3
Sundry receipts	1,035	9	7
	£28,259	12	6

Dr. General Balance-Sheet.	£	s.	d.
Balance from net revenue account	10,439	14	1
Unclaimed interest	51	19	9
Interest payable or accruing and provided for	1.140	10	2
Sundry outstanding accounts	7,117	14	3
Loan account	85,000	0	0
Balance from capital account	64,087	15	1
	£167,837	13	4
Cr.	£	s.	d.
Cash at bankers, current accounts	4,184	11	7
Cash on hand	943	17	4
	5,128	8	11
General stores	3,973	12	10
Sundry outstanding accounts	1,375	7	7
Investments—balance Dec. 31, 1896, £150,728. 15s.; less proportion of interest received applied in reduction of premiums, £500	150,228	15	0
Interest on calls paid in advance—balance Dec. 31, 1896, £8,099. 0s. 8d.; less balance investment and bank interest received, £967. 11s. 8d.	7,151	9	0
	£167,837	13	4

GLOBE TELEGRAPH AND TRUST COMPANY.

The report of the directors of the Globe Telegraph and Trust Company, Limited, for the year ended July 18, to be submitted to the general meeting to be held at Winchester House on Tuesday, states that the net revenue for the year, after deduction of expenses, amounts to £187,582, and makes, with the balance of £948 brought forward, a total of £187,531. From this amount there has been distributed the sum of £127,867 in interim dividends, leaving an available balance of £59,664. The directors recommend the payment of a final dividend for the year of 3s. per share on the preference shares, and of 3s. 6d. per share on the ordinary shares, making with previous distributions a total dividend for the year of 6 per cent., less income tax, upon the preference, and 4½ per cent. net (against 4½ per cent. for the preceding year) upon the ordinary shares, leaving a balance of £2,023 to be carried forward. During the current year the West Coast of America Telegraph Company has been reconstructed, the £10 shares of that company having been exchanged for a similar number of shares of a nominal value of £2. 10s. each, while their 8 per cent. debentures have been replaced by 4 per cent. debentures, guaranteed both as to capital and interest by the Brazilian Submarine Telegraph Company, Limited. The Postal Telegraph Cable Company, some of whose shares this Company recently acquired, has been taken over by the Commercial Cable Company, the shares of the former company being exchanged for 4 per cent. debentures in the latter, £103 of these debentures being given in exchange for every £100 nominal of shares in the Postal Telegraph Cable Company. Since the last meeting the Company's investments have been distributed over a larger area. The present market value of the securities now held by the Company considerably exceeds the cost after taking into consideration the deficiency resulting from previous sales and exchanges of investments.

DIRECT UNITED STATES CABLE COMPANY, LIMITED.

The report of the directors for the six months ended June 30, to be presented at the general meeting to be held at Winchester House on Tuesday next, states that the half-year's revenue, after deducting out-payments, amounted to £43,892, as compared with £42,457 for the corresponding period of 1896, being a difference of £1,436 in favour of the half-year under review. The working and other expenses for the same period, including income tax, but exclusive of cost of repairs of cable, amounted to £19,560, leaving a balance of £24,333 as the net profit of the half-year, making, with £4,843 brought forward, a total of £29,176. For the corresponding period of 1896, the working expenses and other payments amounted to £19 692. Three quarterly interim dividends of 2s. 6d. each per share, amounting to £22,766, have been declared and paid during the financial year, and a final dividend of 2s. 6d. per share is now proposed, together with a bonus of 2s. per share, making, with the three interim dividends, 3 per cent. for the year, being a total distribution of £36,426. After transferring £4,000 to the reserve fund account, the balance of £3,928 on the revenue account is proposed to be carried forward. The reserve fund account has been debited with £1,540 for cost of cable repairs, and with £2,000 written off the Ballinskelligs buildings account, and after being credited with interest on the investments, profit on security sold, and sum transferred from revenue account, the balance of the reserve fund now amounts to £338,489. The additions and improvements to the staff buildings at Ballinskelligs, which have been in progress for some time, are expected to be completed within the current half-year.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Novorossjisk (Russia). — Tenders will be received up to November 13 by the Municipal Authorities of Novorossjisk for the concession for the construction and working of an electric tramway.

Herve (Belgium) —Offers will be received up to October 1 by the Municipal Authorities of Hervé, in the Province of Liège, for an installation of town lighting. No information is given as to the system (electrical or otherwise) which would be preferred.

Hapton (Lancs.).—The Parish Council invite tenders for lighting Hapton township with electricity from September 1 to April 30. Endorsed tenders to be sent to Mr. Ed. O'Shaughnessy, clerk to the Council, St. Anne's-terrace, Padiham, by August 2. Full particulars on application.

Halifax.—Tenders are invited for the supply of trolley wire, bonds, and insulators. Specifications and forms of tender may be obtained on application to Mr. T. P. Wilmshurst, borough electrical engineer, Foundry-street, Halifax, on payment of £1. 1s., which will be returned on receipt of a bona fide tender. Sealed tenders, endorsed "Electric Line Construction," must be sent to Mr. Keighley Walton, town clerk, before 10 o'clock a.m. on July 26.

Brighton.—The Council invite tenders for the supply of coal required at the Corporation electricity generating station during the year commencing August 1, 1897. Particulars of the descriptions of coal to be tendered for, and of the estimated quantity required, together with the conditions of supply, may be obtained on application at the office of Mr. Francis J. Tillstone, town clerk, Town Hall, Brighton. Sealed tenders, endorsed "Tenders for Coal," must be delivered before 10 o'clock in the forenoon on Monday, July 26.

War Office, S.W.—Tenders are required for the supply of specific quantities of the undermentioned articles during the next 12 months—namely, electrical instruments (submarine mining), indiarubber goods, metals (copper, lead, tin sheet, zinc sheet), and telegraph cable and wire. Manufacturers who may wish to be applied to when tenders are required should address Mr. A. Major, director of army contracts, War Office, Pall-mall, S.W., by letter, stating the particular articles which they manufacture, and the names of at least two well-known firms or public bodies who have purchased from them, and are in a position to certify as to the quality of their productions.

Jassy (Roumania).—Tenders will be received on September 6-18 at 4 p.m., in the hall of the Communal Council of the Mairie of the Commune of Jassy, for the concession for a term of 40 years of the contract for gas or electric lighting, or gas and electric lighting, of the public thoroughfares and communal buildings. Every applicant, before being entitled to tender, will be required to deposit a provisional security of 70,000fr. in cash or Roumanian public bonds. All tenders must be sealed and lodged at the Mairie by the day and hour named. Conditions of tender and specification respecting this concession will be forwarded on application to Mr. C. Gall, secretary.

Hull.—The Electric Lighting Committee of the Town Council are prepared to receive tenders for the supply, erection, and hiring of certain plant and machinery required in connection with the electric lighting installation during the winter of 1897-8. Specifications for the above, with conditions of contract and any further information, may be obtained at the office of Mr. A. S. Barnard, borough electrical engineer, Dagger-lane, Hull. Tenders, sealed and marked "Electric Lighting—Temporary Plant," are to be addressed to the Chairman of the Electric Lighting Committee, and to be delivered at the Town Clerk's Office, Town Hall, Hull, before noon on Thursday, July 29.

Egypt.—The Secretary of State for Foreign Affairs has received a despatch from her Majesty's Agent and Consul-General at Cairo, drawing attention to a notice published in the *Official Journal* of the Egyptian Government of 23rd ult., in which it is stated that tenders are invited by the Egyptian Government for Welsh coal for the use of the Administration of Railways and the Port of

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Alexandria. Tenders should be sent under cover by registered post, and should reach the President of the Administrative Council by October 15 next. Such further particulars as have been received may be seen at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 6 p.m.

Jassy (Roumania).—Tenders will be received on and after September 6-18 at 3 p.m., in the hall of the Communal Council of the Mairie of the Commune of Jassy, for the concession for a term of 40 years of a line of tramways to serve the Commune of Jassy, the said concession to include the construction, maintenance, and working of the line. Every applicant, before being entitled to tender, will be required to deposit a provisional security of 50,000fr. in cash or Roumanian public bonds. All tenders must be sealed and lodged at the Mairie until the day and hour above named. Conditions of tender and specification respecting this concession will be forwarded on application. Tenders will be subject to articles 68-79 of the Public Accounts Act. Mr. C. Gall, secretary.

Newport (Mon.).—The Electricity Committee require tenders for the erection of buildings and machinery foundations for extensions of the municipal electricity works of the county borough. The drawings and specification, with conditions of tender and contract, may be seen at the offices of Mr. Robert Hammond, M.I.E.E., the consulting electrical engineer to the Corporation, Ormond House, Great Trinity-lane, London, E.C., or at the offices of Messrs. Conyers, Kirby, and Son, the architects, Stow-chambers, Newport, on and after 17th inst., and copies of bill of quantities may be obtained from the Architects on payment of £2. 2s., which sum will be returned on receipt of a bona fide tender. Tenders, sealed, and marked "Tender for Electricity Works Buildings," must be addressed to Mr. Albert A. Newman, town clerk, Town Hall, Newport, and delivered before 10 a.m. on 30th inst.

Sofia (Bulgaria).—The Municipality of Sofia will receive offers up to September 22 for the concession of the public and private lighting of the city, for power, and also for electric tramways. The duration of the concession is for 50 years. Such further information as has reached this country can be seen at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 6 p.m., and particulars, in French or Bulgarian, can be obtained for 5f. from the Mairie at Sofia. The mayor is Mr. D. M. Yablanski, and the engineer Mr. Chr. Taneff. NOTE.—In accordance with a custom prevalent in the Balkan States, when the tenders have been opened, it will be admissible for anyone to underbid the lowest one up to October 2. In the language of the notice, "tenders will be received for either or both of the undertakings at the offices of the Municipality of Sofia up to September 22 next, and will then be examined, but a final adjudication will be held on October 2, if in the interval a reduction of 5 per cent. is offered on the tenders containing the most favourable terms."

Newport (Mon.).—Tenders are required by the Electric Lighting Committee for the supply and erection of the following plant for the extension of the municipal electricity works (the whole bound up in one specification, price £2. 2s., returnable on receipt of bona fide tender): (Section A) boiler-house plant—Lancashire boilers and fittings, mechanical stokers, feed pumps, economiser, electric motor, etc.; (B) steam and exhaust pipes, valves, etc.; (C) engine-house plant—steam alternators and exciters, accumulators, oil filter and tanks; (D) switch gear and instruments; (E) arc lamps, posts, and accessories; (F) coal elevator; (G) allowance for day-load plant. The ground plans of plant, and specification, with terms and condition of tender and contract, may be obtained at the offices of Mr. Robert Hammond, consulting engineer to the Corporation, Ormond House, Great Trinity-lane, London, E.C., on payment of £2. 2s. for each copy, which sum will be refunded on the return of the specification filled up with a bona fide tender. Tenders, sealed and marked "Tender for Electric Lighting," must be addressed to Mr. Albert A. Newman, town clerk, at the Town Hall, Newport (Mon.), and must be delivered on or before 30th inst.

Sedgefield (Durham).—The Visiting Committee of the Durham County Asylum, Sedgefield, having decided to instal the electric light in the Winterton building at the Sedgefield Asylum, invite tenders with specifications for the work. Each firm will be at liberty to suggest its own method, power and arrangement, and number of lights. The building for the housing of the machinery will be erected by the Visiting Committee on plans to be arranged with the firm whose proposal for the installation is accepted, and will be on such a scale that additional machinery can be placed therein so as to provide for the lighting of the main building when that project is decided on. As a guide to firms it may be stated that from 500 to 550 16-c.p. lights will probably be required for Winterton, and a larger number for the main building. Plans of the buildings can be seen at the office of Mr. Crozier, county engineer, Shire Hall, Durham, and the buildings may be inspected and further information obtained upon application to Dr. Smith, the resident medical superintendent at the asylum. Tenders, addressed to Mr. A. O. Smith, clerk to the Visiting Committee, Durham, will be received at his office, 19, Elvet-bridge, Durham, up to noon on August 7.

Madras.—Tenders are invited for the utilisation of water flowing from the Periyár Lake for purposes other than irrigation and not incompatible with the use of the water for drinking. The irrigating season extends over nine to ten months, during which time the discharge is likely to be from 1,100 to about 500 cubic feet a second, according to the demands for irrigation and the available quantity in the lake. Subject to the risk of interruption by accident or drought, supply can be given throughout the irrigation season. No supply can be guaranteed at other times, but, so long as water is available, the Government will be prepared to issue it in such daily quantities as may seem to it advisable with reference to the time which is likely to elapse before the supply is replenished by the setting in of the rains. The fall from the tunnel to the foot of the hills is approximately 900ft., and the distance measured along the course of the stream about 6,800ft. One cubic foot per second falling 900ft. is estimated to produce over 60 effective horse-power. Intending lessees should state the quantity of water required in cubic feet per second and the annual rent offered for each cubic foot per second. No rent will be charged for the first year from the date of the concession; for the second year the charge will be one-fifth, and an additional charge of one fifth will be made every year until the full rent is reached. The whole or part of the concession may be surrendered on a year's notice being given. Lessees will construct at their own expense, on plans to be approved by Government, all the weirs and other works required to divert the water from the river below the tunnel. For further information, application may be made to the Chief Engineer for Irrigation, Madras, by whom tenders will be received up to October 31, 1897.

Birkenhead.—The Corporation are prepared to receive tenders for the supply and laying complete of cables, street boxes, etc., in certain streets in the borough. Plans can be seen, and a copy of the general conditions and the specification, with form of tender, can be obtained on payment of £1. 1s., to be returned on the receipt by the Corporation of a bona fide tender, at the Town Clerk's Office, Town Hall, Birkenhead, or at the office of Mr. James N. Shoolbred, C.E., 47, Victoria-street, London, S.W. Tenders, which must be on the prescribed form, sealed and endorsed "Tender for Electrical Cables," must reach the Town Clerk not later than 5 o'clock in the afternoon of July 23 (to-day).

Sunderland.—The Corporation are prepared to receive tenders for (1) combined arc lamp and trolley poles, (2) arc lamps and accessories. Specifications can be obtained from Mr. John F. C. Snell, A.M.I.C.E., borough electrical engineer, Dunning-street, at his office, on payment of a deposit of £1. 1s. on each of the two specifications, which will be returned on receipt of bona fide tenders. The persons or firms whose tenders are accepted will be expected to pay the rate of wages to workmen engaged in carrying out the work which is payable by the particular trade affected by the contract in the district where the work is executed. Sealed tenders, addressed to the Chairman of the Highways Committee, Town Hall, Sunderland, must be sent to the Town Clerk's Office on or before July 28, not later than 12 o'clock noon. Tenders to be submitted separately and endorsed "Tender for Lamp and Trolley Poles" and "Tender for Arc Lamps" respectively.

Derby.—The Corporation are prepared to receive tenders for the supplying and laying of high-tension cables, junction boxes, cable and hauling winch (Section A); transformer boxes, switches, safety fuses, etc. (Section B), in the borough of Derby. Specification and form of tender may be had on deposit of £1. 1s. (which will be returned on receipt of a bona fide tender) from Mr. J. E. Stewart, engineer, Electric Lighting Station, Derby. Tenders, endorsed "Electric Lighting, Tender for Cables, etc.," to be sent to Mr. H. F. Gadsby, town clerk, not later than 12 noon on July 26.

Hull.—The Corporation require tenders for the erection of a building on land in Albion-street, adjoining Albion Chapel, and for the alteration of arches under the south approach to Argyle-street Bridge for electric lighting sub stations. Forms of tender and other particulars may be obtained at the office of Mr. A. E. White, city engineer, Town Hall, Hull. Tenders, endorsed "Tender for Electric Lighting Extension, Contract No. 12," are to be addressed to the Chairman of the Electric Light Committee, and delivered at the Town Clerk's Office before 10 a.m. on 29th inst.

RESULTS OF TENDERS.

Liverpool.—For the extension of the electric supply works at Oldham-place Station, for the City Council, the tender of Messrs. J. Henshaw and Son, at £1,069, has been accepted.

Kidderminster.—For the construction of an electric tramway from Kidderminster to Stourport, the tender of Mr. G. Law, Kidderminster, at £24,000, has been accepted.

London.—The Metropolitan Asylums Board have received the following tenders for electric lighting machinery, wiring and fitting up, etc., at the Grove Hospital:

	Section A.	Section B.	Combined tender.
Mavor and Coulson, Limited, Glasgow	£4,011	*£4,950	£8,961
Crompton and Co., Limited, Mansion House-buildings, E.C.	4,420	5,400	9,320
Joel and Potter, Limited, Finsbury-square, E.C.	—	—	9,972
T. Scott Anderson, Sheffield	4,450	5,700	10,150
Brush Electrical Engineering Company, Limited, Queen Victoria-street, E.C.	4,872	5,440	10,312
Electrical and General Engineering Company, Grace church-street, E.C.	—	—	10,705
W. J. Fryer and Co., Limited, Sloane-square, S.W.	4,427	6,647	11,074
Laing, Wharton, and Down, Limited, New Bond-street, W.	5,099	6,059	11,100

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J. H. Pickup and Co., Limited, Queen Victoria-street, E.C.	4,790	.....	6,890	.....	11,680
Sharp and Piper, Victoria-street, S.W.	5,790	.....	6,450	.....	12,240
Fowler, Lancaster, and Co., Limited, Birmingham.....	4,985	.....	7,448	.....	12,400
F. B. Camden and Co., Victoria-street, S.W.	—	.....	—	.....	13,073
Siemens Bros. and Co., Limited, Queen Anne's-gate, S.W. ...	*4,180	.....	—	.....	—
J. H. Holmes and Co., Newcastle-on-Tyne	4,120 to 4,890†		—	.....	—
V. G. Middleton, Westminster, S.W.	—	.....	7,412	.....	—
A. H Wood, Victoria-street, S.W.	—	.....	4,720	.....	—

* Accepted. † According to description of engines supplied.

BUSINESS NOTES.

Personal.—The report that Messrs. Kilburn's electrical engineer was injured in the late Chitpur riots is unfounded.

The Yarmouth Trams.—The Town Council have referred the question of municipal electric tramways to the Lands Committee.

British Aluminium Company, Limited.—An interim dividend at the rate of 7 per cent. per annum on the cumulative preference shares is announced.

Kennington.—An electric lighting plant has been successfully installed at the Kennington-road baths under the direction of Mr. J. M. Trezise, of 13, Clifford's-inn.

Paisley.—A beginning has been made with the laying of the wires for the lighting of the town by electricity. The cost of the installation is estimated at £30,800.

London Paper Mills Company, Limited.—This Company, which has been formed for purposes indicated by the title, also takes power to construct electric works.

British Electric Traction.—The British Electric Traction Company has acquired a controlling interest in the North Shields and Tynemouth District Tramways, Limited.

The Metric System.—The Weights and Measures (Metric System) Bill was read a second time in the House of Lords on Tuesday night on the motion of Lord Balfour of Burleigh.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended July 18 amounted to £1,506, as compared with £1,267 in the corresponding week of the previous year, being an increase of £239.

Western and Brazilian Telegraph Company.—The receipts for the week ending July 16, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, were £2,397.

Carbide of Calcium.—The Acetylene Illuminating Company, Limited, have issued a useful pamphlet which practically reprints the regulations of the London County Council and their form of license under the Petroleum Acts.

City of London Electric Lighting Company, Limited.—Warrants for the interim dividend on the 6 per cent. preference shares of this Company, payable for the six months ended June 30 last, were duly posted on the 19th inst.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended July 16 were £2 804. 8s. 9d., compared with £2,497. 15s. 6d. for the corresponding period of last year, being an increase of £306. 13s. 3d.

Romsey.—In discussing the question of the disposal of refuse at the Town Council meeting, the Mayor said he thought that the time would come when they would have to do as other towns did, burn their refuse and generate electricity, etc.

Preston.—The National Electric Supply Company have given notice to the Rural District Council that they intend to apply to the Board of Trade for a provisional order authorising them to supply electricity to Broughton and other townships.

Fatal Accident at Dublin.—Miss Margaret O'Donnell, book keeper in a pawnbroker's establishment in Dublin, while riding a bicycle on Sunday evening, got in the way of one of the electric cars at Dalkey and was instantly killed, the tram passing over her body.

Liverpool.—It is stated that the Finance Committee of the Corporation are contemplating the issue of further stock to the extent of £2,500 000 to pay for the tramway system recently purchased, for the development of the electric lighting service, and other works.

Thomas Parker, Limited.—This well-known firm, of Wolverhampton, have issued a very handy and neat little catalogue of continuous-current dynamos, motors, etc., which also contains a valuable amount of information. The illustrations are few, but interesting.

London Lighting Extensions.—The London County Council have sanctioned applications for extensions of mains from the London and Brush Provincial Electric Lighting Company, the Metropolitan Electric Supply Company, and the Westminster Electric Supply Corporation.

Dumbarton.—A communication from the Imperial Electric Lighting Company, London, was read at the Town Council meeting saying it was their intention to apply to the Board of Trade for a provisional order to introduce electric light into the burgh, was allowed to lie on the table.

Visit to Works.—The members of the South Staffordshire Institute of Iron and Steel Works Managers recently had their annual excursion, when they visited Wolverhampton and inspected the electrical engineering works of Thos. Parker, Limited, and the Corporation electric lighting works.

The Embankment Tramway.—At the London County Council meeting the Highways Committee again submitted their recommendations in favour of power being obtained to bring a tramway over Westminster Bridge and along the Embankment to Blackfriars, and after some discussion the proposal was agreed to.

Incandescent Electric Lamps.—Messrs. Downie and Adams, of 24, Newman-street, Oxford-street, have sent us a copy of a handsomely-designed catalogue and price-list of lamps. The pages are chiefly filled with admirable illustrations, and the particulars relating to them are given in a very handy and concise form.

Safety Concentric Wiring Company, Limited.—This Company has been registered, with a capital of £30,000 in £1 shares, to acquire, upon the terms of a certain agreement, the undertaking of the Safety Concentric Wiring Company, Limited, of 5 and 6, Bovay-street, Holloway, and to develop and extend the same.

Special Settlements.—Applications have been made to the Stock Exchange Committee to appoint a special settling-day in and to grant a quotation to the British Electric Traction Company, Limited, 10,000 ordinary shares; and the House-to House Electric Supply Company, Limited, 10,000 7 per cent. cumulative preference shares.

Bridgwater.—The Town Council have decided to apply for an electric lighting provisional order. The Lighting Committee had prepared an exhaustive report on the subject, which was favourably discussed at the Council meeting and adopted. The low-tension system is to be adopted, and the estimate amounts to about £15,000.

City and South London Railway.—The returns for the week ended July 18 were £844 compared with £857 for the corresponding period of last year, being an decrease of £13. The total receipts for the half-year 1897 amounted to £2,777, compared with £2,675 for the corresponding period last year, being an increase of £102.

Heathtown.—The South Staffordshire Blast Furnace Power Syndicate and the Midland Electric Corporation for Power Distribution, Limited, have intimated to the Heathtown Urban District Council their intention to apply for power to supply electricity for public and private purposes within the limits of the Council's district.

The Brighton Electric Railway.—The sea-going car on the Brighton and Rottingdean electric railway has resumed working, and is being extensively patronised. It will be remembered that this line was started by Mr. Magnus Volk, and that it was severely damaged by the timber which was washed away from the old chain pier in the gale of December last.

County of London and Brush Provincial Electric Lighting Company, Limited.—The directors of this Company have declared an interim dividend for the half year to June 30, 1897, on the first and second issues of preference shares, at the rate of 6 per cent. per annum, less income tax, on the amounts paid up thereon and calculated from the due dates of payment.

Sedgley.—The General Purposes Committee reported at the District Council meeting that notices of intended application for powers to introduce electricity into the district had been received, and they recommended that a committee of the whole Board consider the notices, and decide what steps should be taken in relation thereto. The report was adopted.

Burton-on-Trent.—At the Town Council meeting the report of the Gas and Electric Light Committee dealt chiefly with a proposed reduction of the price of both illuminants, and, after the report had been approved, Alderman Lowe, as chairman, gave notice that at the next meeting he should make the necessary propositions to effect the reductions named.

Galashiels.—At a meeting of the Town Council a letter was submitted from an electric light company in London giving notice that it is the intention of the company to apply for a provisional order for electric lighting within the district of the Corporation, and asking the consent of the Corporation to the same. It was agreed not to consent to the company's request.

Electric Lighting Schemes.—The Bills containing provisional orders for electric lighting schemes relating to the following places have been before the examiners in the House of Commons, and found to have duly complied with the standing orders: Levenshulme, Moss Side, Stretford, and Withington, Northwich, and Bangor. The Bills will come in due course before the Unopposed Committee.

Blackburn.—The General Purposes Committee of the Corporation have considered the proposal to municipalise the local tramways, and have passed a resolution recommending the Town Council to purchase the undertaking subject to terms being satisfactorily arranged. A special meeting of the tramways company is to be held on Monday to consider the offer of the Corporation.

Buxton.—A discussion was opened at the Urban District Council meeting as to what was done at a special meeting *re* the electric lighting of the town, and Mr. Smithurst asked if the adjourned meeting had been a private one. He did not believe in it coming before a private meeting as it had done. It was ultimately decided to discuss the subject in committee of the whole Council on August 6.

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St. James's and Pall Mall Electric Light Company.—The directors have declared the following interim dividends for the half-year ended June 30: at the rate of 7 per cent. per annum on the preference shares and at the rate of 7 per cent. per annum on the ordinary shares. The sale of electricity by the Company for the quarter ended June 24 amounted to £14,533, as against £10,657 for the corresponding period of 1896.

Franco-English Motorcar Factory Company, Limited.—This Company has been registered, with a capital of £22,000 in £1 shares (20,000 preference), to acquire the business carried on at 13, Rue Grange-aux Belles and 9, Avenue de la Grande Armée, Paris, by Dessert and Minart; and to manufacture, sell, and deal in motorcars, horseless carriages, cycles, motors, engines, etc. The directors are G. Dessert, P. Minart, and J. Marin.

Deptford.—At the London County Council meeting, the Finance Committee reported upon an application from the Deptford Baths Commissioners for a loan of £2,200 to defray the cost of the installation of electric light at the baths and wash-houses. The Local Government Board had, the committee stated, sanctioned the borrowing, and they recommended that the loan be granted, repayable on the annuity system. This was agreed to.

Swansea.—The Tramways and Electric Lighting Committee of the Corporation have adopted a recommendation from the Parliamentary Committee that the Council consider the advisability of reopening negotiations with the Tramway Committee, the Parliamentary Committee stating that they ventured to hope that the Council in its wisdom would not allow matters of such importance to drift into the hands of speculative companies.

Dundee.—The Gas Committee have decided to extend the electrical main so as to allow of electricity being supplied to the nurses' home of the infirmary. They have also agreed to procure three arc lamps by way of experiment in connection with the proposal to light streets in the centre of the city by electricity. One of the lamps to be ordered is the same style as is used in Edinburgh, and the two others are similar to those erected in Glasgow.

Small-Power Arc Lamps.—We have received a price-list of the "Hansen" continuous-current shunt arc lamp, for series or parallel burning. These lamps can be used with currents of 1½ amperes and upwards, and from the particulars given they appear to be a very economical and useful article. We note that liberal discounts are given to the trade, and that the prices range from £3. 12s. to £7. 12s. Messrs. Gülich and McIntyre, of 11-12, Great Tower-street, E.C., are the agents.

Central London Railway Company.—The fourth ordinary general meeting of the shareholders of this Company will be held at 16, Great George-street, Westminster, S.W., on Wednesday, August 4 1897, at 3.30 p.m., for the purpose of receiving the report of the directors and statement of accounts for the half-year ending June 30, 1897, and for other the general business of the Company. The transfer books of the Company will be closed from July 31 to August 4, both days inclusive.

St. Annes (Lancs.).—The General Purposes Committee reported at the Urban District Council that they had received a letter from the Electric Supply Association, Limited, London, of their intention to apply during the parliamentary session of 1897-8 for a provisional order under the Electric Lighting Acts, 1882 and 1888, for the granting to them statutory powers within the district of St. Annes. It was decided to inform the company that it is the intention of the Council to apply for an order themselves.

Wolverhampton.—The Town Clerk having reported at the Town Council meeting that he had received notice of the intention of the Midland Electric Corporation for Power Distribution, Limited, to apply for a provisional order to supply electricity within, amongst other districts, the borough of Wolverhampton, it was resolved that the town clerk be instructed to take all necessary steps to protect the interests of the Wolverhampton Corporation, and that the corporate seal be affixed where necessary.

Ayr.—On Saturday forenoon Alexander Campbell, Allison-street, while employed at the sub station in Hope-street of the electric lighting works, met with a serious accident. His right shoulder came into contact with the high-tension cable, and he was at once rendered unconscious. Medical aid was speedily procured, and he soon recovered. On examination by Dr. Gemmil Thomson it was found that he was severely scorched on the shoulder. This is the first accident since the introduction of the electric light into the town.

Battersea.—It was agreed at the Vestry meeting to draw the following cheques for the purchase of property required for the central lighting station in the Lombard-road: Mr. A. L. C. Audoire, £2,100; Mrs. E. Audoire, £800; the Birkbeck Building Society, £1,200; Mrs. E. Audoire, £1,300. Mr. Belt asked if the Vestry were not precluded from erecting machinery on certain portions of the land. The Chairman said the matter had been thoroughly considered in committee, and it was evident that the committee was satisfied.

Harrow.—At the Urban District Council meeting, Mr. Charles reported that he had received from the Harrow Electric Light Company notice of an extension of their mains through the Churchyard, part of Church Fields, and down the whole length of Roxborough-park. Mr. Hawkins asked whether there would be any boxes down the steep path. Dr. Stiven said if the surveyor objected to these boxes he must say so at the outset. The boxes complained of in West-street would be scored, and if that did not do would be tar paved.

Kingstown.—A special meeting of the Town Commissioners has been held, at which, on the motion of Mr. M'Cullagh, seconded by Mr. Thompson, portion of a resolution adopted by the Commissioners on April 26, 1897, respecting the application of the Dublin Southern District Tramway Company for an order in Council pursuant to the Tramways (Ireland) Act, 1860, and Acts amending same, were rescinded. The meeting also perfected an agreement with the tramway company in respect of the proposed interlacing of the lines in Upper and Lower George's-street

Ludlow.—The Corporation offer a prize of £20 for the best and most economical scheme of electric lighting for the borough. The scheme must deal exhaustively with the whole matter, and give definite information of the cost of steam and water power for the purpose of comparison with the total cost of the undertaking and working expenses. Schemes to be delivered at the offices of Mr. John Herbert Williams, town clerk, marked "Scheme for Electric Lighting," before 4 o'clock in the afternoon of Wednesday, September 1 next. For further particulars see advertisement.

Change of Name and Address.—The Preston Electric Company, Limited, of 270, Broad-street, Birmingham is the name and address of the company which was formerly known as the Midland Electric Company, and it is under the same management. The company informs us that they found it necessary to change the name of this company when it was reconstituted under the Companies' Acts, 1862 to 1890, in order to comply with their requirements and prevent mistakes. Removal to larger and more convenient premises also became necessary in consequence of the continual growth of the business.

Anglo-American Telegraph Company, Limited.—The directors announce, after placing the sum of £6,000 to the credit of the renewal fund, an interim dividend for the quarter ending June 30, 1897, of 14s. per cent. on the ordinary stock, and £1. 8s. per cent. on the preferred stock, less income tax, payable on July 31 to the stockholders registered on the books of the Company on July 13, 1897. After paying the foregoing dividends there will be a balance of about £8,500 to be carried forward to the next account. A year ago the dividends were 12s. per cent. on the ordinary and 24s. per cent. on the preferred stock.

Limavady.—At the sitting of the Londonderry Grand Jury, Mr. Miller applied on behalf of Mr. J. E. Ritter, who also appeared by memorial, for permission to open the public road from the townland of Largy and along the public streets of Limavady for the purpose of laying an electric cable to supply the shops and dwellings which required it with the electric light. The memorial was signed by a large number of the inhabitants of Limavady. Mr. Ritter having been examined, the Grand Jury held that the service of notices had not been made in accordance with the Act of Parliament, and the case was not properly before them.

The Cardiff Exhibition.—Messrs. Clay Bros. and Co., electric light engineers and contractors, of Cardiff, inform us that they have been entrusted with the carrying out of the lighting of the exhibition building of the town for the Marquis of Bute. The installation will consist of 1,050 incandescent lamps of 32 c.p. each and 10 arc lamps. They have also in hand the lighting of Messrs. David Rees and Co.'s new premises (the Hayes Market), 250 lamps of 16 c.p. and 16 10-ampere arc lamps with dynamo; Messrs. Morgan and Co.'s premises (The Hayes), 180 lamps of 16 c.p.; Methodist Free Church, 40 lamps of 32 c.p. and 30 16 c.p., and several other small jobs.

Cricket.—On Saturday last the staffs of the various contractors engaged on the Wandsworth and St. Luke's works played a friendly game at Balham, resulting in favour of St. Luke's. Afterwards the teams and their friends, to the number of 35, adjourned to the Alma Hotel, Wandsworth, where host Parrott provided a substantial dinner. In the unavoidable absence of Mr. A. J. Lawson, manager of the County of London Company, the chair was taken by Mr. B. Deakin, resident engineer, Wandsworth, supported by Messrs. Dale, Donnet, Pringle, and Goslin. After the dinner the usual toasts were given, and the evening was concluded by an enjoyable smoking concert.

Tramway Scheme for Ramsey.—Last week the committee of the Manx Tynwald Court sat to consider the scheme of a marine promenade and electric tramway from the southern extremity of Ramsey Bay to Queen's Pier, over 2,000 yards, with the possibility of extension to the harbour. Evidence was given by townspeople showing practical unanimity in favour of the scheme. The chief feature is to organise a quarter-hour tram service from Douglas to Ramsey, and express cars in connection with all the steamers arriving at Douglas, performing the journey in an hour and a quarter. There was practically no opposition, and the committee adjourned for a fortnight to enable a formal agreement to be laid before them.

Broadstairs.—Notice was received at the Urban District Council meeting from the secretary of an electric supply company of the intention of his company to make application in December next, in pursuance of the Electric Lighting Acts, for a provisional order, to be confirmed in the ensuing session of Parliament, empowering the company to supply electricity in the area under the jurisdiction of the Council. Councillor Horrell thought it wise to oppose any application of this kind, although he might be in favour of the introduction of electric light at the proper time, and he moved that notice be given that the Council would not assent to the application. Councillor Lawrence seconded, and the motion was carried.

Metropolitan District Railway.—Lord Morley's Committee of the House of Lords have passed, as an unopposed measure, the Bill promoted by the Metropolitan District Railway Company. By this Bill, which has now been sanctioned by both Houses, power is given to the company to construct a railway under their existing lines from Earl's Court Station to the Mansion House, and to work the same by electricity. For this purpose additional

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capital is authorised to the extent of £1,200,000, with a further £500,000 for adapting electricity to their existing system. The Bill also confirms an agreement with the Ealing and South Harrow Railway Company, under which the District Company guarantee the capital of the Harrow Company.

Compressed-Air Traction Company, Limited.—This Company has been registered, with a capital of £125 000 in £10 shares, to adopt and carry into effect an arrangement with the American Air Power Company, and to acquire any interests in any patents, brevets d'invention, licenses, concessions, and the like conferring an exclusive or non-exclusive or limited right to use, or any secret or other information as to any invention in relation to mechanical traction, and the production, treatment, storage, application, distribution, and use of compressed air and electricity and of any apparatus therefor, or generally any invention which may seem to the Company capable of being profitably dealt with, as stock and share dealers, company promoters, etc.

Edison and Swan United Electric Light Company, Limited.—The accounts for the year ending June 30, 1897, have been considered by the directors, and they have determined to recommend the payment of a dividend in respect of the six months ending June 30, 1897, at the rate of 6 per cent. per annum on the "A" share capital of the Company as now paid up, carrying forward about £8,500, as against £5,300 in the previous year. The above distribution, together with the interim dividend at the rate of 5 per cent. per annum already paid in February in respect to the first half-year, will be equal to a dividend of 5½ per cent. for the entire year. The dividend warrants will be posted on August 12, 1897, upon the register as it stands this day.

Telephone "Extortion."—In the House of Commons, on Tuesday, Mr. Weir asked the Secretary to the Treasury, as representing the Postmaster-General, whether he was aware that the National Telephone Company insisted upon its subscribers paying for the telephone service during the time (sometimes months) that there was practically no service whatever owing to some fault in the company's system, and whether steps would be taken to protect the public from such extortion. Mr. Hanbury said the Postmaster-General had no knowledge of any such action on the part of the National Telephone Company as could be characterised by the term "extortion." Mr. Bowles asked whether the use of such a word was in order. The Speaker said it was certainly not a proper phrase.

Sunderland.—At a meeting of the Tramways Committee a letter was received from the tramways company offering to sell the whole of their lines and rolling-stock to the Corporation under the provisions of the Act of 1870, and to adopt electric traction, providing the Corporation would lease the undertaking to the tramway company for 21 years. The committee did not take any action on this, but a resolution in favour of electric traction was adopted, and Mr. Snell, the electrical engineer, was instructed to prepare estimates, and go into the entire question, and report to an early meeting of the committee. The meeting terminated with the understanding that information should be gathered with reference to the routes, and the whole question is to be brought up at the next meeting.

Bath.—The high opinion the directors of the City of Bath Electric Lighting and Engineering Company hold of the services rendered to the company by their late engineer-in-chief was evidenced on Monday in a handsome presentation. The chairman, Mr. T. O. Callender, on behalf of the directors, handed to Mr. Metzger, at a complimentary luncheon held at the Royal Hotel, a valuable keyless gold watch and chain, inscribed "Presented to G. F. Metzger, A.M.I.C.E., M.I.E.E., in recognition of his valuable services to the City of Bath Electric Lighting and Engineering Company, Limited, January, 1897." Mr. T. O. Callender referred to the long and pleasant connection between the company and their engineer, and expressed a hope that it might be no less cordial between the city electrical engineer and his committee.

Bermondsey.—The Electric Lighting Committee reported at the Vestry meeting the receipt of letters from the County of London and Brush Provincial Electric Lighting Company and the Bourne and Grant Electric Supply Company, notifying their intention of applying for provisional orders to supply electrical energy for public or private purposes in Bermondsey. The committee recommended that the Vestry give notice of their intention to oppose both applications. Mr. Pomeroy asked why the committee recommended them to oppose the applications. Mr. Cox (chairman of the committee) replied that they had not yet received the report of the experts who were employed to advise the Vestry whether they could profitably undertake the supply themselves. If the report was favourable they could continue their opposition; and if not, withdraw it. The committee's recommendation was adopted.

Copper.—The mid-monthly copper statistics show an increase of stocks for the fortnight of 1,588 tons and one of 1,288 tons in the visible supply. The increase in the supply had been fully anticipated, and in spite of this and of the dispute in the engineering trade, which must necessarily diminish the demand for a time, the market for G.M.B.'s has remained fairly steady, the closing values showing a fall of no more than 2s. 6d. per ton on the week. The total supplies for June show an increase of over 2,000 tons as compared with the corresponding month of last year, the advance being chiefly in shipments from the United States, although Spain also considerably increased her exports of this class. The consumption, however, advanced by over 3,500 tons, more than keeping pace, therefore, with the growth of supply, and so far there is no reason to anticipate any marked decline in values.

The Leeds Tramways.—The Highways Committee have decided to invite the members of the Council to the formal opening of the Kirkstall-Roundhay line. No date was fixed, but it was reported that within a month a complete service of electric cars will be running on the route. A deputation from the borough of St. Helens, consisting of the Mayor, several members of the Corporation, and the tramways manager, has visited Leeds for the purpose of inspecting the electrical tramway works. They were taken to the generating station at Crown Point, and afterwards saw several portions of the line and the newly-erected car-shed at Kirkstall-road, where six fully-equipped cars were on view. In their tour of inspection the deputation were accompanied by the deputy-chairman of the committee (Councillor Henry) and several members; Mr. Prince, the surveyor of highways; Mr. Wharam, the tramways manager; and Mr. Talbot, representing Dr. Hopkinson, electrical engineer.

Edinburgh.—At the Town Council meeting, the Town Clerk submitted a letter from the managing director of the Imperial Electric Light and Power Company, London, intimating that it is the intention of the company to apply to the Board of Trade for a provisional order for electric lighting within the district of Portobello, and asking the consent of the Magistrates and Council to the same. Mr. Mackenzie said it was an absurd request; and the Lord Provost said he thought they would all be agreed in refusing the request. This was agreed to. The Electric Lighting Committee of the Edinburgh Town Council have finally adjusted their estimates for the year to May 15, 1898. The expenditure is estimated at £18,920, as against an estimate of £10,730 last year, and an actual outlay of £21,419. 18s. 8d. The receipts for next year are estimated at about £34,155, as compared with last year's estimate of £23,850, and an actual outlay of £26,828. 10s. 11d. The committee estimate their capital expenditure for the next year at £46,900.

National Telephone Company, Limited.—The report for the half-year ended June 30 states that the income amounted to £476,883, as compared with £430,768 for the corresponding period of 1896, an increase of £46,115. The accounts for June, 1896, included the trunk line revenue for the first three months of that year, amounting to about £20,000, which revenue is now received by the Post Office. The working expenses were £266,716, against £224,694, an increase of £42,022. The net result, after deducting the Post Office royalties amounting to £43,156, is a profit balance of £167,011, against £166,524, an increase of £487. The rentals carried forward for unexpired terms of running contracts amounted to £499,963, against £438,322. Out of an available balance of £137,259 the Board recommended a dividend at the rate of 6 per cent. per annum, tax free, on the ordinary shares, that £35,000 be placed to reserve, and that £5,666 be carried forward. The sum of £193,562 has been expended on capital account, the bulk of it in the erection of additional exchange and private lines.

The Engineering Strike.—On Friday last the 400 men employed by Messrs. Crompton and Co. who had remained at the Arc Works, Chelmsford, were assembled in the yard, and addressed by Mr. S. L. Brunton, the works manager. Mr. Brunton stated that Messrs. Crompton and Co.'s had always been a non-union shop, and the firm desired and intended that it should be. They saw plenty of work before them, and hoped their employés would enjoy a better time in the future than they had hitherto done. The firm would be willing to take back as many as those who were out as they had vacancies for if they would renounce the union. Mr. R. E. Crompton, managing director, also briefly addressed the men, and emphasised Mr. Brunton's remarks. At the headquarters of the Amalgamated Society of Engineers on Saturday it was estimated that the total number of men on strike and lock-out was 24,000. The Employers' Federation estimate the number at 23,000. Strike and lock-out pay was distributed on Saturday to about 24,000 men, the total amount being about £20,000.

Cardiff.—At the Town Council meeting, the Cardiff Lighting and Electrical Committee presented the report of the electrical engineer (Mr. Appelbee), stating that the total number of 8-c.p. lamps connected to June 30, 1896, was 14,090; number connected to the corresponding period of last year, 12,643; increase, 1,447. The lamps connected and applications received during the month of June were 299, and the number of lamps awaiting connection was 1,423. The total number of Board of Trade units generated last month were 24,295, compared with 16,558 in June, 1896, an increase of 7,737. The engineer further reported that he had visited the works of Messrs. Ferranti, Limited, who were supplying the Corporation with an additional set of electrical plant. Although the engineers and fitters were on strike the work had so far advanced that he did not anticipate any serious delay. The Chairman stated that when the new set of machinery was fixed, 17,000 8-c.p. lamps could be supplied. They were now supplying 14,000, and there were 1,400 waiting connection. Plans were being prepared for the further extension of the works.

National Electric Free Wiring Company.—With a capital of £250,000 in £1 shares, of which 235,000 shares are now offered for subscription, the National Electric Free Wiring Company, Limited, has been formed to carry out the wiring and fitting of premises for the electric light in consideration of an annual payment. The prospectus states that the Company, without any initial charge, propose to fit up premises under agreements with the Company and the local electric supply authority, the latter collecting and paying over to the Company a sum not exceeding 1d. per unit of electricity supplied as a charge for the fittings and fixtures. Other advantages claimed for the system are that the working capital of the Company will be expended in work producing an immediate return, and that it will at once commence a remunerative business. The Company acquires the contracts (with London electric companies and several corporations), licenses, stock, etc., of the Electric Free Wiring Syndicate, Limited, which, it is stated,

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has already successfully worked the system. The purchase consideration for the assets of the syndicate and other benefits is £30,000, payable as to about £14,000 in cash and the balance in ordinary shares.

Radcliffe.—The Electric Lighting Committee reported at the District Council meeting that they had received a letter from Crompton and Co asking if the Council were prepared to transfer their provisional order on payment of reasonable expenditure incurred in obtaining the order, and a favourable offer in regard to the cost of current to be charged to both public and private consumers. They resolved that Messrs. Crompton and Co. be informed that the Council were not at present in a position to make or accept an offer for the transfer of their provisional order. A letter had also been received from the Board of Trade stating that they have no power to extend the time limited by Section 17 of the Radcliffe Electric Lighting Order, 1895, for the execution of compulsory works, but under the circumstances they will be prepared to refrain from exercising the power of revoking the order conferred upon them by Section 18 for a period of 12 months from June 27, 1897. Considerable discussion ensued upon whether it was advisable to accept the conditions named by Mr. Humphreys to the deputation with reference to the completion of the purchase of the land, and it was decided to let the matter stand over to a future meeting of the committee. The minutes were confirmed.

Lowestoft Telegraph Office.—The *East Anglian Daily Times* says: "The Lowestoft Fish Market Telegraph Office, which has been conducted in an erratic manner since its opening about a year ago, and which was closed a week ago for some unknown reason, was reopened on Saturday morning for business, and although Saturday is an 'off day' in the fishing business, a large number of messages were despatched from the office during the day by those connected with the trade. The reopening was virtually brought about by the combined exertions of Mr. David Young, the local secretary of the N.S.F.A., and Mr. J. W. Towse, the London secretary. Mr. H. S. Foster, M.P., was also communicated with, and he promised to do all in his power, but Mr. Towse apparently forestalled the hon. member. The office was closed throughout last winter, and reopened for the season in March, but since then it has been shut up off and on, to the annoyance and inconvenience of those engaged in the fishing industry. The office is worked from the head office in London-road, but who is really responsible for the existing state of affairs it cannot be ascertained. The blame has been laid by many on the local postmaster, but he avers that he has only been carrying out orders from headquarters. When it is stated that sometimes as many as from 2,000 to 3,000 messages are despatched from the fish market office during one day, the grievance of the trade can be understood. Strenuous efforts are being made to have the office kept open all the year round in the future"

Metropolitan Asylums Board.—The South-Eastern Hospital Committee reported at the last meeting that they had for some time past had under consideration the question of improving and extending the electric fire-alarm system at the hospital. The existing system, which was established about 13 years ago, was defective and unreliable; it was also incomplete, inasmuch as it did not extend to the new ward pavilions, etc., recently erected. The system had recently been examined and tested for them by Mr. H. R. J. Burstall, of the firm of Messrs. Burstall and Monkhouse, electrical engineers, of Old Queen-street, Westminster, and they had received from him a report as to the defects in the system, and the alterations and additions required to render it efficient and reliable, and to make it available for all parts of the hospital; and an offer to prepare a specification of the necessary work, and to supervise its execution at an inclusive fee of 10 guineas. The total cost of carrying out the work recommended in Mr. Burstall's report was approximately estimated by him at £140. They had carefully considered the whole matter, and had conferred with Mr. Burstall upon it, and were of opinion that the alterations, etc., recommended by him should be effected as soon as might be convenient, and that his services should be engaged, at the fee above mentioned, to prepare a specification of the proposed work and to supervise its execution. They therefore recommend that the South-Eastern Hospital Committee be authorised (*a*) to engage, at an inclusive fee of 10 guineas, the services of Mr. H. R. J Burstall, electrical engineer, to prepare a specification for the execution, at an approximate total cost of £140, of certain alterations, additions, etc, to the electric fire-system at the hospital, and to supervise the execution of the necessary work; and (*b*) to invite by public advertisement tenders for the execution of the work which will be included in the aforesaid specification. This was agreed to.

Aberdeen.—The Aberdeen works have for the last three months been busy making preparations to change over their entire system from one of 110 and 220 volts to one of 220 and 440 volts, and have just effected this change-over, the supply now being given at 440 volts between the outers This change has been effected without for one moment discontinuing the supply, and the Corporation have already, or are at present, thoroughly overhauling the whole of their consumers' wiring, and have changed at their own expense the equivalent of 26,000 8-c.p. lamps, made up of incandescent lamps, arc lamps, and motors. No consumer is supplied with current at 440 volts. In the case of old three-wire installations the difficulty has been got over by bunching the two old outers together and making one pole of them, and using the old middle wire for the other pole. They have been able to do this in every case, the middle wire having usually been put in of the same section as each of the outers in the original wiring. All the dynamos in the works have been, or are being, rewound for the increased voltage, and although Aberdeen was long behind larger works, such as Edinburgh and Bradford, in commencing the change over they claim to be the first works to actually complete the work. The whole of the arrangements and work have been carried out by Mr. Alfred Blackman, the electrical engineer to the Corporation. At a meeting of the sub-committee of the Docks and Pilotage Committee of the Harbour Commissioners, the question of the reduced scale of charges for the electric lighting at the harbour, as proposed by the Gas and Electric Lighting Committee of the Town Council, was discussed. According to the new scale, 6d. per unit of electricity is to be charged for the first hour and 3d. for every hour afterwards. This, however, did not meet the views of the sub-committee, the general opinion being that as they were large consumers they ought to get a further reduction. It was agreed to have a conference with the Town Council's Committee to urge this view.

Hastings.—A report was presented at the Town Council meeting recommending the purchase for £3,200 of the standards, lamps, cables, wires, etc., the company, without going to the expense of a valuation, having agreed to accept that sum. Councillor Iddenden, the chairman of the Lighting Committee, moved the adoption of the report. He reminded the Council of the terms of the contract of 1892 between that body and the company, in which the Council reserved to itself the right to undertake its own public lighting, and agreed to take over the plant of the company used for public lighting at a valuation. He intimated that whatever was paid for the plant would be deducted from the £58,000, if the purchase of the whole undertaking was not effected at that price, but if that purchase was not concluded the transaction of that afternoon would be in no wise affected. Councillor Ransom seconded the motion, and Alderman Bray was informed by the town clerk that, as a shareholder in the gas company, he could not speak on the matter. Alderman Macer Wright reminded the Council that the agreement entered into with the company was that the plant should be purchased at the expiration of the contract under a valuation to be made in the usual way. The whole difference on that subject was that the valuation had not been made in the usual way. Alderman Bradnam declared that the only valuation that had been made was by Councillor Burrell, who went through the books. Alderman Tree: No, no. Alderman Macer Wright said that was another matter; Councillor Burrell had nothing whatever to do with a valuation. In reply to Councillor Elworthy, it was stated that the whole of the £3,200 would be paid to the company as soon as it had been borrowed. The sum allowed for the plant on the Front line by the borough engineer was £3,100. The report was agreed to unanimously. The Council agreed to advance the Hastings Rural District Council a loan of £450, instead of one of £2,000, for waterworks at Silverhill. Councillor Elworthy inquired if that sum would stand as part of the debt of the outbounds, and was answered in the affirmative.

Leamington.—At the Town Council meeting Alderman Wackrill moved that the Lighting Committee be requested to consider the desirability of applying for an electric lighting order for the borough. He said a great deal was done by electricity in these days, and means should be taken to protect the borough with regard to the electric lighting question. He had in view the action of the Midland Electric Lighting Company. Councillor Bright seconded the resolution. Circumstances had greatly changed since the question was before the town on a previous occasion. At that time they were charged 8d. per unit for the current, and they could not point out any other place where it was obtained for less. He believed that only half the inhabitants in Leamington burnt gas. Lately, there had been great improvements in lamps, and they were largely used. Electric light was superior to gas, but gas at the present time was more economical. Councillor Fell said he would like to have seen the Council give specific instructions to the town clerk that day to apply for the electric lighting order. There were 20 or 30 similar orders coming before the House of Commons. The day gone by when they could leave the public interests in private hands. He would like Alderman Wackrill to put his resolution in this form, "That the town clerk be instructed to apply to Parliament for an electric lighting order for this borough." That would give them an opportunity of appearing in the House of Commons with their evidence in opposition to the electric lighting company's application. Of course, there would be difficulties, and they would have to buy their plant at valuation, but as it had already been condemned by the Board of Trade it would be an easy matter. Councillor Fell concluded by moving an amendment in the terms he had suggested. Councillor Heath Stubbs seconded. If they could introduce electricity into Leamington at somewhere about the same rate that it had been introduced into other towns, they ought to have it without hesitation. There could be no doubt that for a town like Leamington electricity was the proper light. Their buildings, parks, and gardens could be illuminated with electricity much better than gas. Eventually the amendment was carried.

Coventry.—The City Council considered an important report from the Electric Light Committee at their fortnightly meeting. The committee sought the Council's consent to make application to the Local Government Board for sanction to a loan of £37,900 for the provision of a steam alternator at the works, which, with the necessary alterations, would take £8 000 to lay mains along 50 streets, with a total length of 7¼ miles, and to light with 40 lamps 14 of the principal streets in the city. The chairman of the committee (Alderman Hill), in proposing the adoption of the report, stated that the present works would supply between 7,000 and 8,000 8-c.p. lights. There were already applications for over 8,000 lamps. He argued, from what the Council's deputation saw at Portsmouth, Reading, and Newport (Monmouthshire), that

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electric lighting ought no longer to be regarded as an experiment. Mr. West seconded the proposition, remarking that the history of the department showed that the business was steadily growing. The mileage at present was too small for them to make a profit, but it was believed that, with the proposed extensions, in time the rates would be substantially assisted. In the discussion which ensued one of the chief arguments used against the recommendations was the selection of the streets for the mains. Mr. Russell agreed with the principle of keeping pace with the times, but asked whether the ratepayers could keep pace with the rates. Mr. Russell was of opinion that the committee should have shown a profit before bringing forward further extensions; whilst Mr. Lee, who proposed that the report be referred back to the committee, classed the Coventry system as extravagant. The amendment was seconded by Mr. Webb, whilst Mr. Gorton was desirous of knowing if the committee would be coming in 12 months' time again for a further £30,000, and then say possibly there might be some return. Alderman Hill, replying, mentioned that the proposed extensions would increase the capacity of supply from 7,500 to 17,000 8-c.p. lamps. On the question being put to the vote, there was an equal number for amendment and proposition. The Mayor gave his casting vote in favour of the recommendations, on the understanding that the list of streets should be reconsidered. In the end the Council adopted a proposal by Alderman Maycock to adjourn the consideration of the question until the next meeting. This will be in a month's time.

Yarmouth.—At the Town Council meeting the Surveyor stated that applications had been received for 320 additional lamps, increasing the number to 10,895. The income for June amounted to £169. 6s. 8d., and the expenditure to £155. 8s. The cost of capital and sundry charges was £170 a month. Anticipating an increase of income until December, he estimated that not more than £400 would have to be provided out of the rates. In deference to an expressed desire for fuller information relative to the finances of the undertaking, the surveyor added: "The total amount of loans sanctioned by the Local Government Board is £35,200. On March 31 last the capital expenditure was £30,228, leaving a balance of unspent sanctions of £4,972. This will be used in paying outstanding debts on contracts, condensing plant, additional steam and electrical plant, and in making private connections, about 130 of which have to be made out of present loans. To March 31 last there had been provided out of the rates, to meet the deficiencies between that date and the opening of the works, the following amounts: 1895, £766; 1896, £616; 1897 to March 31, £110—total, £1,492. The sinking fund for repayment of capital charges during the same period has been: 1895, £584; 1896, £639; 1897, to March 31, £200 — total, £1,423. From these figures it will be seen that all but £69 of the amount contributed by the rates was required to meet the charges for repayment of capital, which in 25 years will free the installation from debt, and as throughout that period the plant has to be maintained in a thoroughly efficient manner, it may be expected that a very large proportion of the now capital cost will be a valuable profit earning asset of the ratepayers of the time. The works have thus earned within £69 3 per cent. on the capital outlay from their commencement, and, as every week one or two additional customers are connected, there is very little doubt that a short time will see them self-supporting and, I hope, making some contribution to the rates. That they are not already self-supporting I regret, but in my early reports to you, while you were discussing the desirability of introducing the light, I stated that the loss, including the repayment of capital, would probably be £1,500 in the first two years, but that I hoped in the third year they would fully pay their way. The actual cost was in that period £1,372, but I anticipate that a sum of £400 will be required to meet the deficiency this year. As a portion of this loss, I must remind you that on the street lighting there is a deficiency of quite £100 per annum, but I do not think that any ratepayer, to save the additional cost of the lighting, would wish to return to the quantity of light which was provided prior to the introduction of electricity. The capacity of the works is at present 12,000 lights; loans sanctioned should provide 4,500 lights more, making a total of 16,500 lights, of which we have less than 10,000 actually connected. The staff at the station is quite equal to working the full 16,500 lights. Thus, without increasing your working expenses, and by only increasing your capital expenditure some £3,000, for which the Local Government Board have given their sanction, the earning power of your works will be nearly doubled when the output has increased to the capabilities of the station. A full detailed statement of the working of the station will appear in the yearly accounts." To make the works more remunerative, Mr. Preece had recommended that terms should be offered to one of the free wiring syndicates. The surveyor was instructed to enquire and report.

Eccles.—Mr. Walter A. Ducat has held a Local Government Board enquiry into the application of the Town Council for power to borrow £11,408 for purposes of electric lighting. The Town Clerk, in stating the case, reviewed the lengthy history of the project, dating back to 1882, when the first order of the Board of Trade was granted. This was followed by a new order similar in the main points in 1893, the mains of which had to be laid within two years, but extensions had from time to time been allowed, until at last a private company had asked for a revocation of the order and it became impossible for the Council to act upon a "do-nothing" policy. With regard to the previous enquiry, when the sanction was not given, the reasons for the refusal were stated by the Local Government Board as follows: "The Board were advised that the scheme proposed was not altogether satisfactory, and in particular that in a compact district like Eccles a continuous current with low pressure should be used, and not an alternating current with high pressure and transformers as proposed, inasmuch as by the latter system accumulators cannot be used, and heavy expenses would be incurred in keeping the dynamos running all day. The proposal of the Town Council to avoid this expense by cutting off electricity for eight hours every day would result in very serious inconvenience to those who wish to use electricity for other than lighting purposes. Further, the Board are advised that the land proposed as the site for the generating station is too small for the purpose, and that the stipulation in the covenant on the land as to the carrying on of any business which might be deemed a public nuisance or private annoyance might very probably lead to litigation after the works had been set up. Moreover, the Board learn that there is considerable opposition to the proposed scheme, and they understand that there is not now a majority of the Town Council in favour of it." The Town Clerk dealt seriatim with the objections of the Local Government Board. Under the new scheme a continuous supply would be maintained by the use of the accumulators, which when the first scheme was prepared was not considered to be suitable, but which had since been adopted by various districts with great success. The objections as to the site had been overcome by the adoption of an entirely new site in Cawdor-street, on land belonging to the Corporation, and where there were no restrictive clauses. In regard to the opposition, as the light became better known the opposition had dwindled down until now when the resolution as to borrowing powers was put to the Council only one or two hands had been held up against it. As regards income they had much confidence, inasmuch as 2,500 lamps at 10s. per annum each would be sufficient to prevent loss, and he had not heard of a single installation where there was not in a very short time applications for more than that number of lamps. The Town Clerk then proceeded to state that the population of the borough last year was 34,000, and it might be estimated at the present date at 35,000; the assessable value was £115,000, and its indebtedness £80,399; but there was also a sinking fund which reduced the indebtedness by £3,546, so that the actual indebtedness of the borough was about £76,000, an extremely small amount for a borough of this size. Mr. S. V. Clirehugh entered the witness box and stated that he was a civil engineer and member of the Society of Electrical Engineers. He had prepared a modified scheme. The first important matter, he said, in it was the proposal to have the alternating high-pressure scheme, as used by 26 provincial authorities against 12 who used the low-tension system. The high tension was necessitated because of the length of mains required, the residential portion of the borough being of a scattered nature, the houses mostly standing in their own grounds. At times of light load the accumulators would supply sufficient power, and he proceeded to mention those places, Sunderland, Brighton, etc., where accumulators were used. The site selected was fairly central to the borough, and the advantages of it were that it was in the possession of the Corporation and abutted upon the Bridgwater Canal, from whence they could obtain a sufficient supply of water and coal, and adjoining the highway. The area was 1,585 square yards. Other formal evidence was taken.

Glasgow.—At the Town Council meeting, Mr. Maclay moved the approval of the accounts of the Electricity Committee for the year ended May 31 last. The gross revenue amounted to £30,474. 16s. 1d., and the gross profit to £17,999. 1s. 10d. After deducting sums for depreciation, interest on loans, and sinking fund, there was a balance on the year's operations of £1,527. 2s. 10d. Taking into consideration the very satisfactory balance presented, the committee recommended that, on the principle agreed to by the Corporation last year, the price to consumers whose quantity used did not exceed the maximum demand be continued at 6d. per Board of Trade unit; that for all current taken over the maximum demand, at 100 volts pressure, the price be reduced from 4d. to 3d.; and that for current taken over the maximum demand at 200 volts pressure, the price be reduced from 4d. to 2½d. It was also recommended that the price charged for street lamps be reduced from £26 to £18 per lamp. The quantity of electricity sold during the past year to private consumers was 1,287,418 Board of Trade units, being an increase of 45·2 per cent. over the preceding year. That increased consumption was largely due to the demand during the latter months of the financial year, when the benefit of the rebate under the present system of charging had been recognised by consumers. The year had been a prosperous one, and their reduced rates would compare favourably with those of any supply committee or private company in the three kingdoms. The change of volts would involve a change of lamps, and they were prepared to give their customers new lamps in exchange for the old. They hoped that the statement they were able to make was only an earnest of the good things that were in store for them, and that this was only the beginning of a great success which, he believed, was likely to crown the efforts of their committee. They had been negotiating for sites for new works on the north and south sides of the river, and when these were acquired he believed they would be able to still further reduce their rates, and to place their current within the reach of the smallest consumer in the community. Dr. Colquhoun asked whether it was the intention of the committee to grapple with the electrical supply of the city? At the present time the electrical current was the favoured privilege of the few, and the great community of Glasgow was not at the present time in a position to get a supply from the Corporation. The committee in the past had wedded itself entirely to the low-tension system—a system which would never permit of Glasgow as a whole being supplied with electric current. They had it on the authority of Lord Kelvin that where they had a contracted area and a dense demand there was nothing like a low tension for giving an efficient

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and economical supply, and he supposed the central station in Glasgow supplied what might be called a compact area with a tolerably dense demand; but how long had it taken the Electricity Committee to create that dense demand which enabled them to carry on their business? The station was established a good many years ago, and practically this was the first year they had been able to show a good commercial return from the undertaking. What they evidently proposed to do now was to lay down in two parts of the city two new low-tension stations, which, no matter in what districts they were placed, would have to be carried on for several years at a loss, because it was not conceivable that they could put down a low-tension station and be able at once to create what could be characterised as a dense demand. It was only where there was a tolerably dense demand surrounding a low-tension station that it could be carried on profitably. He asked the committee whether they were now prepared to face laying down a high-tension system for the purpose of grappling with a demand for electricity from any part of Glasgow. In Edinburgh they had a combination of the low and high tension systems, which enabled that city to supply the current to any citizen of Edinburgh who asked for it at a reasonable price, and he should like to know whether it was the intention of the Electricity Committee fully to face the problem of supplying any citizen of Glasgow, in any district of the town, with electric light at the low price which Mr. Maclay had been bragging so much about. Mr. Maclay said they were not prepared to adopt the high-tension system. They had adopted the low-tension system on the recommendation of Lord Kelvin, and they had found it to work well enough, especially now that the Board of Trade had permitted them to work up to 500 volts, so that they could send out currents for two or three miles in any direction. The low-tension system did not necessarily confine them to a narrow or congested district. Already they had commenced to book orders for energy for motive purposes. The accounts were then adopted.

PROVISIONAL PATENTS, 1897.

JULY 12.

16428. An improved method of and means for employing electric traction on ropeways, railways, and like means of transit. Joseph Walwyn White and Herbert White, 10, St. George's-crescent, Liverpool.

16443. Improvements in and relating to incandescence electric lamp sockets and holders. Henry Bevis and James Young Fletcher, 73, St. Stephen's-road, Upton Park, London.

16447. Improvements in or relating to apparatus for electrically signalling on railways. Thomas Elliott, 111, Hatton-garden, London.

16488. Improvement in cores for electric machines. George Westinghouse, 322, High Holborn, London. (Date applied for under Patents, etc., Act, 1883, Section 103, January 20, 1897, being date of application in United States.)

16489. Improvement in fastening means for core plates of electrical machines. Edwin Emerson Nolan, 322, High Holborn, London. (Date applied for under Patents, etc., Act, 1883, Section 103, January 20, 1897, being date of application in United States.)

JULY 13.

16553. Framing vault lights by electrolysis. John Meigge Ewen, 46, Lincoln's-inn-fields, London. (Complete specification.

16588. Improvements in electric arc lamps for stage purposes, but also applicable for other purposes. John Vincent Moinett, 115, St. Vincent-street, Glasgow.

16610. Improvements in electric switches. George Henry Congdon, Homecot, Hitherfield-road, Streatham, London.

16629. Improvements in raceways for electric conductors. Henry Edward Newton, 6, Bream's-buildings, Chancery-lane, London. (The American Silex Company, United States.) (Complete specification.)

16665. Improvements in electric batteries. Charles Theryc, 45, Southampton-buildings, Chancery-lane, London.

JULY 14.

16718. Improvements in electrical recording instruments. Hugh Longbourne Callendar, 24, Southampton-buildings, Chancery-lane, London.

16725. Reflector mounting or holder for electric incandescent lamps. Josef Jergle and Glasfabrik Marienhütte Carl Wolffhardt, 53, Chancery-lane, London.

16728. An improved device to be used for electrical heating purposes. Henry Edmunds, 47, Lincoln's-inn-fields, London.

JULY 15.

16764. A new or improved electromagnetic cut-off. Johann Lühne, 8, Quality-court, Chancery-lane, London. (Complete specification.)

16774. A means of utilising the dynamic energies or inductive force of matter and apparatus connected therewith. Hercules Sauche, Monument-chambers, King William-street, London. (Complete specification.)

16787. Improvements in alternating-current motors. Walter Langdon-Davies, 16, Red Lion-street, Clerkenwell, London.

16816. Improvements in the construction of secondary batteries. Henry Leitner, 37, Chancery-lane, London.

JULY 16.

16887. Improvements in devices for recording the duration of use of electric currents. Charles Christian Schumacher and Albert George Zamel, 45, Southampton-buildings, Chancery-lane, London.

JULY 17.

16919. Means in connection with cycles for generating electricity. Paul Wagner, 111, Hatton-garden, London. (Complete specification.)

16942. An electric furnace for the application of polyphase currents in processes of fusion or decomposition by means of the voltaic arc. Charles Bertolus, 6, Bream's-buildings, Chancery-lane, London. (Complete specification.)

16967. Improvements in telephones and telephonic systems. Franz Oprendek and Arnold Sarkany, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1896.

15777. Electrically-actuated vehicle wheels. Théryc. (Date applied for under International Convention, January 30, 1896.)

16342. Prepayment mechanism for electrical or other meters. Bastian and Hodges.

16435. Filaments of electric incandescent lamps. Bowen.

17890. Magneto-electric machines for the electric lamps of cycles. Tilman and Lexow.

17951. Continuous-current generator-dynamos or motor-dynamos. De Puydt and Poncin.

18464. Electric gas-lighters. Orling. (Date applied for under International Convention, April 23, 1896.)

18704. Electric traction systems. Allen and Peard.

18843. Electrical switches. Richardson.

1897.

12642. Contact fingers for electric controllers. Parham. (Date applied for under International Convention, November 18, 1896.)

12643. System of conductors for electric railways. Lachmann.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	9¼-9⅜
Brush Company, Ordinary	3	1⅛-1⅜
—— Non. Cum., 6 per cent. Pref.	2	1⅛-1⅜
—— 4½ per cent. Debenture Stock	100	105-109
—— 4½ per cent. 2nd Debenture Stock	100	93-97
Callender's Cable Company, Debentures	100	108-113
—— Ordinary	5	6¼-7¼
Central London Railway, Ordinary	10	9½-10½
——	6	5⅞-6¼
Charing Cross and Strand	5	13-14
Chelsea Electricity Company	5	9¾-10¼
—— 4½ per cent. Debentures	100	110-113
City of London, Ordinary	10	23¼-24¼
—— 6 per cent. Cumulative Pref.	10	16¼-17¼ xd
—— 5 per cent. Debenture Stock	100	129-134
City and South London Railway, Consolidated Ordinary	100	62-64
—— 4 per cent. Debenture Stock	100	137-139
—— 5 per cent. Pref. Shares	10	15½-16
County of London and Brush Provincial Co., Ordinary	10	12⅞-13⅛
—— 6 per cent. Cum. Pref.	10	15-15½ xd
—— 4½ per cent. 2nd Debenture Stock	10	15-15½ xd
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1⅛-1⅜
—— 5 per cent. Debentures	—	88-93
Edison and Swan United Ordinary	3	2⅛-2⅜
—— 5 per cent. Debentures	5	3¼-4¼
Electric Construction, Limited	2	1⅝-2
—— 7 per cent. Cumulative Pref.	2	2⅛-3⅛
Elmore's Copper Depositing	1	⅞-1
Elmore's Wire Company	2	⅞-1
W. T. Henley's Telegraph Works, Ordinary	10	18½-19½
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	108-113
House-to-House Company, Ordinary	5	8½-9
—— 7 per cent. Preference	5	10½-10⅝
India Rubber and Gutta Percha Works	10	20½-21½ xd
—— 4½ per cent. Debentures	100	105-108
Kensington and Knightsbridge Ordinary	5	13-13½
—— 6 per cent. Pref.	5	8-8½
London Electric Supply	5	1⅝-2
Metropolitan Electric Supply	10	16½-17½
—— 4½ per cent. First Mortgage Debenture Stock	100	118-122
National Telephone, Ordinary	5	6½-7⅛
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	15-17
—— 5 per cent. Non. Cum. Third Pref.	5	6-6½
—— 3½ per cent. Deb. Stock	100	105-110
Notting Hill Company	10	15-16
Oriental, Limited, £1 shares	1	1⅛-2
—— £5 Shares	5	8⅛-8⅜
—— £4½ shares	4½	7⅛-7⅜
Oriental Telephone and Electric Company	1	⅞-1
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	102-104
St. James's and Pall Mall, Ordinary	5	15½-16½
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	36-39 xd
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	8	10⅝-11⅛
Westminster Electric Supply, Ordinary	5	15-16
Yorkshire House-to-House	5	8-8½

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NOTES.

The Institution of Junior Engineers.—On the 17th inst. a large party of the members of this institution visited the electric light and dust destruction undertaking of the Shoreditch Vestry, on the invitation of Mr. H. E. Kershaw, chairman of the Electric Lighting Committee. Under his guidance, assisted by the engineer and the electrician, the visitors were shown over the entire works.

The Electrical Engineers' Volunteer Corps.—We note that the formation of this new department of the Royal Engineers is favourably commented on in the States. It has been suggested that a similar branch should be formed there, so that in case of war a trained body of electrical engineers should be available for defence purposes. We hope Mr. Thomas Edison will not be offended by this hint, implying that his inventive skill, energy, and electrified water, would not quite sufficiently protect the whole area under the stars and stripes.

Underground Telephone System.—We notice that practically all the vestries and local authorities round London are now considering applications from the National Telephone Company for permission to lay telephone wires under their streets. As the consent of the London County Council has been obtained, we trust the smaller authorities will quickly give their consent, and allow of this great improvement being quickly made. We are sure that a view of Fleet-street is all that is needed to convince the doubting members that the proposed reform is a necessity.

The New Royal Yacht.—We gathered from Mr. Goschen's remarks in the House of Commons on Tuesday last that the new yacht to be put in hand this year for the Queen is to be up to date in every respect. A speed of at least 20 knots per hour for eight hours is to be guaranteed. It has been decided to perfect the accommodation rather than to enlarge the space the engines would require to give a higher speed than the above. A total cost of about £250,000 is talked of as approximately what will be spent on the yacht.

Paris-Dieppe Motorcar Race.—Last Saturday a motorcar race took place, the course being from Paris to Dieppe. The most noteworthy point in connection with this race, was that the special train arranged to take the spectators arrived at Dieppe too late to see the finish. The winner averaged 22 miles per hour for the whole course, covering 93¾ miles in 4 hours 13½ minutes. Such speeds on the public roads are suicidal, and we shall expect a fatal catastrophe at an early date. Oil vehicles in this respect are particularly dangerous, as an explosion will most likely follow the smash-up.

Cable Interruptions. — The Eastern and South African Telegraph Company, Limited, regret to announce the interruption of their Aden-Zanzibar cable. As their cable between Mossamedes and Cape Town has been interrupted for the past week, this interruption cuts off telegraphic communication with South Africa, Zanzibar, Seychelles, Mauritius, Mozambique, Madagascar, and Lorenzo Marques. The interruption on the West Coast of Africa is close to Cape Town, and as the ship arrives there next Saturday it will probably be repaired on Sunday or Monday, and communication restored between Europe and South Africa.

Extra High-Tension Scheme.—The work for the transmission of 4,000 h.p. from the river running through the Santa Ana Canyon to Los Angeles and Pasadena, some 80 miles, has been concluded between the Southern California Power Company and the General Electric Company. The power station will be located in the Santa Ana Canyon, The water will be taken from the river by means of a canal or tunnel along the side of the canyon. It will finally enter a pipe line some 2,200ft. long, giving what will be equivalent to a head of water 750ft. high. The waterwheels will be of the impact type, directly connected to the generators, of which there will be four, each of 750-kilowatt capacity. The maximum line potential will be 33,000 volts, to which potential the initial voltage will be raised by 12 250-kilowatt step-up transformers. We trust that the scheme will be successful, and shall be glad to hear later the details of the line equipmeut.

Cyrus Field's Cable Relics.—It is announced by the *Electrical Review*, of New York, that the National Museum, at Washington, D. C., has secured the famous Cyrus W. Field collection of documents, autographs, telegrams, and cablegrams relating to the first Atlantic cable. These have been given by Mrs. Isabella Field Judson, and are being arranged for exhibition by Prof. Maynard. The journal kept by Mr. Field, and the notes of deep-sea soundings made by him and the officers of the "Great Eastern," form part of the collection. Mr. Field's private library forms another part of it. There are also copies of medals presented him by Congress and the French Government, engraved resolutions passed by members of bodies in this country and Europe, a cane made from the wood of the "Great Eastern," cases containing sections of the first cable, and those evolved from it, and the globe used by Mr. Field while working out his plans.

Explosions.—The old story of street boxes exploding, due to the electricity they contain, is a regular item of news for provincial papers. The fact that gas leakages are the cause of such explosions has, of course, been well established, but it is difficult to disabuse the public mind when once made up to accept a scientific theory. The latest addition to the accidents which may have been caused by electricity is the lamented fatality due to an explosive hairwash. After carefully reading the theories as to the use of a vulcanite comb and to the hair being dry, causing sparks under the combing process, we do not think this new idea is correct, as the hair certainly was not dry at the time. The hot weather doubtless caused an explosive vapour to be given off very rapidly, and the ignition, in our opinion, was due to a light left burning in the room.

The Phonograph.—The commercial introduction of this instrument is still hanging fire, although we know of a case where it is employed when shorthand men are very busy. We gather from *L'Electricien* that they are taking the matter up in Spain. It seems that the Société du Crédit Commerciel de Barcelone owns a large telephone network in the north-east of Spain. The trunk lines alone comprise some 1,500 miles of conductors. Messages of the nature of telegraphic despatches are written out by the officials on a typewriter, and duly delivered. The first idea was for the receiving officials to write down the messages in shorthand, and then to transcribe them on the typewriter. Now, a phonograph has been used instead, and the words received are repeated into this instrument. Then the speed of the phonograph in repeating the message to the typist can be varied to suit his requirements. In this way the skilled shorthand writer is saved. A gain in speed in despatching messages is claimed by this innovation.

Central Institution Diplomas.—At a meeting of the council of the City and Guilds of London Institute held on Monday last, the diploma of "Associate of the City and Guilds of London Institute" was conferred on the following matriculated students who have this year successfully completed a full course of instruction at the City and Guilds Central Technical College: Civil and

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Mechanical Engineering Department—H. W. Hanbury (Siemens Medal), J. E. Cornish, W. P. Unwin, H. D. Drury, J. B. Willis, M. Jacomb-Hood, J. C. Malim, A. W. Lewis, R. S. Solomon, H. J. Williams, T. Rich, C. E. Shackle. Applied Physics and Electrical Engineering Department—E. W. Marchant, B.Sc. (Siemens Medal and Premium), W. L. Waters, F. S. Spiers, B.Sc., F. Twyman, E. G. Brown, S. S. Grant, C. Lean, H. M. Kirby, R. M. Sayers, W. E. Barker, W. M. Nelson, S. L. Smith, H. R. Mott, T. A. Kerr. Applied Chemistry Department—F. Silvester, G. Lessels, A. N. Crosskey, F. J. Jessop, H. J. Winch, E. R. Nind, E. W. Devas.

Carbide of Calcium.—We have received the following notice from the Secretary of State: "Since the Order in Council of February 26, 1897, in virtue of which certain parts of the Petroleum Acts, 1871 to 1881, were applied to carbide of calcium, the question of the expediency of exempting small quantities of this substance from the operation of the Order has occupied the attention of the Home Office, and the Secretary of State having been advised that such exemption might be safely extended to quantities of carbide of calcium not exceeding 5lb., when kept in separate substantial hermetically closed metal vessels containing not more than 1lb. each, an Order in Council was made on July 7, 1897, authorising the keeping of not more than 5lb. of carbide of calcium in vessels as above described without a license; and the original Order of February 26 has been amended accordingly. The amending Order appeared in the *London Gazette* of July 9, 1897. It is to be observed that, where the carbide of calcium is not kept in vessels as above described, no quantity may be kept without a license."

The Chelsea Polytechnic.—The South-West London Polytechnic Institute, in Manresa-road, Chelsea, which was opened only in the autumn of 1895, has made rapid strides during the past two years. This was abundantly proved on Saturday last at the annual prize distribution by Mrs. Garnett, when Lord Chelmsford presided over a crowded assembly of pupils and their friends. His lordship, in opening the proceedings, remarked with pleasure upon the progress that had been made. At its opening the science school had a total attendance of only five boys, but at the end of the first year the scholars had increased to 78, and at the present time the pupils numbered 169. The promoters of the institute are making every effort to induce parents to allow their children to stay at least three years in the science school, and to then proceed to technical day colleges. The technical day college, which provides systematic courses of instruction in mechanical and electrical engineering and applied chemistry on lines similar to those of the Finsbury Technical College, has only been in existence nine months, but has already proved a success. The progress of the evening classes has been as rapid as that of the day classes, and during the session which has just ended something like 3,000 class entries bear witness to the eagerness with which the poorer classes avail themselves of the instruction offered to them.

Day Loads for Central Stations.—This has been our cry for many years, and we believe that a day load from motors can be obtained for most central stations. The time when it will be obtained depends on the date at which those responsible for the fixing of the price per unit take the matter up reasonably and reduce their terms to compete with other sources of power. Mr. J. A. Kammerer, in taking the subject up before the Canadian Electrical Association, goes into the matter most fully. He says that only a few Canadian stations give a 24 hours' supply, and hence they lose many customers. He particularly emphasises the advantages of the multiphase alternate-current system from the motor point of view. As regards consumers of power, he details the butcher with his meat-chopping machine, the baker with his dough-mixer, the newspaper with its printing press, the foundry with its line of shafting to drive, and the planing mill with its machinery to be kept going throughout the day, in every town, while other and larger industries will be attracted to a town in which a day power service may be obtained. These different industries all using power during the daytime tend to create a steady load line, which is especially desirable, as it increases the number of hours in which the investment is exercising its earning power, and helping to increase and secure the maximum load line throughout the 24 hours.

The Sunderland Exhibition.—We have received notice of an exhibition of the engineering, mining, electrical, marine, and general trades which is to be opened in November next. We are glad to note that the first department in the opinion of the management is electricity. From the very encouraging reception which the proposal to hold this exhibition has met with, there is every indication of all firms of note in the United Kingdom being represented, and that there will be exhibits in every branch of electrical engineering. The sections under which these exhibits are asked for are as follows: apparatus to illustrate the phenomena and laws of electricity and magnetism; thermo-electric batteries; electrical batteries; secondary or "storage" batteries; machines and appliances for producing electrical currents by mechanical power, etc.—dynamos and alternators; the transmission and regulation of the electrical current; electric motors and their applications; lighting by electricity; heating by electricity; electro-metallurgy and electro-chemistry: electro-forging, welding, shaping, tempering, brazing, etc.; electric telegraphs and electric signalling; the telephone and its appliances; the phonograph; other applications of electricity; the history and statistics of electrical invention; and electrical specialities for mines and collieries. In the Department C, devoted to mining industries, we also notice the following sections: boring machines and apparatus for breaking down coal and cutting rock; apparatus for blasting by electricity; and safety lamps, including lamps for electric light.

The American Institute of Electrical Engineers.—The fourteenth general meeting of the institute has been held this week at Greenacre-on-the-Piscataqua, Eliot, Me. The session opened at 2 p.m. on Monday, July 26. The following papers were presented and discussed: "The Precision of Electric Engineering," the inaugural address, by the president, Dr. Francis B. Croker, of New York City; "The Alternating-Current Induction Motor," by Charles Porteus Steinmetz, of Schenectady, N.Y.; "A New Form of Induction Coil," by Prof. Elihu Thomson, of Lynn, Mass.; "Effect of Heat upon Insulating Materials," by Putnam A. Bates and Walter C. Barnes, of New York City; "The Effect of Armature Inductance upon the Electromotive Force Curves of an Alternator," by Prof. W. E. Goldsborough, of Lafayette, Ind.; "Electric Metering from the Station Standpoint," by Caryl D. Haskins, of Boston, Mass.; "Development of Fire Alarm Telegraph," by Adam Bosch, of Newark, N.J.; "Electrical Traction—Notes on the Application of Electrical Motive Power to Railway Service, with Illustrations from the Practice of the Metropolitan Elevated Road of Chicago," by M. H. Gerry, jun., of Chicago; "The Cost of Steam Power," by Horatio A. Foster, of Buffalo, N.Y.; "Efficiency and Life of Carbons in Enclosed Arc Lamps," by W. H. Freedman, of New York City; "Armature Reactions in a Rotary Transformer," by Prof. B. Owens, of Lincoln, Neb.; "Recent Applications of Storage Batteries to Electric Rail-

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ways," by Herbert Lloyd, of Philadelphia; "The Economy and Utility of Electrical Cooking Apparatus," by Prof. J. P. Jackson, of State College, Pa.

The Tramways Institute Dinner.—The tenth annual dinner of the Tramways Institute of Great Britain and Ireland was held in the Restaurant Frascati on the 22nd inst. This function formed a fitting termination to the business meeting of the day and to the excursion to view the Waterloo and City Railway Company's works. A thoroughly representative company was present, including Mr. John Fell (the president), Earl Russell, Mr. W. Woodall, M.P., Mr. L. Atherley-Jones, M.P., Mr. W. J. Carruthers Wain, Mr. J. E. Waller, Mr. J. H. Rosenthal, Alderman Bray (of Plymouth), Mr. J. E. B. Elliot (secretary), Mr. Nisbet, etc. After a well-served dinner the following toasts were proposed: "The Queen and Royal Family," proposed by the President; "The Houses of Parliament," proposed by Mr. Nisbet, and responded to by Mr. William Woodall, M.P., and Mr. L. Atherley Jones, Q.C., M.P.; "The Local Authorities," proposed by Mr. William Allan, M.P., responded to by Mr. Alderman Bray, J.P., Plymouth; "The Tramways Institute and the President," proposed by the Right Hon. Earl Russell, who said the limits of municipalisation was a question which required a great deal of consideration. It was a very moot point as to the limits in which Municipal Corporations should compete with private enterprise. It was a grave question whether the local authorities dealing with the public moneys were entitled to conduct experiments which might involve heavy loss to the ratepayers. Mr. John Fell, J.P., in responding, said he was not an enthusiast for the municipalisation of tramways, but he realised that that was only a question of time. "Traction," "The Press," and "The Visitors" were the other toasts.

Fuses.—On July 7 Mr. P. Janet presented to the Société Internationale des Electriciens a report by Mr. Laporte on "Experimental Researches on Cut-Outs and Fuses." The work in question was carried out in a central station, and the results were considered under two heads: (1) The fuse wire, etc.; and (2) the apparatus for supporting it. The author refers to the previous works on this subject by Mr. W. H. Preece, Mr. Matthews, and others. He particularly refers to some results obtained by Messrs. Steens, Gats, and Freeman, in America, who found that an eight-ampere fuse took 35 amperes for 10 seconds before melting; in fact, only after about 30 seconds is there a definite fusing current. The lag, and the fact that the wire can often be made red hot without falling, is the great fault with such instruments. Mr. Janet concludes that a film of oxide on the wire acts as a support for a certain time after fusion, and that if oxidation were prevented the phenomenon would disappear. Mr. Laporte therefore tried varnishing the wires, with success. Another cause for the delay in fusing is the conduction through the supports, and in this the form and distance apart of the supports are factors to be considered. Thus, a wire $\frac{3}{4}$in. long and ·12in. diameter melted at 17·7 amperes when mounted on terminals weighing six grammes. With terminals weighing 800 grammes the melting current rose to 24·2 amperes. With double the length of fuse, these valves fell to 13·6 and 14·1 amperes respectively. The curves connecting the fusing current in relation to the length were found to be equilateral hyperbolas. These first results are, we understand, to be followed by others, as the experimenter is still at work on the subject.

The Sanitary Institute.—The preliminary programme of the sixteenth congress, to be held in Leeds from September 14 to 18, has now been issued. The president of the congress is Robert Farquharson, M.D. Edin., LL.D. Aberd., F.R.C.P. Lond., M.P., D.L., J.P. The congress will include three general addresses and lectures. The three sections, meeting for two days each, and dealing respectively with (1) sanitary science and preventive medicine, presided over by T. Pridgin Teale, M.A., M.B. Oxon., F.R.C.S., F.R.S.; (2) engineering and architecture, presided over by Lewis Angell, M.I.C.E., F.R.I.B.A.; (3) chemistry, meteorology, and geology, presided over by Wm. Whitaker, B.A., F.G.S., F.R.S. There will also be six special conferences on the following subjects: river pollution, presided over by Major Lamorock Flower, sanitary engineer, Lee Conservancy Board; municipal representatives, presided over by Councillor B. Womersley, chairman of the Sanitary Committee, Leeds City Council; medical officers of health, presided over by Edward Seaton, M.D., F.R.C.P., F.C.S.; municipal and county engineers, presided over by Thomas Hewson, M.I.C.E.; sanitary inspectors, presided over by Peter Fyfe, F.R.S.E.; and also one on domestic hygiene. The local arrangements are in the hands of an influential local committee, presided over by the Right Hon. the Lord Mayor of Leeds, with J. Spottiswoode Cameron, M.D., B.Sc. (medical officer of health for the city), and A. E. Pearson, M.R.C.P., L.R.C.P., and W. Spinks, A.M.I.C.E., as honorary secretaries. It appears from the programme that over 300 authorities, including several county councils, have already appointed delegates to the congress, and, as there are also over 2,000 members and associates in the institute, there will probably be a large attendance in addition to the local members of the congress.

Paris International Fire Prevention Congress, 1897.—We have received through Mr. F. Hoare, of 249½, High Holborn, some particulars of the above congress. The letter from the French committee is as follows: "We have the honour to inform you that in the hope of preventing a return of the horrible catastrophe of the Charity Bazaar fire of Paris in May last, which has so painfully affected the world, we propose to call together an international congress to discuss all means to prevent and minimise fire in theatres, concert halls, and places of public resort, the date of which will be very shortly announced. We therefore appeal to the Press, to French, English, and foreign architects, engineers, and scientific men generally who are interested in this grave question. In conjunction with the congress there is also being organised an international exhibition of all engines, inventions, products, and plans for the prevention of fire, and fire-extinguishing appliances and materials. We therefore invite all manufacturers, engineers, and inventors to exhibit their machines and inventions there, for which purpose a large building near the congress will be placed at their disposal. In this way all scientific discussion will be strengthened by practical demonstration. To prove the importance of the congress, 150 members of the Senate Deputies, Municipal Councillors of Paris, and scientific men of the Government have already joined the committee." The letter concludes by asking for our support. The question is an important one, but we are not sure that the congress will be able to do more than arrange a good exhibition of fire-extinguishing apparatus. From our recollection of the details of the catastrophe, all ordinary precautions were neglected, even to having no secondary means of exit. Surely the police or the municipal authorities of Paris have at present sufficient power to prevent such death traps being opened to the public. If they have, and neglected to exercise the powers, the congress has every reason to pass some strong resolutions, as the dismissal of a few officials would have a good effect.

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Telephone Correspondence.—The letters we often see in the daily Press, and especially in the *Daily Mail*, on this subject, may, as a whole, be classed as utter rubbish. We read of a certain gentleman, perhaps, who wanted to call up a busy friend whose office was, say, 300 yards away. After trying for 25 minutes unsuccessfully he gave up the attempt and what little temper he had left. People forget that when they call to see important personages or firms in their office they have to wait their turn, or else are interviewed—on the division of labour principle—by some under official. Yet they will as likely as not find that one telephone only is used in that office, and also that the firm's own messages at certain times of the day block the instrument up from all calls. The circular notice issued by the Chicago Telephone Company shows one way out of this difficulty. It reads thus: "Owing to the general observance of the Saturday half-holiday, and the consequent rush of business during the morning hours of that day, subscribers will expedite their own calls and avoid 'busy' calls to a greater extent by extending the period of use of their telephone over as large a number of hours as possible. A very great number of subscribers now attempt to do all of the morning's telephoning between the hours of 10 and 11. As a result, many unavailing calls are made for lines which are almost continuously busy during that hour. By beginning the morning's business which is accomplished by telephone at an earlier hour, and extending it at a more even rate up to 12 o'clock, the service will be expedited. Subscribers whose telephones are of greatest value for receiving calls are recommended to keep their lines as free as possible for that purpose, and to avoid blocking them by outgoing messages. Subscribers who have more than one trunk line or telephone are recommended to keep one line free for incoming work as much as possible." This last hint that two telephones or more can be hired by one firm is worth remembering. We are indebted to our New York namesake for the above circular.

The British Association.—The exodus of scientific men to Toronto has set in, and we trust that benefits derived from the double sea voyage will amply repay them for their outlays in the interest of science. We may remind our readers that the following gentlemen hold offices this year in sections likely to yield papers interesting to them: Section A—Mathematical and Physical Science: President, Prof. A. R. Forsyth, M.A., D.Sc., F.R.S.; vice-presidents, R. T. Glazebrook, M.A., F.R.S., Prof. A. Johnson, M.A., LL.D., Prof. O. J. Lodge, D.Sc., F.R.S.; secretaries, J. C. Glashan, Prof. W. H. Heaton, M.A. (recorder), J. L. Howard, D.Sc., and Prof. J. G. McGregor, D.Sc., F.R.S.E. Section B—Chemistry: President, Prof. W. Ramsay, Ph.D., F.R.S.; vice-presidents, Prof. H. B. Dixon, M.A., F.R.S., W. R. Dunstan, M.A., F.R.S., Prof. J. B. Harrington, Ph.D., Prof W. H. Pike, M.A., Ph.D., Prof. W. C. Roberts-Austen, C.B., F.R.S., T. E. Thorpe, Ph.D., F.R.S.; secretaries, Prof. W. H. Ellis, M.A., M.B, Arthur Harden, Ph.D., M.Sc. (recorder), C. A. Kohn, Ph.D., and Prof. R. F. Ruttan, M.A., M.D. Section G — Mechanical Science: President, G. F. Deacon, M.I.C.E.; vice-presidents, Prof. W. E. Ayrton, F.R.S., Prof. H. T. Bovey, M.A., Sir C. Douglas Fox, M.I.C.E., Prof. John Galbraith, M.A.; secretaries, Prof. T. Hudson Beare, F.R.S.E. (recorder), Prof. Callendar, Prof. Dupuis, and W. A. Price, M.A. The first general meeting will be held on Wednesday, August 18, at 8 p.m. precisely, when Sir John Evans, K.C.B., D.C.L., LL.D., treasurer R.S., president-elect, will assume the presidency, in succession to the Right Hon. Lord Lister, D.C.L., LL.D., president R.S, and deliver an address; on Thursday evening, August 19, at 8.30 p.m., there will be a soirée; on Friday evening, August 20, at 8.30 p.m., a discourse will be delivered by Prof. Roberts-Austen, C.B., F.R.S., on "Canada's Metals"; on Monday evening, August 23, at 8.30 p.m., a discourse will be delivered by Prof. John Milne, F.R.S., on "Earthquakes and Volcanoes"; on Tuesday evening, August 24, at 8.30 p.m., there will be a soirée; and on Wednesday, August 25, the concluding general meeting will be held at 2.30 p.m. Members visiting Canada are requested to note that in order to secure the privileges granted by the Canadian railways they must take with them their tickets of membership for the meeting.

Too Much Light.—Mr. Robert Hill, M.R.C.S.Eng., L.R.C.P.Lond., surgeon on board H.M.S. "Victory," communicates some interesting notes to the *Lancet* on the effects of electric arc on the eyes. It seems that two stokers on the above ship, having a little spare time, became interested spectators of an electric drill used to burn out holes in a hardened steel plate. Both men declared that they only watched the arc for about three minutes, and at the time felt no ill-effects except that all objects appeared to be of a deep gold colour. At night, however, both men were aroused by intense pain and partial blindness for the time being, but both recovered quickly after treatment. The author says that "ever since the electric light has been in use workers at this trade have been subject to attacks of blindness, and cases have been recorded in which erosion of the cornea has followed the inflammation induced. Dark glasses are now always used by men so employed. The electric drill acts by fusing a hole through the steel, and probably the intensity of the light is greatly increased by the rays of light thrown off by the molten metal. The fact that the work is carried on chiefly in the daylight hides to a casual passer-by the extreme brilliancy of the light, and it is not until the patient experiences abnormal colour sensations that he is aware of anything extraordinary. When first this drill was used in Chatham Dockyard, Surgeon P. N. Randall had a few similar cases among the dockyard hands, but as they slept on shore he had no opportunity of observing the acuteness of the pain. The pathology of this condition has been stated to be similar to that of snow-blindness or desert blindness, and to depend on irritation of the branches of the ophthalmic division of the fifth nerve. In the cases above recorded the irritation would appear to have gone on to absolute paralysis and the pain to have been due to the acute congestion attending the nerves in their action of regaining their normal function. A somewhat analogous train of circumstances is found in the paralysis of the sensory nerves of other parts of the body when exposed to extreme cold, such as the ether spray or frost-bite, and the pain in these cases is often very great when the congestion attending the 'coming to' of the part takes place. The short period during which the severe pain lasted is also in favour of this analogy. These cases are, in fact, analogous to snow-blindness, and, as in them, the pernicious effects of the electric light are probably due to the ultra-violet rays of the spectrum."

Technical Education.—The current number of the *Journal* of the Society of Arts contains a number of papers read at the recent conference on technical education. The papers specialise, as will be gathered from the following lists of subjects and authors: "Technical Education in connection with the Gold and Silver Trades," by W. Augustus Steward; "Watch and Clock Making," by T. D. Wright; "Technical Education in Relation to Glass Manufacture," by Harry J. Powell; "Technical Education in Architecture and the Building Trades," by W. R. Lethaby; "Polytechnics," by Quinton Hogg; "Work of the Polytechnics," by Prof. Wm. Garnett; "Reforms in the Organisation of Technical Education," by Prof. Silvanus

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P. Thompson, F.R.S.; and "Evening Schools," by Swire Smith. The papers were too full for reasonable comment in the space at our disposal, but a few extracts will be interesting reading. Thus, Mr. Wright said that "in olden times, if a clever master had an intelligent, willing apprentice, the youth obtained a technical education of the best kind, and we are, no doubt, indebted to the apprenticeship system for most of the old masters whose productive skill obtained for us our reputation in horology." He also adds: "The success of the machine factories need not alarm the young watchmaker, or cause him to fear that his occupation is gone. In the most perfect machine system a considerable amount of skilled labour is required, and the increased output of home productions will probably absorb more skilled labour than was ever required in the whole trade under the old system." Prof. S. P. Thompson's paper contains some cutting truths, amongst which the following will bear emphasising. Thus: "Recreation is not education, and social betterment is not the same thing as educational progress. Success in answering questions set in a paper is at best only a paper success; and education which is not technical is not technical education." Again, we agree that "there is still much need of the cold steel of common sense to divide the true from the sham; to discriminate between things which, though essentially different, are called by the same name; to get rid of statistical nonsense, in which progress is supposed to be indicated by the number of thousands of persons taught, irrespective of the questions as to what or how thoroughly they are being taught; and, lastly, to clear away some of the burdens cast on the technical education movement by enthusiastic but muddle-headed pioneers." "The next point in which reform is needed, and in which it is slowly but surely coming about, is the proper adaptation of the technical training to the needs of the various industries or groups of industries. The sort of training that is right and appropriate in one trade or group of trades may be quite wrong and inappropriate in another. Technical education means a different thing in every trade or group of trades." He concluded by pointing out that in Germany the polytechnic schools are places for serious and responsible educational work. They do not, it is true, teach playing; neither do they play at teaching. If we wish our technical institutes to do as much for English industries as the continental polytechnics have done for continental industries, let us learn one thing from them. Let us make the serious instruction of the day classes accessible to all by its cheapness, while excluding the incompetent by entrance examinations suitable to the standard attained in our existing secondary schools.

The Feeling of Sound.—An abstract of the science lecture for 1896, delivered to the Philosophical Society of Glasgow on December 16, 1896, by Dr. John G. McKendrick, F.R.S., professor of physiology at the University of Glasgow, has been published in *Nature*. It gives a large number of curves of vowels and notes on musical instruments reproduced from the phonograph. Even if these contain all the harmonics, even to the smallest, the shape of them is not very helpful, because the look of the curve depends so much upon the coincidence in phase, of which, curiously enough, the ear takes no manner of account. The following relates to a matter which has been noticed briefly before in these columns, and which is in a certain way interesting: "I shall now show you," says Dr. McKendrick, "another method of recording, not the individual vibrations of the phonograph, but the variations in intensity of the sounds of the phonograph—the intensities of individual notes and chords. I was led to use this method by becoming acquainted with an instrument devised by Prof. Heurthle, of Breslau. He has succeeded in recording the vibrations of the sounds of the heart. I saw that his instrument was very useful, and I adapted it to the particular purpose in hand. Heurthle's instrument is an electromagnet acting on a small plate connected with the elastic membrane of a tambour. Another drum is connected with the first by an indiarubber tube. The metal plate of the first tambour is pulled down by the electromagnet; thus the air is rarefied in the tube and in both tambours, and the lever of the second tambour moves. The next instant the lever flies back. We shall now connect Graham's variable resistance apparatus with the phonograph. As sound waves fall on it, a change is produced in the current passing through the electromagnet; the latter acts on its tambour; a variable pressure is communicated to the other tambour; and if the lever of the latter is brought against a revolving drum a tracing is obtained, and each note and each chord is recorded, so that you get a mechanical tracing of the variations of intensity." This experiment suggested another of a different kind. The current was sent not only through the variable resistance apparatus above the disc of the phonograph, but also through the primary coil of an induction machine. The wires from the secondary coil passed to two platinum plates dipped in weak salt solution. Setting the phonograph going, and putting the fingers into beakers containing salt solution, it is possible to feel the intensity of every note. The variation of intensity, the time, the rhythm, and even the expression of music are all felt. Putting on the mandril of the phonograph a cylinder on which has been recorded a piece of music, there are felt a series of electrical thrills corresponding to every variation of intensity of sound coming from the phonograph. This method shows that the nerves of the skin can be stimulated by irritations coming to it at the rate of the notes and chords of rapid music. Some of the notes produced by the phonograph do not last longer than the five-hundredth or six-hundredth part of a second, but they are quite sufficient to stimulate the nerves of the skin, and it is possible to appreciate the variations of intensity and the *crescendo* and *diminuendo* of rhythmic movement. A number of interesting questions of a physiological nature are suggested by this experiment. The skin is not a structure that can analyse tone or distinguish pitch; it cannot tell the number of vibrations, although there is a curious approach to it. While it is not by any means accurate, one can distinguish tones of low pitch—very low tones—by a feeling of "intermission." Experimenting in this way, and stimulating by interrupting the circuit at the rate of 30 or 40 or 50 breaks per second, and the skin will tell the individual breaks; but getting above that number the consciousness is lost of the individual breaks, and there is a more or less continuous sensation. The phonograph does not necessarily give 50 or 60 stimuli to produce a sensation of a tone. It is not the number of stimuli that determine pitch, but the rate at which the stimuli affect the sense organ, whether it be ear or skin. The question arises, What is it in the skin that is irritated? It is not the corpuscles. They have to do with pressure. There is no organ for the sense of temperature, and against the idea that the feeling is muscular is the fact that the effect is most marked when the current is so weak as to make it unlikely that it passes so deep as to reach the muscles. This experiment suggested the possibility of being able to communicate to those who are stone deaf the feeling, or at all events, the rhythm of music. It is not music, of course, but, so to say, "is music on one plane and without colour." Even, however, with these restrictions, it proved sufficient to recall to a person who could once hear, but had become completely deaf, the recollection of music.

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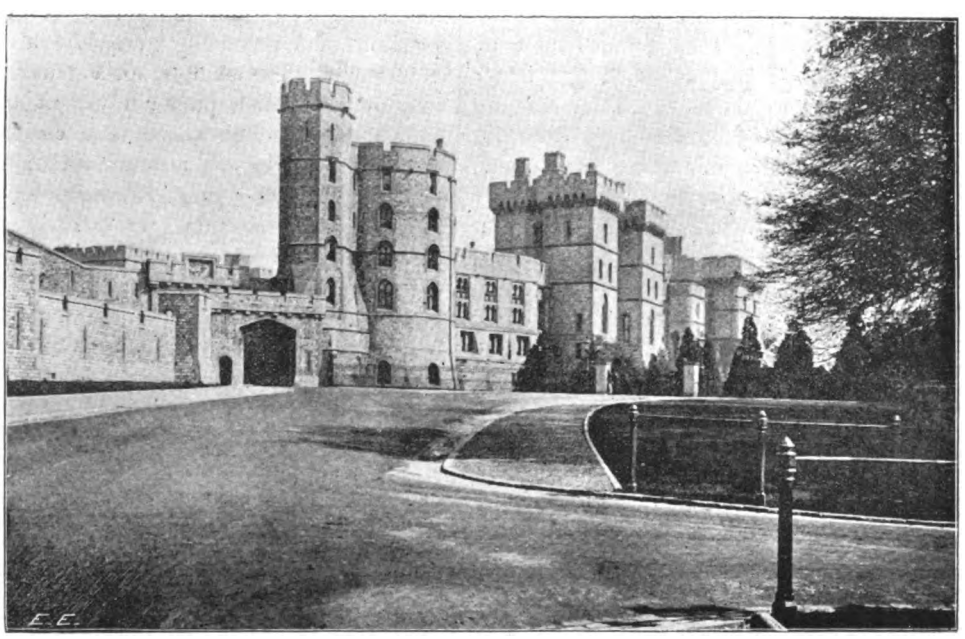
WINDSOR ELECTRICITY WORKS.

The municipal and parliamentary borough of Windsor has for centuries derived its chief support from the fact that it has been one of the most favoured residences of the kings and queens of England. The castle was constructed by Henry I., and has been added to and improved by almost every successive sovereign. The adjoining town

MR. A. E. FARROW, ENGINEER-IN-CHARGE OF THE WINDSOR ELECTRICITY WORKS.

MR. M. DRURY LAVIN, CHAIRMAN OF THE WINDSOR ELECTRICAL INSTALLATION COMPANY.

of Eton is also full of ancient associations, which are grouped round the school building where some of the most famous Englishmen have received their education. These two towns are separated only by the Thames, and hence naturally come under one system of supply of electric light. The history of the movement for the supply of electricity to these towns has been a chequered one, not unmarked by temporary failure in days gone by. The first provisional order for supply of electricity in Windsor was obtained in 1890 by a local company. The active person in the company formed for obtaining this order was Mr. William Sevenoakes, a local plumber and decorator, and also a member of the Windsor Town Council. The engineer to this first company was Major-General Webber. This provisional order did not include Eton. After two years of hard work on the part of Mr. Sevenoakes, it was finally arranged that Messrs. J. E. H. Gordon and Co. should put down a small plant and lay mains in three of the principal streets, the mains and plant to be sufficient to supply some 3,000 8-c.p. lamps. The works were started in 1892, but not under the supervision of Major-General Webber. A 30-h.p. Babcock and Willcox boiler and two small engines, driving with belts two 12-unit dynamos, were installed. The mains laid were copper tubes, supported on circular insulators laid in a concrete conduit, which was then filled with a mixture of tar, pitch, and sawdust, a roll of calico or some such material was laid over the tar, and concrete put over the whole. On account of the hilly nature of Windsor, the heat of the sun caused the tar to run out of the conduit, which left the mains bare. Also, where service wires were taken from the mains, the water got in, electrolytic action soon took place. After eight months' run the station was shut down, and the company went into liquidation. This was largely due to the fact that the shares had never been taken up to any extent, and hence the necessary repairs could not be made.



WINDSOR CASTLE.

Nothing more was done regarding the lighting of Windsor till 1894, when the Corporation applied to the Board of Trade to cancel the order held by the old

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company on account of the failure of the supply and of the non-completion of the compulsory work. This was done, and the same year the Windsor Corporation obtained a new provisional order. Mr. J. N. Shoolbred was then consulted as to whether it would pay the Corporation to carry out the works themselves. They decided, on his advice, not to exercise their electric lighting powers themselves, but to advertise for a company to lease the order. Three different companies sent in offers to take over the order, and, after careful consideration, it was transferred to the Windsor Electrical Installation Company, Limited. Mr. A. E. Farrow, the engineer now in charge of the station, was practically the organiser of this latter company. He had a certain amount of connection in the district, from having lighted up several gentlemen's houses with electric lighting plants. It speaks well for the work done by him that several of these gentlemen offered him all the financial support needed for the larger scheme of lighting Windsor and Eton. First amongst these was Mr. M. Drury Lavin, the present chairman of the company, whose portrait we reproduce herewith, and who now is one of the largest shareholders. It was decided to call in Mr. A. H. Preece as consulting engineer, to advise as to the selection of the plant, the site, etc., and finally the company was successfully floated. There was such a demand for prospectuses that there are now none available at Windsor, but the statement of accounts given below will show that the company was started not as a scheme to make money by promotion, but by generating and selling electrical energy. The Board of directors now consists of the following gentlemen: M. Drury Lavin, Esq., Iver Heath (chairman); H. L. Prior, Esq., J.P., Datchet (deputy chairman); A. A. Somerville, Esq., M.A., Eton College; Rev. R. H. Whitcombe, M.A., Eton College; Tonman Mosley, Esq., Iver; W. Shipley, Esq., Windsor; and Edward Riley, Esq., Marlow. We give the places where these gentlemen reside to show that they are all interested in the near neighbourhood of Windsor. The secretary at present is Mr. W. T. Le Feuvre. Mr. A. H. Preece, A.M.I.C.E., still acts as consulting engineer, while, as mentioned above, Mr. A. E. Farrow is resident engineer. His past experience is as follows: After a good mechanical training, he took charge of the temporary and

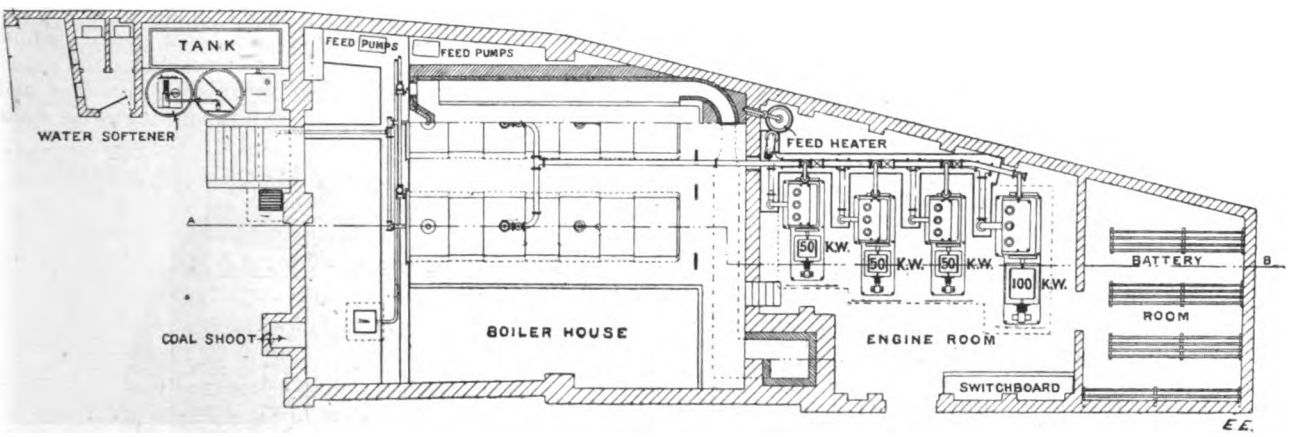


FIG. 1.—Plan of the Windsor Electricity Works.

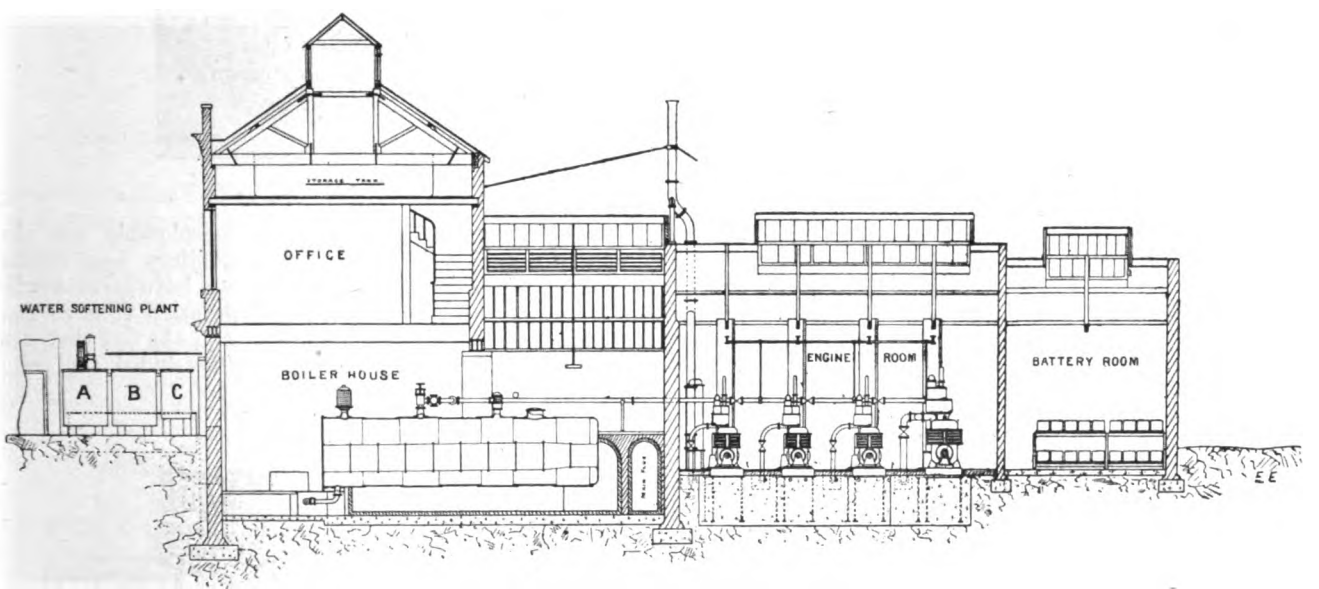
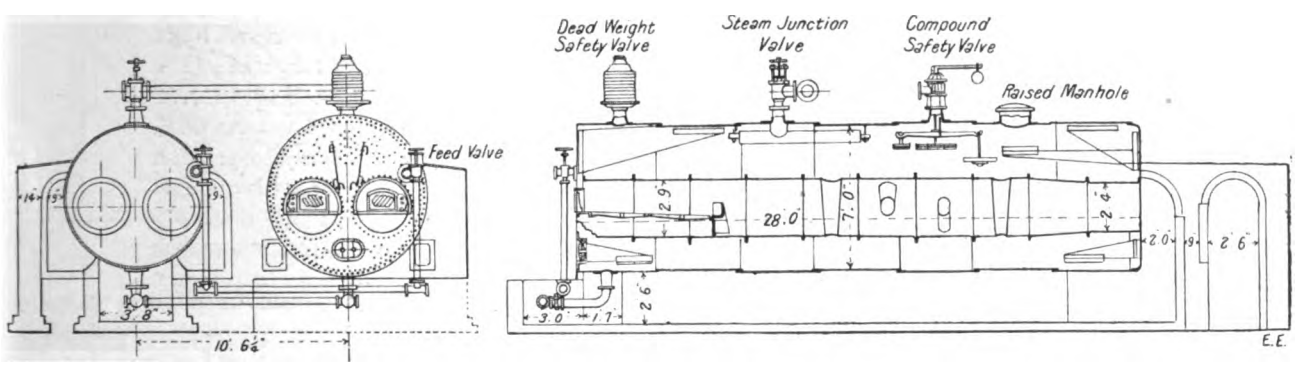


FIG. 2.—Sectional Elevation of the Station.



FIGS. 3 AND 4.—Details of the Boilers and Boiler Settings at Windsor.

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ever-changing installation of electric light on the Manchester Ship Canal works. He was then engaged by Messrs. Roger Dawson, Limited, first as their engineer, and afterwards as manager of their Windsor branch. He then became the manager to the local installation company, whose business is now incorporated with the supply station. While with Messrs. Dawson and the above company he carried out 26 private installations of electric light with gas, steam, and oil engines, the total number of 8-c.p. lamps in these installations amounting to over 5,000.

It was decided to start the supply in Windsor and Eton from a temporary plant erected in Eton, which commenced running in November last. The main station was finished in February, and had thus a load ready to start away with.

Equipment of Works.

It was finally arranged by Mr. A. H. Preece to equip the station on the low-tension three-wire system, with 110 volts at the consumers' terminals. Tenders were asked from all the principal firms, and the contracts were eventually placed with Messrs. Siemens Bros. and Co. and Messrs. Callender's, Limited. The first-mentioned firm supplied the whole of the plant in the central station, while the latter firm has been responsible for all the cable work.

The buildings in Peascod-street were used originally as a brewery, but have been cleverly altered by Mr. W. Summerville (architect), parts being rebuilt. The result is satisfactory, and the cost was considerably less than what it would have been had new buildings been erected. The shape of the site would in any case have given trouble. The general plan (Fig. 1) and the elevation (Fig. 2) show the construction of these buildings, and the fact that none of the engine-room walls are parallel precluded the use of a traveller, but strong transverse girders are placed over each steam-dynamo. For these girders a suitable traversing crab has been provided, which has to be shifted on to the girder over the machine to be moved. Over the boiler-house a suite of offices and a showroom have been constructed. These are approached by an iron staircase outside the building. The showroom is nicely fitted out to give the consumers an idea of what the various fittings will look like when erected. As the company is doing prac

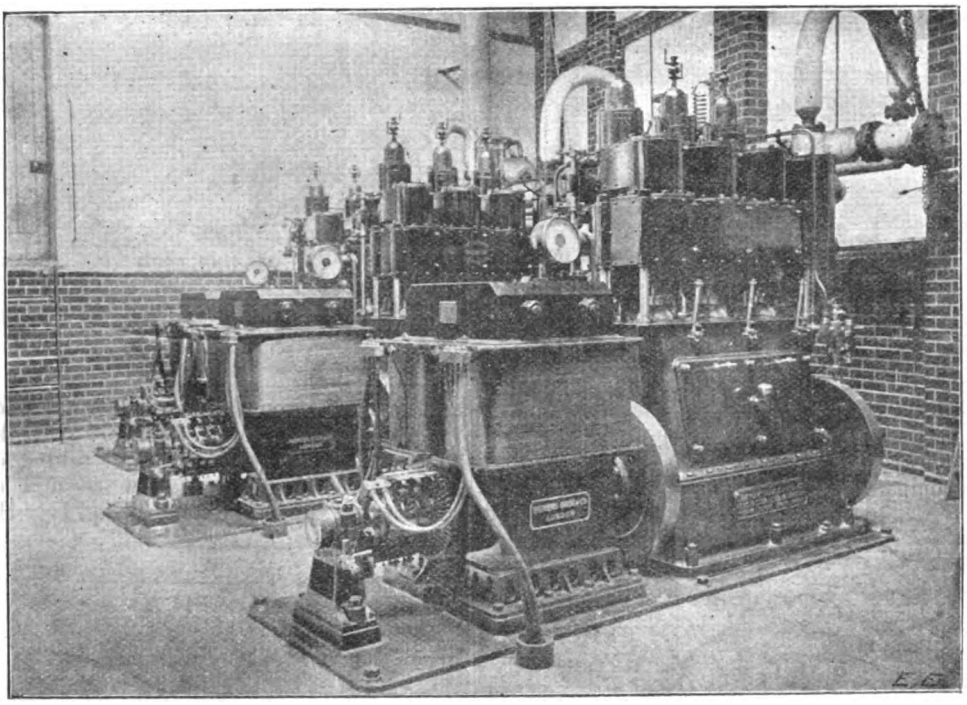
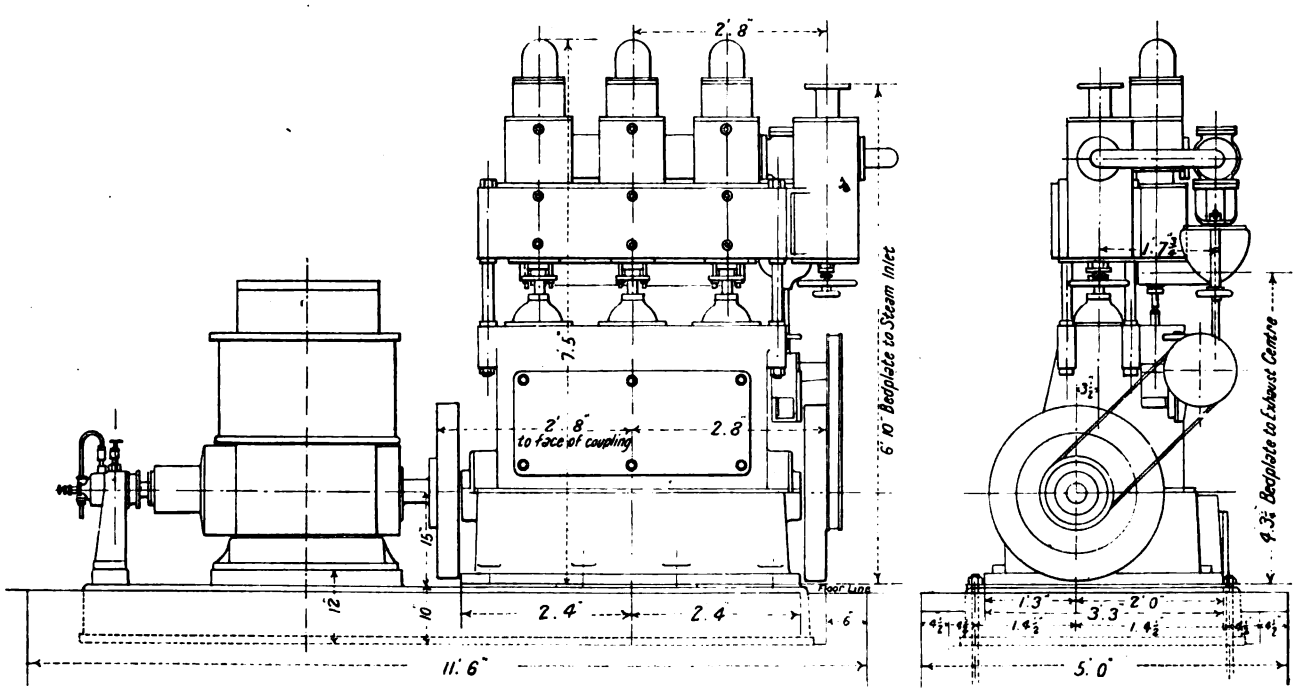


FIG. 5.—General View of the Windsor Engine-Room.



FIGS. 6 AND 7.—Elevations of the Siemens-Peache Steam Dynamos.

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tically all the wiring work for their consumers at competition prices, this showroom was a necessity. The chimney shaft erected for the station is some 60ft. high and 4ft. square inside. The following are the details of the generating plant :

Boilers.

There are present in the boiler-house two Lancashire boilers, made by H. and T. Danks, of Netherton, near Dudley. These, with their setting, are shown in Figs. 3 and 4. The dimensions of the boilers are as follows : Length 28ft. by 7ft. diameter, plates in shell $\frac{11}{16}$in. thick, flues 2ft. 9in. diameter, tapering at last ring but one to 2ft. 4in.

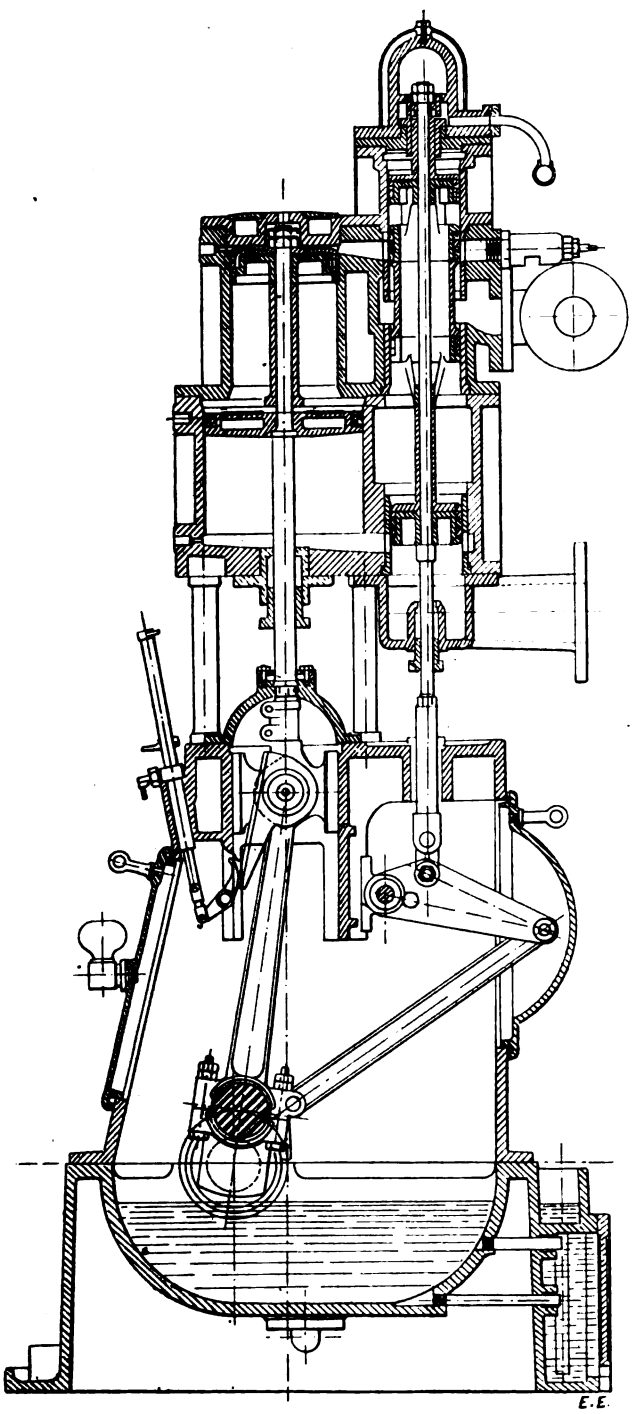

FIG. 8.—Section of One Line of Cylinders of the Peache Engine.

diameter, plates $\frac{1}{2}$in. thick, end plates $\frac{11}{16}$in. thick. The manholes and stools are of wrought steel. The circular seams are lapped and double-riveted, and the longitudinal seams butt together, and are connected by double-cover strips having six rows of rivets. The working pressure is 150lb. per square inch, and the boilers were subjected to a hydraulic test of 250lb. per square inch. The fittings of the boilers consist of two of Dewrance and Co.'s water gauges, fitted with their patent protectors of toughened glass. These protectors consist of flat plates of toughened glass mounted in bronze end-frames, which are held together by screwed rods and surround the gauge glass so as to protect the stokers should a gauge glass break, a dead-weight safety valve, a high-steam and low-water safety-valve, an isolating valve, and the usual blow-off cocks, etc. The feed water is supplied to the boilers by Worthington feed pumps, of which two are at present provided. Each of these is capable of supplying the necessary water to keep the full load of the station going. A duplicate feed gear, by means of injectors, is now being considered by the engineers, and will probably be fixed shortly. The feed water before being used is passed through one of Maignen's water softeners. This apparatus is fixed under a shed just outside the boiler-house, and gives, we are informed, good results. The feed-water is also passed through an exhaust steam feed-water heater, of the Babcock-Wilcox type. The heater has 84 square feet of heating surface, and is capable of raising about 600 gallons of water per hour up to boiling point.

Steam and Exhaust Pipes.

The steam pipes, when the third boiler is fixed, will form a ring main, but at present only one side of the ring has been put in. This is shown in the plan and elevation, Figs. 1 and 2. It consists of a 4½in. steel pipe, slung up to the principals of the roof. Copper bends are used for connections from this to the stop-valves of the engines. The exhaust pipe is of cast iron 8½in. diameter, and is placed underground. It is arranged to discharge either through the feed heater or direct into the atmosphere. All the valves in the steam and exhaust pipes are of the Hopkinson type and make.

The Steam-Dynamos.

There are at present three coupled sets of engines and dynamos in the Windsor station. Each is capable of giving an output of 400 amperes at 125 volts when running at 500 revolutions per minute. These engines and dynamos can be seen in position in Fig. 5, while Figs. 6 and 7 show the elevations of one of the sets. The three engines were made by Messrs. Davey, Paxman, and Co., under the Peache patents, and are of the high-speed single-acting type. They are three-crank tandem compounds, and thus give exceptionally even turning, and run quite free from vibration. The special features of this make of engine are simplicity and strength of construction, and we understand that the governing is exceptionally close. A hand-speed adjustment giving 25 per cent. range is fitted, and throughout the whole range of speed adjustment the variation of speed between full and no load does not exceed 2½ per cent. The cylinders are completely isolated from the crank-chamber, and thus the lubricant in the latter cannot be overheated or decomposed by steam from the cylinders. No artificial cooling of the lubricant is necessary. At the same time, another great advantage secured by this system of construction is that when the engine is worked on a condenser it is impossible for oil from the working chamber to be drawn over into the condenser. The cylinders are not placed centrally with the crank axle, so that on the working stroke the obliquity of the connecting rods is much reduced. The valve motion (see section, Fig. 8) is taken from the connecting rod, no eccentrics being used, and thus room is left for ample and well-supported bearings. All parts are readily accessible for examination or repair without taking the engine to pieces. There are no internal glands, and the pistons and valves are as strong and simple in construction as is the case in an ordinary well-made double-acting engine. Both pistons and valves are kept single-acting by adequate cushioning at all loads, and thus the engines will run noiselessly for long continuous periods.

We understand from the makers that the engines are being well received in central stations, and that they have a large number of engines now under construction. Since the engines have been started at Windsor they have received a further order for an engine of 200 h.p. from the Windsor Electric Light Company, to enable them to cope with the extension in the demands for electric supply.

The three dynamos at present fixed are of the Siemens H B $^{15}/_{23}$ type, having drum armature rotating between the poles of a vertical horseshoe magnet. The armatures are drum-wound and connect so that the brush collects on

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the vertical axis of the commutator. The winding is held in place by binding wires and driven by wooden pegs. The commutator is built up of hard-drawn copper segments of high conductivity, insulated throughout with mica, and the machine runs absolutely sparkless at all loads. On trial it was found that no part of the machine rose as much as 60deg. Fahr. above the surrounding air after six hours' run on full load. Special automatic lubrication of the ring type has been provided for these machines, which has been found to give good results, as no attention whatever is required. Each set is provided with a tachometer, as seen in the general view of the station. A fourth and much larger set is now being supplied for extensions, consisting of an Hc Peache engine, coupled to one of Siemens H.B. $^{21}/_{36}$ dynamos, giving an output of 450 amperes and 250 volts at 400 revolutions.

We also understand from Mr. Preece that a balancing set or motor generator is on order, and that it will be installed in a month's time. This will be capable of transferring 100 amperes from one side of the system to the other, and hence will be useful when charging the batteries, as one engine only then will need to be run.

The Switchboard.

This was also made by Messrs. Siemens Bros. and Co., and is worthy of special note. The diagram of connections (Fig. 9) shows what the various instruments have to do, and the arrangement of these instruments is shown in Fig. 10. The switchboard is divided up into seven panels, two at either end for the generators and three centre panels for the battery, regulating switches, and the voltmeters with their accessories. All the instruments are mounted on enamelled slate slabs, which are fitted in a neat and substantial teak frame. The board is arranged for the three-wire system. On each machine panel, and in the circuit of each machine, is a minimum cut-out adjusted to break the circuit when the current falls below about 15 amperes, such adjustment being easily made; a Siemens ammeter; a two-way double-pole knife switch, by means of which the dynamo can be thrown on to either side of the three-wire system; and a plug bar arrangement for charging and discharging the battery; also circuit fuses and ammeters. The battery switches are designed to carry a current of 200 amperes, and have 12 contacts on each side, with a resistance interposed to prevent the cells being short-circuited when putting them in or out of circuit.

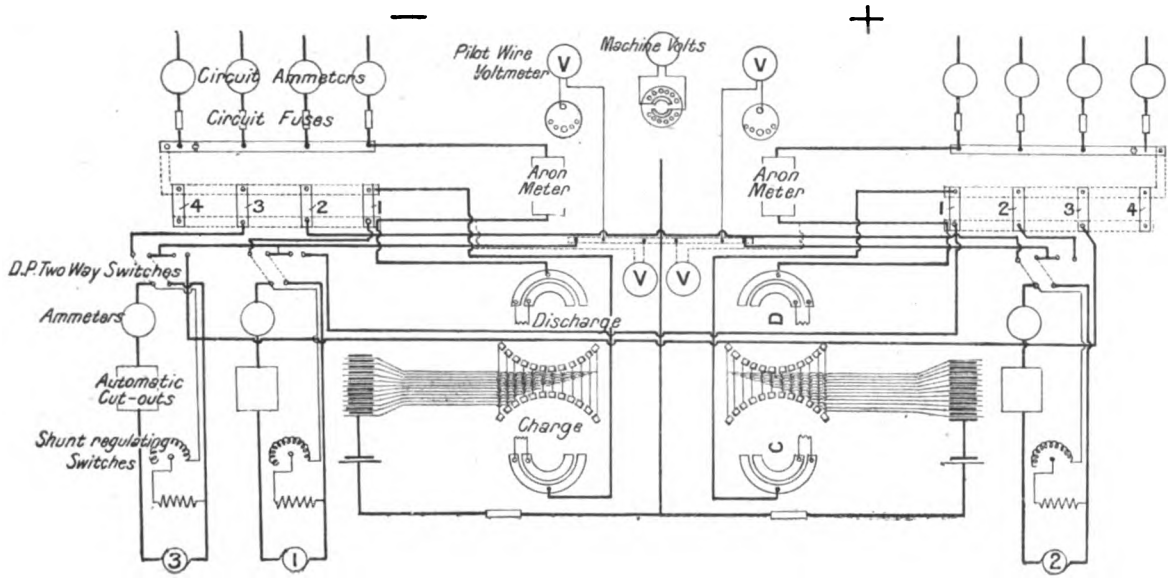

FIG. 9.—Diagram of the Switchboard Connections.

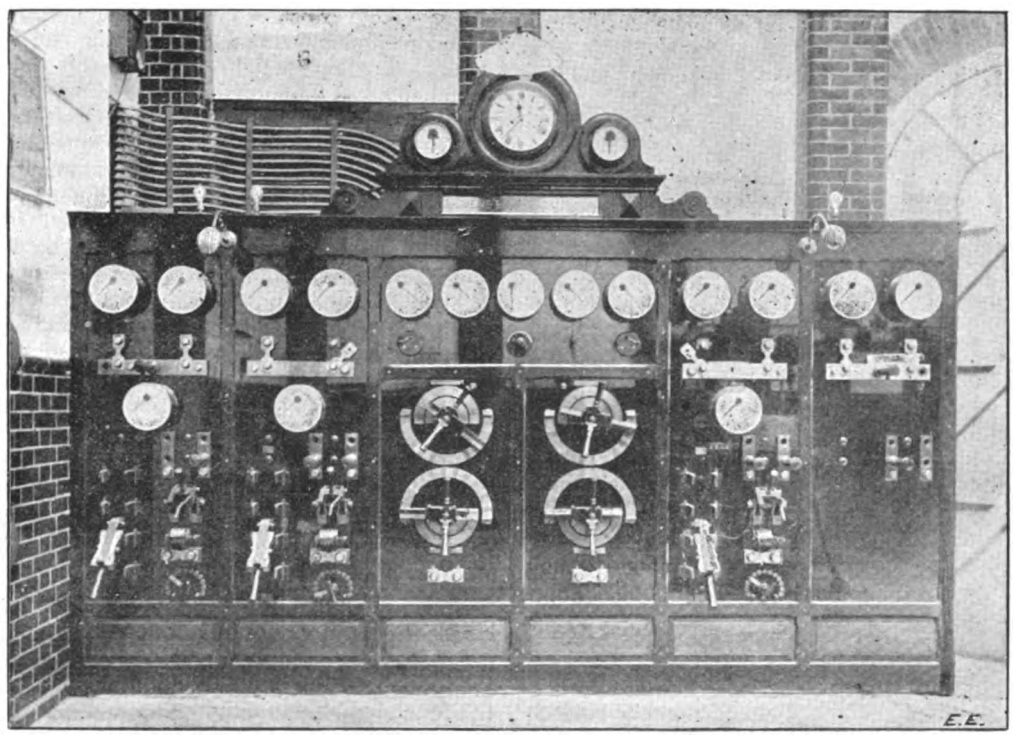

FIG. 10.—General View of the Windsor Switchboard.

The Accumulators.

These were supplied by Messrs. Pritchetts and Gold, as sub-contractors to Messrs. Siemens Bros. and Co. The

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battery consists of 130 cells of the 15-plate type in glass boxes, the plates measuring 9in. by 9½in. by ½in. thick. The capacity is 540 ampere-hours at 50 amperes discharge, or 210 amperes for one hour. The plates are of the latest type; both positive and negative plates are of Planté formation, and their capacity has been proved to be up to the above specified quantities. The battery is placed in the launch charging station. The fourth feeder goes on to supply the Eton schools, and on account of its length a large section is required. The conductors in this case are respectively ·4 square inch, ·2 square inch, and ·4 square inch. The distributors are mostly one size, having conductors ·15 square inch, ·075 square inch, and ·15 square inch, but two other sizes have been used in places. One

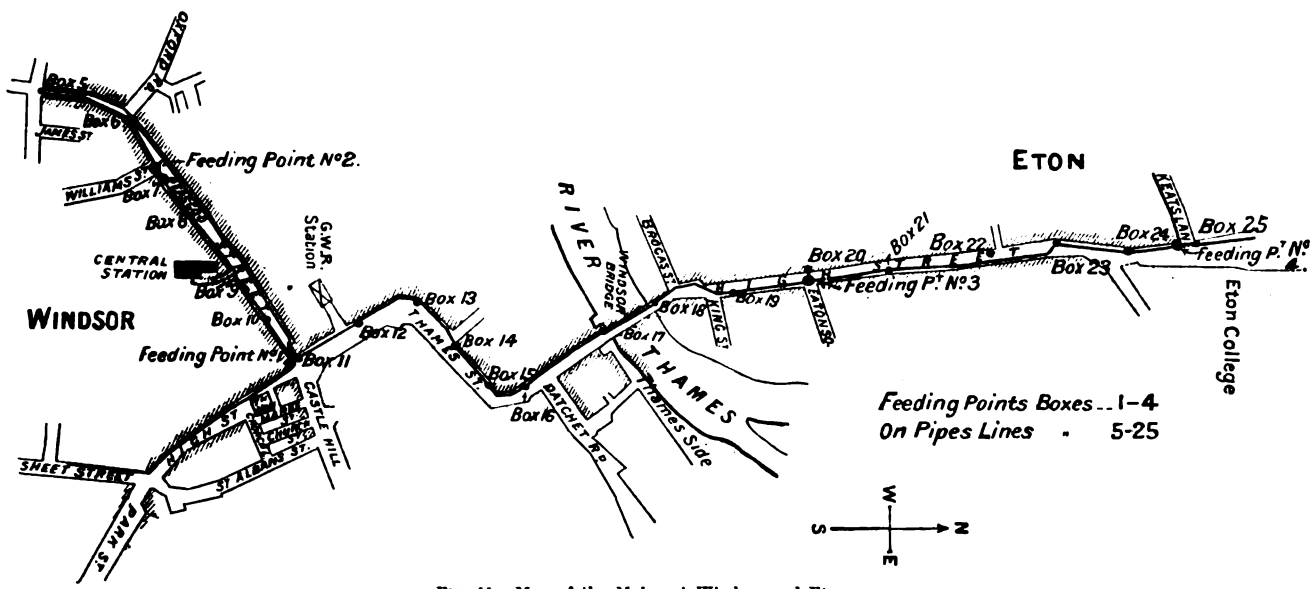
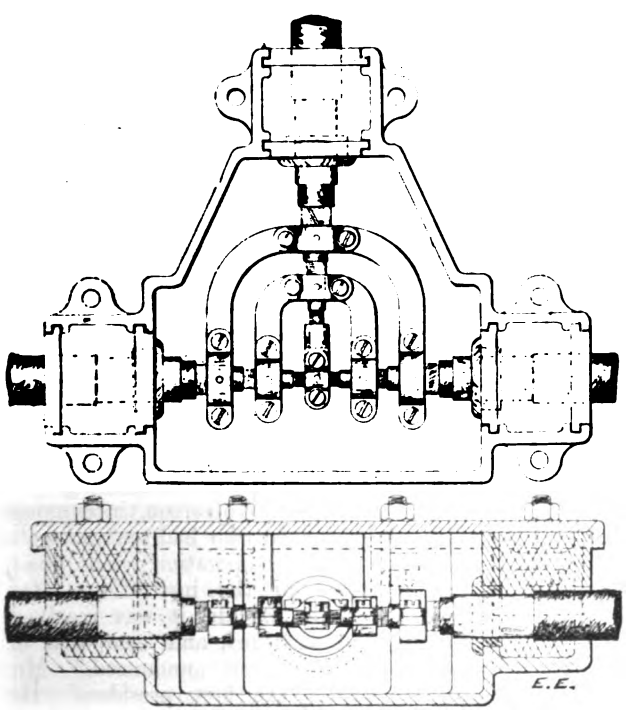


FIG. 11.—Map of the Mains at Windsor and Eton.

the room adjoining the engine-room on substantially arranged stands.

Mains.

These were supplied and laid by Callender's Cable and Construction Company, under the superintendence of their Mr. H. Schiassi. The extent of the mains and feeders already laid is shown by Fig. 11. The individual cables are not shown, but wherever the sides of the streets are shaded distributing cables have been laid. The feeders, which are three-wire, are of the following sections. Feeder



FIGS. 12 AND 13.—Detail of Callender's Triple Concentric Tee-Box.

No. 1 goes to the junction of High-street with Peascod-street, and its conductors are respectively of ·2 square inch, ·1 square inch, and ·2 square inch sectional area. Feeder No. 2 is the same size cable, and runs to the corner of William-street and Peascod-street. The other two feeders cross to Eton, No. 3 ending in Eton-square. This cable has conductors of ·25 square inch, ·125 square inch, and ·25 square inch sectional area respectively. It is tapped at the point where it crosses the bridge to supply

of these is a heavier cable with the outside conductors ·2 square inch, and the zero wire ·1 square inch. The other cable used for distribution has just half the above capacity.

All these conductors, both for feeders and distributors, are made triple concentric. The insulation is bituminised fibre, and the cables are lead-sheathed and armoured. The steel tape used for armouring is a specially-selected brand, to ensure great resisting power to the tools of careless workmen. The cable is covered over all with jute yarn, and dressed with Stockholm tar and bitumen. All these cables have been buried directly in the ground. At the time of laying, however, a 4in. Doulton earthenware pipe was put in along the whole length, so that extra feeders could be drawn in when required. The advisability of this procedure is shown by the fact that already these pipes are being used for extensions, and without any further breaking-up of the pavements. The street boxes are of the usual Callender type for triple concentric work. One of these is shown in Figs. 12 and 13. Owing to the fact that the cables and boxes are often under water in times of flood, a specially heavy oil has been used to fill them in. Nearly the whole of the street work was carried out last autumn during the continuous wet weather then experienced. Nothing could have been more unfavourable for laying cables, and at Windsor the conditions, owing to floods, were specially trying. It hence is a great credit to the firm and to their superintendent, Mr. Schiassi, that the results now are so favourable. We saw tests of the insulation resistance which confirm the above opinion as to the character of the work. The firm has now a lot of extensions in hand for Windsor.

Conditions of Supply.

The consumers at Windsor and Eton are charged 7d. per unit at present, which compares not unfavourably with the charges for gas. The price per thousand for this commodity at Windsor is 3s. 4d., and at Eton 4s. A good business is being done in launch charging from the station. For this purpose supply is given to a local boathouse at the above price per unit. This supply is at the normal voltage, and the boathouse proprietor has to reduce the voltage to suit the requirements of the launches. It is stipulated that he shall not charge more than 1s. 3d. per unit. We understand that during the first six weeks some 2,600 units have been sold to these boat people. This source shows promise of a good summer load, which will greatly relieve the financial charges on the station.

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The schoolhouses at Eton are taking the light up pretty generally, as six masters have already had their houses wired. The financial statement we give below is, of course, not representative of the standing of the company, as the supply was from a temporary plant and for a very short time. We congratulate all concerned on the economical and yet sound basis on which the plant has been laid down and the company organised.

The outgoing expenses for machinery and mains, etc., to date are as follows:

Provisional order, goodwill, and preliminary expenses	£1,000
Land and building	4,500
Machinery	4,750
Mains	4,000
Meters, etc.	1,000
Total	£14,050

The nominal capital of the company, which was originally £15,000, has recently been increased to £25,000, and a further £5,000 has been issued. It is worthy of note that this was all subscribed by the directors and old shareholders.

REVENUE ACCOUNT YEAR ENDED DEC 31, 1896.

Dr.	£	s.	d.
Coal or other fuel ... £27 3 1			
Oil, waste, and engine-room stores ... 0 16 3			
Proportion of salaries of the engineers, superintendents, and officers ... 35 19 4			
Repairs and maintenance ... 23 6 8			
	87	5	4
Rents payable, and rates and taxes	15	6	8
Salaries of managing engineers, secretary, etc. ... 38 1 3			
Stationery and printing ... 4 0 0			
General establishment charges ... 24 0 0			
	66	1	3
Law expenses	59	15	11
Total expenditure	228	9	2
Balance carried to net revenue	2	2	4
	£230	11	6

Cr.	£	s.	d.
Sale of current per meter at 7d. per B.T.U.	18	8	1
Sale under contracts	14	4	9
	32	12	10
Profit on installations	196	1	11
Rents receivable	1	16	9
	£230	11	6

GENERAL BALANCE SHEET, DEC. 31, 1896.

Liabilities.	£	s.	d.
Capital account: amount received	10,477	15	0
Sundry tradesmen and others, due on construction of plant and machinery, fuel, stores, etc., to Dec. 31, 1896	—		
Sundry creditors on open accounts	1,182	0	10
Forfeited shares	1	7	6
Net revenue account: balance at credit thereof	23	4	9
	£11,684	8	1

Assets.	£	s.	d.
Capital account: amount expended for works	6,323	16	6
Stores on hand at Dec. 31, 1896	498	2	6
Sundry debtors for amounts paid on account of contracts in course of completion	1,418	11	1
Preliminary expenses	333	19	3
Sundry debtors for current supplied to Dec. 31, 1896	32	12	10
Other debtors	12	4	10
Cash at banker's, £805. 19s. 10d.; on deposit, £2,220; in hand, £39. 1s. 3d.	3,065	1	1
	£11,684	8	1

INSTITUTION OF MECHANICAL ENGINEERS.*

This institution is now celebrating its jubilee in Birmingham, the city of its birth. On Tuesday last the summer meeting was opened at the Technical Institute, Suffolk-street, and will be continued until to-day (Friday). There were about 300 members present at the opening meeting, including the president (Mr. E. Windsor Richards), Sir William Anderson, Sir Edward H. Carbutt, Bart., Sir Douglas Galton, Messrs. Richard Williams, Charles Cochrane, J. Head, W. H. Maw, Henry Davey, Bryan Donkin, J. I. Thorneycroft, S. W. Johnson, E. P. Martin, J. H. Wickstead, A. T. Walker, J. A. F. Aspinall, Arthur Keen, A. Bache (secretary), etc.

The LORD MAYOR, who wore his chain of office, attended the meeting, and gave the members of the institution a most hearty welcome to the city. They had done very much, he said, towards the progress of the city. The mechanical engineers and dependent branches of trade had been connected with Birmingham for the last 100 years, and he thought the city had been long celebrated for its machinery, tools, and engineering requirements. The Institution of Mechanical Engineers, like many other organisations, political and otherwise, started their life in Birmingham, and hence it was fitting that they should hold their jubilee in that city. They in Birmingham were alive to the importance of the best training for students who intended to take up mechanical engineering, and in the workshops and classes of Mason College and in the technical school they had the advantage of a training which would be invaluable to them in after life. At the present time they had 700 students in the technical school who were studying subjects immediately connected with mechanical engineering. He again gave the members a most hearty welcome, and expressed the hope that their visit would not only be enjoyable, but instructive all round.

The chair was then taken by the PRESIDENT, who said the institution accepted with very much pleasure their invitation to hold the summer meeting of their jubilee year in Birmingham—the place of their birth.

The SECRETARY then read the minutes of the last annual meeting, and stated that since then 66 new members had been elected.

Presidential Address.

The PRESIDENT then delivered his address. He said the institution, which in 1847 commenced in this city its life of usefulness, that day revisited its birthplace to celebrate the fiftieth year of its existence. He expressed his high appreciation and grateful acknowledgment of the immense influence for good which had been exercised by her Majesty throughout the 60 years of her glorious and beneficent reign, and during which their institution had so greatly prospered, and said that an address had been presented by the council to the Queen-Empress. He recalled to members the original ideas of those who initiated the institution, which were the following: to promote the science and practice of mechanical engineering and all branches of mechanical construction, and to give an impulse to inventions likely to be useful to the members of the institution and to the world at large, and also to enable mechanical engineers to meet and to correspond, and to facilitate the interchange of ideas respecting improvements in the various branches of mechanical science, and the publication and communication of information upon such subjects. Had they attained the object for which the institution was formed? To answer this vital question it would be necessary for him to review rapidly for their consideration some of the work done by the institution during the times of the several presidents, and to give some brief notes on the origin and history of the institution. On Wednesday, January 27, 1847, a general meeting was held at the Queen's Hotel, Birmingham, for the purpose of forming the institution. Mr. McConnell, of Wolverton, occupying the chair, read a list of gentlemen who had sent answers to a circular inviting their co-operation and their consent to become members of the institution. On his proposal, seconded by Mr. Buckle, it was resolved "That the institution be established, and composed of the gentlemen whose names he had announced." Mr. George Stephenson was elected the first president. He sketched the proceedings at these early meetings of the institution in Birmingham, and went on to speak of the various presidents from the time of the inauguration of the institution, of the inventions they had made, and of their effect upon the various industries to which they were applied. During 1848 and 1849 the meetings were held in the Philosophical Institution, Cannon-street, Birmingham; and it was there that the president occupied the chair for the last time on Wednesday, July 26, 1848, when his paper on the fallacies of the rotary engine was read and discussed. His death took place only 17 days

* We are indebted to the *Birmingham Daily Post* for part of our report.

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later. In 1850 a house was taken in Newhall-street, where for 14 years afterwards the meetings were mostly held. The proposal of holding the summer meeting of the institution in the leading centres of engineering throughout the kingdom originated in 1856 with Mr. James Fenton, who was consulting engineer to the Lowmoor Iron Company from 1851 to 1863; and through his energetic exertions the proposal was realised in September of the same year by a meeting held for the first time in Glasgow, under the presidency of Mr. Joseph Whitworth. As one result of this new step, the number of members in the institution, which for the seven preceding years had remained at almost a dead level of just over 200, now began at once to increase at a rate of growth which had since continued to progress steadily up to the present date, when they had 2,360 members. During the presidency of Sir Joseph Whitworth in 1856-7 Henry Bessemer's discovery was announced, by which it was claimed that by blowing cold air into and through molten metal malleable iron and steel could be produced without fuel. This statement startled the whole engineering and metallurgical world, and was received by manufacturers of wrought iron with mingled feelings of panic and unbelief. The production of Bessemer steel has now attained to a yearly quantity of nearly two million tons of ingots in Great Britain, and of five million tons in America. Sir Henry Bessemer was now in his eighty-fourth year; and he might be justly proud that by his invention, conceived and matured during the reign of her Majesty, the world was producing about 10,500,000 tons of Bessemer steel annually. Sir William Siemens, president 1872-73, and whose name was associated with that of his brother Frederick as inventors of the regenerative system for melting iron and steel, read a paper in Birmingham in July, 1862, on the gas furnace. No one could possibly have foreseen the really marvellous developments brought about by this invention, by which the process of steel-making known as the Siemens or ore process, and that of Siemens-Martin or pig and scrap process, were made possible. At the time of his presidency of this institution 25 years ago, the production of Siemens-Martin steel was 40,000 tons for the whole of 1872, and the price of ship-plates about £17 per ton; whilst last year the production in Great Britain had reached nearly 2,354,000 tons, the price of ship-plates being brought down to £5. 5s. to £5. 10s. per ton. The total production of open-hearth steel in all countries in 1896 was nearly 7,000,000 tons. In 1879 the quantity of ship-plates made by this process was 20,000 tons, as compared with 9,000 tons made by the Bessemer process, and it was at that time predicted that open-hearth steel would take possession of the field for ship and boiler plates, while the Bessemer process would supply the great bulk of the material required for railway purposes. It would appear as if this prophecy would soon be realised, for they found that in 1896 the production of plates and angles by the Siemens process was about one million tons, and by the Bessemer about 60,000 tons, while by Bessemer about one million tons of rails were made, and by the Siemens 40,000 tons. Sir Frederick Bramwell, who was president in 1874-5, in his address at the Cardiff meeting, strongly directed attention to what he correctly termed the cruelly and wickedly wasteful manner in which they were rapidly using up the principal source of the wealth and power of the country—namely, coal. At that time 120 millions of tons were being raised in the United Kingdom, and to-day nearly 200 millions. These grave words of warning did not receive the attention they deserved, and he could repeat them to-day with even greater emphasis; but he (the president) feared no words of warning, however clearly and solemnly they might ring out by even this great and observant authority, would avail with those who worked collieries with no other object than that of obtaining the utmost profit out of them. At the summer meeting held in Bristol in 1877, the president (Mr. Thomas Hawksley), in his address, took a gloomy view of the relations existing between employers and employed, asserting that our labour was too dear for successful competition with foreign countries—too dear in respect of the quantity of work performed, and too dear in respect of the obstructions and restrictions which the modern workman thought fit to place upon his employment and employer. After a lapse of 20 years these words seemed even more applicable to the present state of those relations than they were at the time they were written. To complete the list of the half-century of presidents, it was necessary that he should add the name of Edward Windsor Richards, 1896-97. All that need be said of him was that he greatly desired to be of service and further the interests of the institution. He had the earnest hope and belief that when the centenary was celebrated the then president would be able to congratulate the members on the progress made in the second half of the century, and that it would be as great as or greater than that of the first half, and that the home built at this time for the purpose of drawing the members into closer companionship might have greatly contributed to that increased success. The institution house was now making rapid progress, and the architect held out the hope that the lecture theatre would be available for the next spring meeting. The review of the work of the institution was sufficient to prove that they had carried out the objects for which the institution was formed, and they could justly claim that they had contributed largely to the general happiness and material prosperity, not only of the people of Great Britain, but of the whole civilised world. Although they had reached their jubilee year, they were still in their youth, full of vigour and full of determination to keep abreast with all progress affecting their profession.

After a vote of thanks had been proposed and carried the PRESIDENT said that the announcement from the chair at the Belfast meeting of the illness of their secretary (Mr. A. Bache) would have prepared them for the statement that he was now obliged by ill-health to resign. Mr. Bache had been a faithful servant, and had done all he could for the interests of the institution, and his health had now given way under the stress of his work. He had been allowed six months' holiday, but shortly after he returned he found that his health was so impaired that he could not do justice to the different interests of the institution. The council had accepted Mr. Bache's resignation, and considered they could not do less than offer Mr. Bache £3,000 as an acknowledgment of his services for a period of 43 years. He asked their consent to this arrangement, and this was unanimously given by the meeting. Mr. BACHE returned his thanks for the generous recognition of his services. His work had been a happy one, and he had memories which would continue as long as life endured. The meeting also approved of the grant of a testimonial of the value of £50 to Mr. J. Forrest, the secretary of the Institute of Civil Engineers.

A paper by Mr. F. J. Osmond (Birmingham), upon "Some Points in Cycle Construction," was read by the SECRETARY, and afterwards discussed, and Mr. HENRY DAVEY, in the next paper, described the Corporation waterworks.

In the afternoon the members visited the new general hospital, under the guidance of the architect (Mr. W. Henman), the consulting engineer (Mr. Henry Lea), and the house governor (Mr. H. J. Collins). They also visited works in the city, and a section of the members journeyed to Wolverhampton, and were shown over some of the chief engineering establishments there.

The members of the institution dined together in the evening in the Grosvenor Rooms at the Grand Hotel.

The following paper was read at the meeting:

High-Speed Self-Lubricating Steam-Engines.

BY ALFRED MORCOM, BIRMINGHAM.

The subject of high-speed engines is one of such real importance and interest that it may be useful and appropriate on the occasion of the present meeting to give some account of the part taken in their development by the writer's firm, Messrs. G. E. Belliss and Co., of this city.

Steam Cutters and Pinnaces.—In 1864 the firm commenced, with Mr. J. S. White, of Cowes, to supply to our own and foreign Governments steam cutters and pinnaces for use with warships. These small boats, which are now such a feature in all our harbours, were at that time unknown. The first boat was a steam life-cutter, built for the late Marquis of Hastings, the primitive engine having a single cylinder 5¼in. diameter and 6in. stroke. With all these small craft throughout, for naval and private purposes, the problem has been the same—namely, to get the greatest power that can be developed out of a given weight of machinery with a reasonable factor of safety. As far

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as the engines are concerned, exceeding care with the design and the materials and quick revolutions have alone rendered advances possible in this direction, but the limits have necessarily been soon reached, and in recent years the chief advances have been made in the boilers, with forced draught to assist the combustion. The shallow draught of these vessels requires a small diameter of propeller, and this, together with the necessity for minimum weight of machinery, has always required the speed of revolution to be kept high. In these small boats, which are carried on board the ships of war, the machinery varies in power from about 12 i.h.p. in the cutters to 200 i.h.p. in the vidette boats. The gradual progress made is illustrated by the fact that in the first vidette boat built a speed was obtained of 14 knots with 142 i.h.p. for a total weight of 5½ tons of machinery, including water in boilers, and in the last a speed of 17·88 knots with 206 i.h.p. for the same weight of 5½ tons.

Torpedo Boats.—A considerable number of sets of machinery have also been built for first-class torpedo-boats, and for torpedo-boat destroyers; and last year the machinery was completed for two of the latter vessels, the "Spitfire" and "Swordfish," built by Sir W. G. Armstrong, Whitworth, and Co. The particulars of the machinery and of the trials are given in Tables 1 and 2. The general features of these engines by all makers are similar. The engine bearers are separate light steel castings, supported on the angle frames running fore and aft between the bulkheads. From these bearers the cylinders are carried by forged-steel columns suitably braced. All the working parts are made as light as possible, as the momentum due to the high piston speed of 1,250ft. per minute on trial is a considerable factor in the working of the machinery. A peculiar feature in these engines, which has considerably assisted in the excellent results obtained, is the arrangement of the cylinders, the low-pressure being divided into two equal cylinders with cranks opposite, and the high and intermediate being also arranged with cranks opposite. This permits the fitting of two links instead of four, reduces the fore and aft space considerably, leaves the ends clear for thrust and air-pump, and gives well-balanced pressures on the shaft bearings. This design was here adopted because it has proved so effective and satisfactory in the two-crank compound engines, of which large numbers have been built by the writer's firm for supplying electric light and power. The absence of four sets of link motion and accompanying gear will be fully appreciated by everyone who has had charge of machinery, developing such large power in such small space as is necessary in torpedo-boat destroyers. The engines are balanced by small weights on the crank cheeks placed at suitable angles; and although the cranks form practically a right-angled arrangement, with these weights fitted the steadiness of the hull and machinery at all powers is remarkable. The boilers are Yarrow water-tube, eight in number. By far the most important improvement in recent years in high-speed ship machinery has been the introduction of the water-tube boiler. This alone has rendered possible the great advance in speed; and there is little doubt that in the mercantile marine the same requirements for speed will lead to the more rapid adoption of this kind of boiler, perhaps more or less modified. The total weight of the boilers in each of the torpedo-boat destroyers is 41¼ tons, which for 4,590 i.h.p. is about 20lb. weight per horse-power. Although there are no separators fitted on the steam pipes, there was not the least symptom of difficulty throughout the trials, and no instance of leakage of tubes or other parts. In Table 3 are given for the sake of comparison the weights of several classes of marine engines.

TABLE 1.—Full-power Trials of H.M.S. "Spitfire," August 17, 1896. Draught of water: forward, 5ft. 2in.; aft, 7ft. 4¾in. Speed of ship: mean for three hours, 27·461 knots; mean on measured mile, 27·775 knots; maximum, 28·571 knots.

—		Three hours full power.		Six runs on measured mile.	
Air pressure in stokeholes	inches of water	3·09		2·76	
Steam pressure in boilers, per square inch above atmosphere	lb.	195		198	
		Right.	Left.	Right.	Left.
Vacuum in condensers, inches of mercury		24·3	23·6	24·5	24·0
Revolutions per minute	revs.	401·9	395·7	408·7	403·6
" " " mean	revs.	398·8		406·2	
Steam pressure in reservoirs, per square inch above atmosphere	high lb.	187	187	185	186
	inter lb.	87	90	85	87
	low lb.	24	25	24	24
Mean pressure in cylinders, per square inch	high lb.	68·0	70·2	65·3	69·3
	inter lb.	30·7	33·3	30·4	32·7
	low forward lb.	20·2	20·6	20·2	19·8
	low aft lb.	19·8	18·8	19·2	19·3
Mean indicated horse-power	high I.H.P.	686	697	668	700
	inter I.H.P.	651	700	657	699
	low forward I.H.P.	453	457	460	445
	low aft I.H.P.	446	416	439	437
Total power of each set	I.H.P.	2,236	2,270	2,224	2,281
Joint power of both sets	I.H.P.	4,506		4,505	

TABLE 2.—Full-power trial of H.M.S. "Swordfish," October 21, 1896. Draught of water, forward 5ft. 2¼in., aft 7ft. 5in. Speed of ship, mean for three hours 27·117 knots. Air pressure in stoke-holes 2·3in. of water. Steam pressure in boilers 203lb. per square inch above atmosphere.

		Right	Left
Vacuum in condensers	inches of mercury	24·1	24·4
Revolutions per minute	revs.	399·2	398·2
" " " mean	revs.	398·7	
Mean pressure in cylinders, per square inch	high lbs.	66·2	66·7
	inter lbs.	36·4	36·2
	low forward lbs.	19·3	19·5
	low aft lbs.	18·9	19·0
Mean indicated horse-power	high I.H.P.	672	662
	inter I.H.P.	771	764
	low forward I.H.P.	431	428
	low aft I.H.P.	424	418
Total power of each set	I.H.P.	2,298	2,272
Joint power of both sets	I.H.P.	4,570	

TABLE 3.—Total Weight of Machinery per Indicated Horse-power in Various Classes of Vessels.

Ordinary merchant steamer	450lb.
Passenger mail boat, twin screw	430lb.
Battleship or cruiser, natural draught	265lb.
" " forced "	195lb.
Torpedo gunboat, forced draught, locomotive boilers	100lb.
Torpedo boat, " " "	75lb.
"Spitfire" and "Swordfish," forced draught, water-tube boilers	47lb.

Lubrication.—The engine-room of a torpedo-boat destroyer during a full-power trial is certainly not a comfortable situation. Constant attention on the part of a considerable number of men is required in order to ensure effective lubrication, and success largely depends on their ability, and on the care with which the lubricators are designed, and the pipes fitted and secured. Yet, to anyone accustomed to slowly-moving horizontal engines, it is astonishing to see how easily well-designed and well-managed machinery of this kind gets through its difficult performance. In the early days of torpedo boats the writer had to take charge of the trials of large numbers of them on behalf of the Admiralty; and, coming as he did from the massive slow-moving machinery in the ships of war of those days, he must confess to having experienced a feeling of sheer fright on finding himself for the first time boxed up in a compartment with a set of Thornycroft's machinery running at about 650 revolutions per minute. Although these engines were then, as now, the perfection of good design and manufacture, it seemed almost impossible to get through a two or three hours' trial with machinery whizzing round at a rate which rendered the details invisible. But as time went on, and the boats were satisfactorily completed, the writer's experience was that although boilers, which, of course, in those days were not water-tube, might give out, or vibrating pipes might burst, or other outside parts might break down, yet the engines themselves rarely gave trouble, or, if they did, it was generally in some detail connected with the lubrication. But on the lubrication a good deal depended; and to ensure success the men employed about it had to be almost acrobats in their capabilities.

Since that time the field for high-speed running has gradually widened, and the more advanced engineers have for long past been prepared to accept the fact that high speed is easily possible with safety, and have used it whenever circumstances have appeared to make it desirable. That it is desirable far more frequently than it is used is a statement which is being made frequently nowadays; and it will be useful to insist upon it here. After their 30 years' experience with high-speed engines, it was natural for the writer's firm to come into the field with this kind of engine for supplying electric light and power. Some preliminary work showed clearly that open engines were not in a position, without further development, to compete with the Willans engines so largely used in central electric stations. These engines are excellent in design and manufacture; and the single-acting cylinders and enclosed plan of lubrication render them quiet running, and easy to look after in the station. Their special claims in regard to economical performance had also to be taken into consideration. It was finally decided to combine a double-acting engine of ordinary construction with a system of forced lubrication, supplying oil under pressure to every bearing; and to enclose all the working parts, in order to prevent splash from the abundant oil supply, and in order to keep out dirt. In the first instance a small single-cylinder engine was put in hand, and the expectations formed were more than realised by its performance. It was found, as had been anticipated, that the oil under pressure enabled the working parts, even when slack, to work without noise, and that after some months' constant working at a load considerably higher than the ordinary full load for this size of engine the bearings had not worn perceptibly. A two-cylinder compound engine indicating 300 h.p. was then completed for driving a dynamo at Messrs. Siemens' Charlton Works. After this engine had been at work continuously for four years, doing the full load required

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for the supply of electric power, it was opened out; and the working parts, which had not been adjusted during this period, were found practically unworn. These and other experiences gained during the same period proved that the plan of forced lubrication served most satisfactorily all the purposes of quiet and efficient running at high speed, and during the last year or two many hundreds of these engines have been turned out, from the smallest size up to 500 h.p. The increasing demand for still larger engines has led to the recent erection by the author's firm of new works for building engines of this kind up to any power that may be required.

Standard make of High-Speed Engines.—The small sizes up to about 15 h.p. are all single-crank with single or tandem compound cylinders. The smaller compounds up to 300 h.p. are of the two-cylinder "Crescent" type. The cranks are opposite, and a single eccentric actuates the slide valves. The oil-pump is an oscillating one, worked off the eccentric, and its oscillation performs the necessary valve action on a surface at the bottom of the pump. The pumps are therefore most simple, without either valves or packing to get out of order. The engine is indeed throughout as simple in every detail as it is possible to make it. The oil is usually drawn from the bottom of the engine casing, through strainers which can be easily removed, into pipes leading to all the bearings; but occasionally, as at Bedford, at the Charing Cross and Strand Electricity Supply Station, at Leeds, and at other places, a complete series of reservoir tanks has been fitted, supplied by separate and independent pumps. Pure mineral oil is used at a pressure of about 15lb. per square inch. These two-crank engines are made triple-expansion when necessary by adding two single-acting high-pressure cylinders, tandem with the other two; and this forms one of the simplest and most effective designs that can be devised for high-speed triple-expansion engines. Formerly the engines were fitted with outside glands only where they were used with condensers on board ship; but recently this design has been adopted throughout, in order to keep the patterns constant, and also to prevent the trouble which water from the glands causes with some kinds of oil. The oil question becomes of serious importance in central electric stations fitted with condensers, especially where water-tube boilers are used.

(To be continued.)

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TRAMWAYS INSTITUTE OF GREAT BRITAIN.

SIR,—In the report of the meeting of this institute I notice my name is included as being one of the council. I shall be glad if you will allow me to state that this is the first formal intimation I have received of having been elected to the council, and to add that I have never been invited to join, neither have I consented to my name being proposed.—Yours, etc, STEPHEN SELLON.

SIR,—I observe it is stated in the Press that I have joined the council of this institute, and I should be glad if you would permit me to say that I have never been invited to join the council, I have never consented to do so, and have not received any intimation from the institute either that my name was about to be proposed or that I have been elected to the council.—Yours, etc., E. GARCKE.

DISTRIBUTING SYSTEMS.

SIR,—The interesting paper by Mr. J. R. Blaikie, of Bristol, on the above subject, which was read before the Municipal Electrical Association on the occasion of the recent convention at Manchester, contains a tabulated statement intended to show the kind of mains used by each of the electrical undertakings in Great Britain. The statement is given under five headings, including both "solid" and "drawing-in" systems, but among the latter no mention is made of the Doulton conduit. Having regard to the enormous extent to which this system has been adopted, its omission renders the table referred to so misleading as to call for correction. This will be obvious from the fact that the earthenware conduit has been adopted as a standard system for over 40 undertakings in Great Britain. This figure includes eight of the London supply schemes, and in many instances the Doulton conduit has been laid throughout the whole area of supply.

We think you will agree with us, that a system which has proved of such utility both for metropolitan and provincial work should certainly have found a place in Mr. Blaikie's table.—Yours, etc., DOULTON AND CO.

Lambeth, S.E., July 26, 1897.

SIR,—I shall be obliged if you will allow me to correct a slight mistake which appears in your report of my remarks on "Distributing Systems" at the Municipal Electrical Association meeting.

I did not say that I preferred a separate low-tension plant for the arcs, but, on the contrary, I advocated either the use of rectifiers, or else connecting the lamps direct on to the low-tension mains.—Yours, etc.,

C. J. SUTHERLAND.

Electricity Works, Hanley, July 26, 1897.

THE ELECTRIC FREE WIRING COMPANY.

We have been asked to insert the following letters, which appeared originally in the *Standard*.—ED. *E.E.*

"SIR,—As the statements contained in the advertisements of this proposed company are likely to produce a very erroneous impression concerning the cost of wiring average houses for the electric light, we trust you will allow us space to draw attention to the matter.

"So far from the sum of 12s. 4d. representing the average prime cost of wiring per light, with fittings, we find that this sum barely covers the cost of the materials, without any provision for labour, an item which frequently costs as much as the materials. We may add that double the sum, or 24s. 8d., with plain ornamental fittings, is much nearer the mark. Unless, therefore, the quality of the work is such as is likely to be unsafe and condemned by the insurance companies, it is evident that the sum of 12s. 4d., which forms the basis of the estimates in the prospectus, must be very considerably increased.

"We have little doubt we shall be denounced as interested parties, but as we do not anticipate that anyone but the working classes would be willing to pay such a high rate of interest for the accommodation offered, our only anxiety is to prevent our clients from thinking that we are making large profits at the prevailing rates, a fact which our books would show is far from being the case.—We are, Sir, your obedient servants,

"DRAKE AND GORHAM, STRODE AND CO.,
VERITYS, LIMITED, J. E. SPAGNOLETTI AND CROOKES,
RASHLEIGH, PHIPPS, AND CO., GEIPEL AND LANGE.
ROGER DAWSON,

"SIR,—With reference to the letter appearing in the *Standard* of to-day's date, bearing the signatures of several firms of electric wiring contractors, I am instructed to say that your correspondents appear to have overlooked the fact that the sum of 12s. 4d. mentioned as being the cost of wiring and fitting a 16-c.p. light is not an estimate, but the actual ascertained cost of wiring and fitting 50 houses of all classes, and certified by Messrs. Chalmers, Wade, and Co., the eminent accountants of Manchester and London. The work has not only been passed by the fire insurance companies interested, but also by the electric supply authorities.

"I am further instructed to say that had it been thought desirable to name a lesser sum than 12s. 4d. as the actual cost of wiring and fitting a 16-c.p. lamp, this could have been done with perfect accuracy by taking an isolated case of a large installation in London, the wiring of which was carried out under this particular system, and the cost of which was a fraction under 10s. per 16 c.p. lamp. It may be well to mention that this installation was also passed by the fire office, as well as by the engineer to the supply company. Further comment on the letter of your correspondent is probably unnecessary.—I am, Sir, your obedient servant, "H. J. NISBETT, secretary (*pro tem.*).

"11, Charing-cross-road, July 22."

Meeting.—The fourteenth ordinary general meeting of the shareholders of the Edison and Swan United Electric Light Company, Limited, will be held to-day (Friday) at the Cannon-street Hotel, at 2 p.m.

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THE

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TO CORRESPONDENTS.

All Rights Reserved. *Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.*

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C Anonymous communications will not be noticed.*

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STORAGE BATTERIES FOR MOTORCARS.

The subject of this heading, and especially that of private locomotion by electrical means, is of greater importance to the profession than most electrical engineers would suppose. But, without anticipating in this direction, have we set about the solution of the problem in accordance with the rules of common-sense, and with due consideration of certain technical and scientific facts which have an important bearing upon the question, and which—though to some they may be novel—are by no means of a recondite nature?

We will not waste our space by insisting upon points which are not only obvious but are universally admitted: the necessity of durability, of a comparatively high rate of discharge—even a very high rate for short periods of time—and of a high ratio of capacity to gross weight of accumulator. Nor is it necessary to point out that, so far as our present knowledge extends, lead active-material, and, in the case of the peroxide plate at least, lead supports are alone available. But lightness in proportion to energy stored being a *sine qua non*, it appears to us sufficiently obvious—though the point may not be universally conceded—that light—*i.e.*, *thin*—lead supports *must* be used in the construction of accumulators for traction, and more especially in those intended for private locomotion. The views which have been, and may be, advanced in a contrary direction involve the acceptance of an unnecessarily high resistance and current density—two conditions which should be carefully avoided.

Admitting, as we do, that thin lead supports or plates must be used, two of the most serious difficulties in the solution of the problem crop up, clearly and distinctly, to overcome us or to be overcome by us. Nor need we waste endeavour on minor points whilst these more vital obstacles oppose us. Difficulty number *one* is that in the case of plates of any ordinary size, and of thickness varying, say, from twenty-five to seventy-five mils, the conductivity, under ordinary conditions, is insufficient to allow of a high rate of discharge, or of charge, if the whole, or anything like the whole, capacity of the elements is to be utilised; in other words, when contact with the plate is made in the usual way along a portion of its upper edge, the distribution of the electro-chemical action over the surface of the plate becomes so irregular at high rates of charge and discharge that the upper half of the element becomes fully charged or discharged long before the lower portion has reached the same condition. Difficulty number *two* is simply that lead plates, perforated or unperforated, of the specified thicknesses, are, under ordinary conditions, altogether deficient in durability in the case of the peroxide of lead element. Provided the former difficulty is overcome, sheet lead of the thickness of twenty-five mils is quite effective and practicable in the case of the spongy-lead element, and with ordinary care will last for an indefinite period. Whereas, in the case of a peroxide element, a plate or support of the specified thickness may become eaten through and destroyed by corrosion within a period of three weeks, even when every

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cause of corrosion other than the local action which normally occurs between the peroxide of lead and its lead support is carefully eliminated. With sheets of less extreme tenuity, the durability rapidly increases as the weight per square foot is augmented; but the means here indicated for obtaining a moderate degree of durability is precisely that from which, under the circumstances, we are precluded. It appears evident, therefore, that unless this difficulty also can be overcome—unless the local action can be obviated or sufficiently diminished, or unless a convenient and inexpensive system for replacing at intervals the peroxide element can be devised—the problem of obtaining light accumulators for private locomotion cannot obtain a satisfactory solution.

The question arises whether energetic means should not at once be taken to surmount these difficulties, or to ascertain that they cannot, at the present moment at least, be overcome. But supposing they have already been overcome, and very completely overcome, by some patient electro-chemist, with little time or care for self-advertisement, toiling day after day and year after year to solve problems such as the above, the future importance of which he has been able to foresee. We do not say that this has actually occurred, for we have not personally investigated the question. But we do say that much quiet and steady work has been expended in the endeavour to overcome the difficulties above referred to, and it has been claimed that these endeavours have in both directions been successful. It appears to us, moreover, that, whether this claim be well-founded or otherwise, our captains of industrial enterprise, our great manufacturers and our foremost electrical engineers, are not sufficiently in touch with the more or less secluded laboratory workers. It is futile and irrational to say, "if a man has an important improvement, why does he not make some batteries and demonstrate his invention to the world?" The man is not necessarily himself a manufacturer; the demonstration may to him be possible only on a small scale, although it may be readily susceptible of confirmation on a large scale. There are but few competent electro-chemists; has any one of them been invited to co-operate in an undertaking which, if practically solved, would bring a flux of work to hundreds of engineers?

In other directions, we think, electrical engineers have boggled over a problem which otherwise might, ere this, have been brought within the domain of practice. It has been stated, with some weight of authority, that "a battery that can work for only two or two and a half hours must be almost useless for motorcars and carriages," and that "a five-hours' run without recharging is a necessary condition for commercial success." Now, from statements such as these we must totally dissent. We have a strong opinion as to the expediency, in commercial matters especially, of beginning at the beginning, of attempting the simple before the complex, of meeting the smaller before proceeding to satisfy the larger demand. Moreover, we have observed that when paterfamilias—whose semi-detached villa is not very far from an electric supply station—takes his spouse for the usual Sunday afternoon drive, the time occupied by the latter is usually well within two or two and a half hours; and Mr. Walworth, who no longer enjoys a bicycle ride as he used to do, and whom business requires to be in the vicinity of Victoria-street from 9 a.m. till 6 p.m., has himself impressed upon us that an automotor that would take him to and from his work would be to him a convenience and a boon. It is in a multiplicity of such small requirements, carried into effect with a comparative readiness which is satisfactory both to buyer and to seller, that a great industrial application, developing and extending from year to year, may best take its rise. It may be likened to a great river derived from a multitude of small and apparently insignificant streamlets. We do not undervalue the recent achievement which goes to prove that nine hundredweights of Faure-King cells can convey a traction weight of one ton (including the cells) over a distance of from twenty-nine to thirty-six miles. But for various reasons this result does not appear to be a centre of growth; and one of the reasons may be that we have fallen into the error of beginning at the wrong end, and of attempting to run before we were certain of our power to walk.

MUNICIPAL ELECTRICAL ASSOCIATION.

SECOND ANNUAL CONVENTION, MANCHESTER, JUNE 30.

(Concluded from page 109.)

The Localisation of Faults in Underground Mains.

BY ROBERT C QUIN, A.I.E.E., BOROUGH ELECTRICAL AND TRAMWAY ENGINEER, BLACKPOOL.

(Concluded from page 109.)

If the former were the case, we should get a concentric main free from external induction and quite useless for our purpose; with the latter the whole of the applied current would be effective. But as has been previously said, both of these conditions are impossible, the probable distribution being more in accordance with Fig. 8. If the earth lead were connected to the gas or water mains, the whole of the current would have to pass from the sheathing to the gas or water mains, but it would first be distributed along the sheathing.

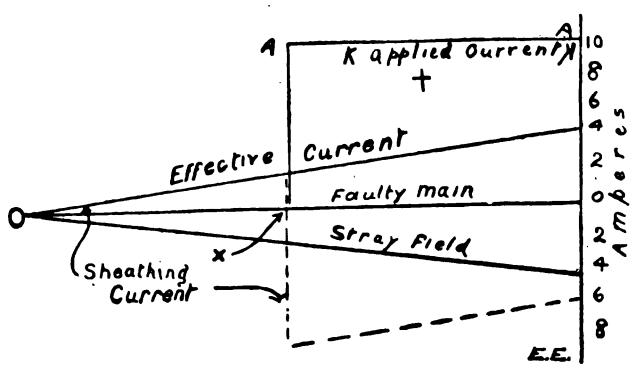

FIG. 7.

A reference to Figs. 7 and 8 will show that the sheathing current on the home side is opposing the effect of the current in the conductor and rendering the test less sensitive, and, further, that the sheathing current on the far side continues the effect of the conductor current. If at the point X (Fig. 7) the current in the sheathing on the home side be eight amperes, then the effective is 10 − 8 = 2 amperes, 10 amperes being the applied current in the conductor. The sheathing current on the far side also becomes 2 − 0 = 2 amperes, gradually diminishing to zero as the circuit is completed, *vid* gas and water mains. The effective current is, therefore, directly proportional to the difference between the conductor and sheathing currents, or, in other words, to the strength of the stray

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field. But while this method relies for its sensitiveness and accuracy on the strength of the stray field, the fact of the existence of such a field necessitates the distribution of the sheathing current, and is, therefore, the reason of its failure. The symmetry of Fig. 7 will not, of course, be preserved in practice, the crossing of gas and water services and mains will give rise to steps in current value, and also in volume of humming sound, but these steps are quite as likely to occur at a perfect point in the main under test as at the fault.

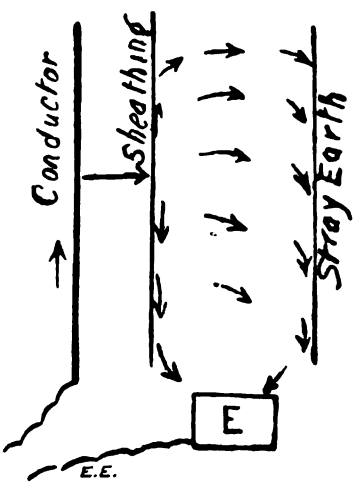

Fig. 8.

One or two cases from the author's experience will help to substantiate this explanation. Having arrived at the section of a network in which a fault existed, he instructed an assistant to locate the position of the fault, giving him for this purpose a specially made search coil and telephone receiver. The author found the tester shortly afterwards tracking a gas-main down a side street in which no cables were then laid, a strong proof of the extent of the stray field. This search coil was flat at the bottom and about 4ft. long, the sides were 6ft. high and vertical, the top being semi-circular; in fact, it resembled nothing more than a semi-circular headed window frame. The current used was intermittent, the cables being single lead covered and armoured. The next case occurred when locating a fault on rubber cables which were drawn in iron piping. In this instance the current was alternating, and the search coil of smaller dimensions. Having located the fault (by what method really does not matter, except to say that in this case no testing instruments were required), and while the current was still on, the author took the opportunity of tracking the cable beyond the fault and found a very definite hum quite 200 yards away when the coil was placed on the ground above the pipe containing the cable. He then had a draw-box opened and placed the search coil in the box and on the faulty cable, but no hum was then obtained, thus showing that the effect was due entirely to the sheathing current.

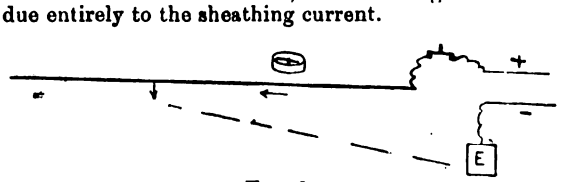

Fig. 9.

The next method to be touched upon is one which entails the use of an intermittent current. The compass test shown in Fig. 9 is referred to. No comment is needed, beyond saying that the writer has found, as would be expected, that it had all the faults of the telephone method previously described. But this compass method, unreliable though it is in its crude form, is capable, with slight modifications, of some surprisingly accurate results. Fig. 10 gives the connections for this modified method.

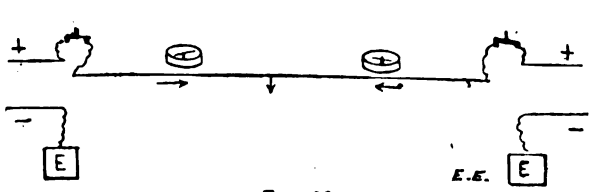

Fig. 10.

It will be seen that it is neither more nor less than the original compass method applied simultaneously to both ends of the faulty main. There are certain precautions, however, to be taken when using this—viz., all other cables in the same trench must be disconnected—otherwise their influence will render the test unreliable, the compass needle must be brought parallel to the main (for this purpose a bunch of keys forms a handy controlling magnet, the keys of the electrical engineer being usually magnetised), the current must be applied simultaneously at both ends and the direction of the steady deflection noted. Where one pole of a network, other than a faulty main, is already earthed, it is advisable to connect that pole to earth at each end of the main under test; otherwise connect the negative or outer, with two-wire system, or neutral or outer, with three-wire system, to earth. A glance at Fig. 11 will show the probable circuits and currents obtained when this method is used, the same ratios of current values being taken here as in Fig. 7. It will be observed that at the fault the effective current is *nil*, that it reverses its direction on either side of the fault. The *modus operandi* therefore is to place the compass on the ground over the cable, adjust the compass so that the needle is parallel to main, switch on current at both ends, then if the needle is permanently deflected

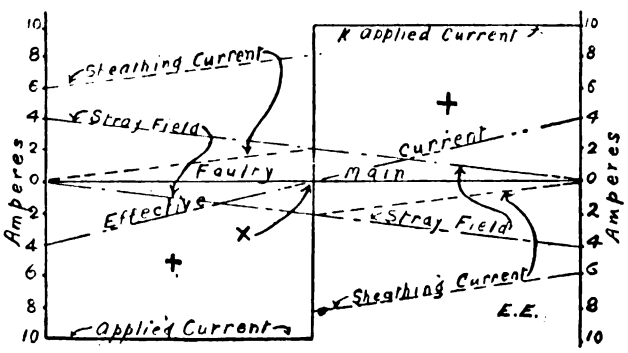

Fig. 11.

to the right, or left, as the case may be, you are still on the home side of the fault; switch off current and move farther along cable, and proceed as before. Should the direction of deflection reverse, you have passed the fault. The author has used this method very largely, and has invariably been successful in locating the position to within a yard either way. But this method has nevertheless several disadvantages. In the first place it is only applicable to continuous-current networks, and secondly it requires a considerable current to earth, the minimum being about 30 amperes with metal sheathed conductors laid about 2ft. 6in. below the surface. In this connection the author may say, having dealt with considerably more than a hundred, that faults in lead-covered cables are generally of the order of an ohm, and therefore, under ordinary circumstances, the requisite current is easily obtainable.

We now come to the author's final method, and the reasons which led him to adopt it may not be without interest. The conditions which a perfect test should satisfy, and which he laid down when devising his were: (1) resistance must not be a factor; (2) a small current only must be required; (3) it should be of practically universal application. Now the principle underlying Fig. 11 seems to the author to be as near the ideal as we are likely to attain, but the great problem which besets us is—how to apply this to alternating-current mains; how to obtain the necessary reversal, alteration, or modification at the fault? There is only one characteristic which can be effectively varied—viz., periodicity—and upon this principle he has based the method which he now recommends. Fig. 12 shows the general connections, and it will be seen that at each end of the main is placed an induction coil, the contact breakers being of different lengths, one pole of each coil being connected to the faulty main, the other being connected to a gas or water main earth for preference. Where the general supply is alternating, this can be applied through a resistance to one end of the main in question, using an induction coil or small motor-alternator at the other end. As regards the difference of periodicity, the authors prefers to use 84 periods and 160 periods per second; the memory of one tone and the impression of the other produce a wholesome discord, which is very effective in bringing the tracker to a halt, especially when he has what is generally termed a "musical ear." As regards the sensitiveness of the test, this, of course, depends largely upon the design of the apparatus. The search coil and telephone

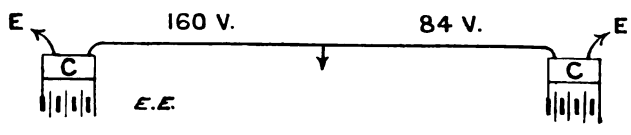

Fig. 12.

receiver which the author is now using is one of special construction, designed by himself, and constructed by his mains engineer. The receiver, which is placed in the centre of the search coil, consists of an ebonite drum containing a cylindrical laminated steel magnet forming the core of a finely-wound bobbin, connected in series with the search coil. At each end of the magnet is fixed a diaphragm and resonator chamber, connected to which

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latter are phonograph ear tubes. The whole is contained in a box 12in. by 9in. by 7in., and weighs about 7lb. It has proved to be very sensitive, one ampere effective current giving a distinctly audible hum at a distance of 10ft. It requires but little ingenuity to adapt this method to any possible earth. There is, however, one class of fault, fortunately of rare occurrence, which needs mentioning. With pilot cables, whether of multiple type or otherwise, it sometimes happens that a strand (or conductor) breaks after being laid down. When the length of cable is considerable and has a fairly high inductive capacity, the fracture can be located, presuming that it is well insulated from earth, by comparing the capacity of a similar sound strand, or conductor, with the broken one and taking *pro rata* lengths. The author was once called upon to locate such a broken conductor in a five-cored pilot about 1¼ miles long. There was no intermediate point at which access could be obtained to the cable, and therefore the only thing left was to test from the end. Capacity test located within 20ft. of the fracture, which, under the circumstances, was a good result. But the "discord buzzar" localisation method is also applicable to faults of this class when sufficient capacity current can be obtained.

A word as to the nature of faults which may be expected. In the lead covering of cables there is a probability of impurity, usually zinc, giving a brittle spot which is liable to fracture during laying. The lead is also liable to mechanical damage. Then with the impregnated cables, the substance used may, by impurities, affect the lead. The author has found lead pitted on the inside more than once. Further, the strands may be buckled, either by twisting during laying or in manufacture, and the insulation pierced and lead fractured. With "drawn in" systems there is a very great probability of damage ensuing from rough handling while drawing in. Faults may also occur subsequently by the weight of the cable resting on a sharp edge either to a draw-box or at a pipe-joint. Apart from the necessity of complying with the Board of Trade regulations as to the electrical connection of all metallic coverings, prudence directs that it should be done, seeing that with high-tension cables drawn in short isolated lengths of iron piping, and not otherwise metallically covered and connected, there is considerable risk of sparking through. The great enemy of all impregnated cables is damp, and the utmost care should be taken during laying, and afterwards at the boxes, to prevent access of moisture. In the matter of the connection of cables to boxes, the author prefers, in the case of lead-covered ones, to wipe-joint the lead covering on to the box. This answers two purposes: (1) we obtain a good electrical connection; (2) we prevent moisture creeping along the cable into the box. Compound glands are more in favour now principally on the score of cheapness, but the author does not like them. In the first place, the electrical connection of the lead to box is not good, and although this may appear a small matter it becomes serious when there is an earth on the cable near it, the probability being that arcing will take place at the gland and burn the lead, leaving an aperture for access of moisture, and when you find this happen do not blame the jointer, blame the system. In the second place, compound glands do not make a satisfactory and lasting watertight joint.

One other cause of faults, and by no means the least, is chemical action. The author refers more particularly to the external action between the cable and the soil in which it is laid. Again, there is the electrolytic action between lead and iron, where lead-covered cables are drawn in iron piping to which water has access, more especially sea-water, or water containing free acid in solution. The chemical stability of certain insulating compounds is also a point which requires investigation.

The duties of the mains electrician, distribution engineer, or whatever else we choose to call him, have hitherto been far too lightly considered. To be at all fitted for the post, he must combine within himself the engineer, electrician, and chemist. He must have an intimate knowledge of the exact position of all his cables, boxes, and joints. He must know the weakness of the particular class of mains he is in charge of, the characteristics of his jointers, the state of the weather when any one joint was made, or any length of cable laid. Further, if his cables are buried direct in the earth, or if water containing the soluble matter of the soil can get access to them, he must know the chemical composition of the particular soils with which he has to deal, and their probable effect on the cable under static and electrolytic conditions. It is not to the laboratory, nor even to the cable factory, that we must look for the information necessary for the construction of the long-looked-for perfect cable, but to the practical investigations, under working conditions, of the qualified mains engineer.

Discussion.

Mr. Callender had no great experience in finding faults, because they had almost always been in the boxes.

Mr. Fedden had not had any faults to find except on the high-tension arc cable. [The **Chairman**: But suppose you had a fault, what would you do?] He would probably try a telephone.

Mr Nesbitt said Mr. Quin was the first paper in which a new instrument had been brought before the association. He had seen the instrument of Mr. Quin's, but was not allowed to examine it. He understood there was once a fault not far from that building, and the Post Office discovered that. It burnt up their instruments. That localised the fault, but the Post Office did not care for the method. It seemed hardly worth while to put high-pressure wires into cables in order to test for faults. He believed the telephone method was fairly reliable. He had occasion some time ago to find a fault in a cable in an iron conduit built in a subway belonging to the County Council, who make a practice of having their men take the keys away, so that no one can get in. The fault was localised within 5 yards' working from the surface of the street, in spite of the gas-pipes and water-pipes in the subway. The differential ammeter was ingenious, but required a good deal of current. One instrument that was largely used at Blackpool for localising faults was the nose. There was no cause for Mr. Quin's remark on the probability of impurity in the lead.

Mr. Gray could only describe three ways of finding a fault. One was the American way on the low tension Edison stations, and that was to disconnect every Sunday, earth one of the wires, and put on a 1,000-h.p. machine. That they found to be a most practical way. Another way they tried there was to take an insulated wire and a lady's hat pin and stick the latter into the rubber, and see on which side of the fault you are. [The **Chairman**: You don't recommend that way, Mr. Gray?] The third was the Admiralty plan as used on search-light cables, which was to use an intermittent current. The plan of breaking down the fault, though brutal, was perhaps the best.

Mr. W. Lackie (Glasgow) described an interesting and novel method of preliminary localisation of a fault as between two boxes by the use of an ordinary compass. On a continuous-current system, placing the couples on the main, there would be a deflection. Flashing to earth the needle would kick. Only the direction need be noted. Trying along the line in this way, when the fault was passed the direction of the kick changed. In Glasgow they had found faults within 2½ hours, and a manhole full of water had not stopped them. For Mr. Quin's method one must be a bit of a musician. He thought they ought to have one cable only in a pipe, so that there could be never a fault without an earth. The compass method was applicable to alternating currents if the plunger of a Kelvin meter was used.

Mr. Stewart (Derby) thought highly of Mr. Lackie's plan.

Mr. Mountain (Huddersfield) said faults usually occurred not on the heavy mains, but on the branch service mains.

Mr. Andrews had had faults between inner and outer cables. They burnt themselves out. Faults upon the secondary mains made the telephone go wrong, and the telephone people rang them up at once.

Mr. Jeckell (South Shields) had usually turned his faults into dead shorts and localised them by meter-bridge and accumulator. Over a length of six or seven miles you could localise within a few yards if you knew your instruments.

Mr. Snell said the Silvertown set and a small portable transformer were excellent for work on the mains, as this was more portable than a heavy battery.

Mr. Murray said in a high-tension arc system, where ebonite was used, the first thing to do was to look at it for oil or a conducting film.

Mr. Tittensor (Dundee) had found the trouble from faults to be on the consumer's premises. A good method was to earth the middle wire for a few seconds.

The **Chairman** congratulated the convention on having got through its programme with 10 minutes to spare. He was a little sceptical as to whether the scientific method of fault finding, or the 4,000 h.p. and a column of smoke, or whether the pick and shovel were not the best instruments. In Manchester the mains were under constant test with the whole power of the station behind them, because their middle wire was earthed, and if there was a fault one must find it.

Mr. Quin replied very briefly. The telephone people made no objection or charge for the use of the telephones. As much as Mr. Lackie did could be done in many ways. It would fail with a cable in a conduit. The reason of the success of the telephone localisation in the County Council subway was the other pipes. There was practically a metallic circuit.

This concluded the public proceedings of the convention. On Saturday, July 3, there was a business meeting for members only at the Dickenson-street works. The conclusions arrived at at that meeting have already been given.

The Excursions.

In the matter of excursions, we—throughout not the editorial We, but the municipal electrical engineers, their visitors and associates, according to precedent—went first to the west, and, after looking about there, returned at the end of the day. The first excursion on the programme was to Liverpool, and we went straight from the railway to the new Paradise-street generating station. Half-a-dozen Willans engines, direct coupled to Siemens dynamos all in a row down the room, and the switchboard along the wall opposite. Somewhere about the centre of this was an interesting little coil apparently engaged in taking particular care of a fuse. The precise function of it puzzled some of us at first, but it was really Mr. Holmes's arrangement for

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ascertaining which circuit a fault is on. The brand new station and all in it is, of course, spick-and-span. Most of the Electric Lighting Committee came down to meet us. These were Mr. C. Petrie (chairman), Mr. Wm. Oulton (deputy-chairman), Alderman F. Smith, Alderman W. H. Williams, and Mr. F. Henderson (members of the Lighting Committee); not to forget the town clerk (Mr. Harcourt E. Clare), and, of course, the city electrical engineer (Mr. Bromley Holmes). There were speeches in strict moderation, and then we separated. Some went to Prescot, and, it is understood, had a good time there. The present writer, after seeing the row of vertical engines and direct-coupled machines at Paradise-street, decided to go and inspect the row of big horizontal ones running the rope-driven dynamos at the overhead railway power-house. Having thus maintained a strictly impartial attitude between the engine which stands at its work like a man, and the engine which lies on its side (and lets you hear it is at work), it became time to consider what next to do. On the list of places that might be visited were the simple words, "Liverpool Grain Storage Company." This did not look very promising to anyone who did not know that that was a place where one could see three-phase motors not on show but actually at work. A Belliss engine was driving the three-phase generator. Who made the latter we will not say, as the name-plate was taken off. It was a work of art and adventure to get at the motors—a thing that will go anywhere that you can take a wire gets into such very inaccessible places. Most of the grain-storage men seemed, at one time or another, to have been sailors. And when, after almost enough climbing to take one to the top gallant yard, one did reach the motors, the American habit of covering everything up with pierced metal sheet naturally did not leave much to see. All the men said the motors worked exceedingly well, required next to no attention, and were in every way satisfactory.

On the following day (Friday) the programme left an option between Bradford and Halifax, with a finish in either case at Huddersfield. The writer has the greatest possible respect for Halifax, but decided to equalise matters by doing one continuous and one alternating station. At the railway station a strange thing happened. Mr. Secretary had arranged with the company that we should have special carriages and special fares. The executive and engineering department was, as usual, all right; it was on the administrative side that there was trouble. Our carriages were there all right, but neither booking-clerk nor stationmaster had heard anything about special fares. A reference to Mr. Secretary, with the additional particulars that he had been in Manchester, belonged to Huddersfield, and was supposed at that moment to be somewhere in Halifax, did not materially advance matters—deadlock. At last a bold, bad man suggested that we had better take possession of the carriages and leave the railway people to make the next move. The suggestion was immediately adopted, and the next move was to start the train. Whenever the train stopped, various officials of various companies made futile attempts to collect non-existent tickets. One porter called to an invisible Jim to unhook us and shunt us. Jim did not respond, so how we should have contrived to run on the shunt like a demoralised meter is not to be known, but it is obvious such distinguished engineers would have managed to get on somehow. Ultimately it seemed to be taken as a rather good joke that we should travel about between Manchester and Halifax and Bradford and Huddersfield, over anybody's lines, without any voucher to show for it. After it was all over, Mr. Secretary was found on his own ground, and promptly rose to the situation. He went round and collected something which was not the full fare nor the special fare, but a sum that he settled on for himself, and everyone was satisfied. We have it on presidential authority that he is a man that can make any station pay, and no one doubted his ability to deal with any number of railways on his own terms.

On arriving at Bradford we went straight to the new generating station in Valley-road and saw Mr. Gibbings's marine-type boiler, fitted with Ellis and Eaves's system of induced draught, with fans driven by electric motors, and all auxiliary machinery, such as feed-pumps, circulating-pumps, fans, and air-pumps, driven by electric motors. There is at present no hydrokinetor, or means of procuring water circulation on first firing—a matter to be considered. This is not a description of central stations, and the new Bradford one will doubtless be properly dealt with when it is finished. The only thing possibly open to criticism in it is the material chosen for the steam-pipe. Everything seems to have been done to procure a plant which shall be of the best, and to house it in such a way that it can be worked to the best advantage. Steam had been got up in our honour, and the steam-pipe been specially jointed up that morning in order to run the great Willans engine in the dynamo-room for our inspection. But more than one of the joints protested that they must have time to set, and could not put up with it. We had thus an opportunity of seeing how excellent was the ventilation of boiler-house and engine-room, but the amount of free energy, the atmosphere in the form of sound waves, became so great that some of us removed the only instruments with which we could estimate it, for fear that they might be overstrained. Upstairs there was a collection of obsolete switches; some of them were really marvellous examples of misapplied ingenuity. Also there was another collection of anything but obsolete incandescent lamps, 50 to 8 c.p. One was 6,000 hours old and still going. The point of it all, of course, was the alleged impossibility of a good 8 c.p. lamp at 230 volts. The Corporation were very polite. By this time we had come to regard strawberries and tea as a matter of course. The Mayor came down specially from London to meet us, and Mr. Dixon (the late chairman of the Electrical Committee) did a thing which is for many reasons very rarely done. He took us all over his large wool-combing works, which immediately adjoin the new electricity works, and explained the whole process It was exceedingly interesting, but this account must be confined to matters which are more or less municipal-electrical. After all this we were naturally pleased at being able to congratulate the committee on the excellent design of their new station. The neat little souvenir given to us in the form of a description and history of the Bradford electricity supply undertaking should not be forgotten, although it is not going to be reprinted here.

Then to Huddersfield. There the generating station is at the end of the town. The first sign of it was a tall and an exceedingly shapely shaft at the bottom of a hill. To the right one saw afterwards that there was a considerably taller and equally shapely chimney. That is the gasworks, but Miss Electricity has managed to secure a place for herself in the middle of the front row, where everyone must see her.

We did the works more or less in procession. In the boiler-house, Babcock boilers and Meldrum furnaces. In the dynamo-room, the most prominent object is the big Ferranti alternator and Maclaren engine. Further up, rope-driven Mordey alternators. The switchboard occupies a long gallery down the side and end of the room. In a room outside we came on a portent. It was a good-sized calcium carbide furnace which, though disused, had evidently done some considerable amount of work. It seems Mr. Mountain allowed certain experimenters to play about there in the daytime, duly metering and charging them with their units, and adding the latter to his day load. There at last was a clue to the enigmatical utterance of Alderman Calvert at the convention, as to the possibility in the improvement of gas, which most of us passed by at the time as a mere oratorical flourish. The notion of the electricity works manufacturing calcium carbide all day to enable the gasworks on the opposite side of the street to brighten up their light a bit by mixing in acetylene is perfectly lovely. Marvellous are the results of municipal ownership. Then we were all taken to the Queen Hotel, where they gave us something like a premature supper, if it had not borne more resemblance to an out-of-date luncheon. Whatever one called it, it was a well-served and excellent meal. Alderman Calvert took the chair, with Mr. Councillor Longbottom on one side of him and Mr. Wordingham on the other. Mr. LONGBOTTOM proposed "The Association." They (the Town Council) were only anxious to have their darkness illuminated and their minds enlightened. He

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congratulated the association on the way in which members communicated to each other what they knew, instead of attempting to keep it as a money-making secret. Altogether, Mr. Longbottom was very complimentary, but seemed a little shocked at the youth of the company. (To be 40 constituted one a grave and reverend signor, and many had the impudence to be under 35.) Mr. WORDINGHAM replied. The inspection of works like Huddersfield more and more convinced him that excellent results could be obtained whichever of the rival systems was adopted. The continuous and the alternating man sat side by side, and while the continuous man naturally continued on his opinion, the alternating man refused to alternate in his.

Alderman BOON thanked Huddersfield for giving Southampton Mr. Nalder as a town clerk, and proposed the health of Alderman Calvert. Then Mr. Secretary Mountain's health was proposed. That gentleman, who appeared to have acquired the temporary habit of always being somewhere else, was found, brought in, and at once proceeded to accept and acknowledge all the kind and complimentary things which he was certain had been said of him. Then back to Manchester. It gets dark slowly in Yorkshire in the first week of July, so one could not form an opinion on Mr. Mountain's alternating arcs.

This was practically the wind-up of the convention, as, unless they "got in by a printer's error," even associates were not admitted to the Saturday meeting.

Arrangements had been made for members of the association and visitors to inspect the Blackpool Corporation electric lighting works, the Blackpool Corporation electric tramways (and other things), the Southport Corporation electric lighting works, and even to go to the Isle of Man and see the very interesting electric tramways there. Duty, however, and the North-Western Railway took the writer rapidly in the opposite direction.

That Dinner.

Unfortunately, there has been so busy a time with electrical meetings lately that the record of the convention dinner has had to be postponed, and must be curtailed so far as our columns are concerned. But we console ourselves with the idea that gastronomic successes after all form but a fleeting quantity, and after-dinner speeches are made to be pleasant rather than profitable. It is pardonable now and then to unbend, for Englishmen are apt to take all things too, seriously even to dining. Yet the doctors tell us 'tis worry, not work, that kills. Hence the intense pleasure one gets from these humane interludes to the more serious business of reading and discussing papers.

On the evening of June 30 there was a big gathering at the Grand Hotel, Manchester, to inaugurate the first annual dinner of the Municipal Electrical Association. Great Britain and Ireland were well represented, and Mr. C. H. Wordingham, the president, may comfort himself with the assurance that succeeding years and succeeding presidents will find it difficult to go one better, whether it be in number, reputation, or talent.

The toast list was of the usual character, those of the "Queen" and "The Prince and Princess of Wales and the other Members of the Royal Family," being proposed by the PRESIDENT.

Mr. CROMPTON proposed and Mr. WORDINGHAM replied to the toast of the evening, "The Municipal Electrical Association." Both agreed as to the value of such an Association.

The company then heard with great satisfaction a song by Mr. Pope (of Messrs. Jackson), who indeed met with great success and was in as great demand.

Mr. RIDER (Plymouth) proposed "The Manchester Electricity Committee," to which Mr. Alderman HIGGINBOTTON responded.

The next toast was that of "The Guests," proposed by Mr. ARNOT (Glasgow), responded to by Mr. J. W. SWAN, who was urged to give the history of the incandescent lamp, Mr. W. H. TALBOT (the town clerk of Manchester), and Mr. KERSHAW (Shoreditch). Subsequently Mr. SWAN said a few words in recognition of the labours of Mr. Staite in the forties, admitting that his own mind was turned towards electric lighting problems by what he had heard at one of Mr. Staite's lectures.

Mr. A. H. GIBBINGS (Bradford) proposed "The Electrical Manufacturers," to which Mr. FERRANTI replied.

The evening's entertainment in the shape of toasts concluded with that of "The Press," proposed by Councillor G. PEARSON (Bristol), and responded to by Mr. H. ALABASTER (*Electrical Review*).

The end of all things, dinners and toasts included, comes naturally, but we always think these meetings break up in a very perfunctory way. In the middle of the performance a man rises, stealthily leaves the room, then more and more go, till the majority of chairs are vacant, and the curtain rings down to a very sparse audience. The first to go is a little shamefaced, and may be presumed to say, with Prof. Aytoun—

"Let me go. Now, chuckster, blow it, 'pon my word, this is too bad;
If you want me, ask the waiter, he knows where I'm to be had.
Au revoir."

LEGAL INTELLIGENCE.

FLOATING AN ELECTRIC LIGHTING COMPANY.

In the Lord Mayor's Court, before the Recorder (Sir Charles Hall, Q.C., M.P.) and a special jury, the case of Haywood *v.* Messrs. Carlton, Hessey, and Co., Mr. James Carlton, sen, the Madeira Electric Lighting Company, Limited, and Mr. Josiah Beazley was disposed of.

The plaintiff, Mr. Alfred Haywood, describing himself as a mining agent, of 95 and 97, Finsbury-pavement, claimed a sum of £2,333. 6s. 8d., being an amount for commission alleged to be due from the defendants.

The Plaintiff said that in the year 1892 he negotiated with a Mr. Welstead, the proprietor of certain gasworks at St. Michael's, in the Azores for the purchase of the same, and also with the manager of the gasworks, who held a concession obtained from the Portuguese Government for introducing electric lighting at Funchal, the capital of Madeira. His idea was to form a company to take over the gasworks and the concession. The scheme fell through, however, and Mr. Welstead elected to carry on the gasworks. The concession held by Mr. Copke was then in the market. He (plaintiff) knew that Messrs. Farmer and Brandon, Brazilian merchants, of Eastcheap, held a power of attorney for Mr. Copke in this country. At the end of 1894 an interview took place at the offices of Messrs. Carlton, Hessey, and Co., with Mr. Carlton, senior. Mr. Carlton at this interview agreed to give him (plaintiff) one-third of the total profits in the event of the plaintiff introducing the business, and a purchase being effected of Mr. Copke's concession. The plaintiff introduced Mr. Farmer to Mr. Carlton, sen. As a result a company was formed to take over the concession, and a profit of £7,000 was realised. He now claimed one-third of the amount, being the agreed portion he should receive.

In the course of the case **Dr. Blake Odgers, Q.C.**, counsel for the plaintiff, admitted that no cause of action had been disclosed against the Madeira Electric Lighting Company, Limited, and Mr. Josiah Beazley.

A verdict was accordingly entered for these two defendants, the **Recorder** remarking that it was scandalous that they should have been joined as defendants in the action.

Mr. W. J. Farmer was called on behalf of the plaintiff, and stated, in reply to Dr. Blake Odgers, that Messrs. Carlton, Hessey, and Co., and Mr. Carlton, sen., were introduced to him by Mr. Ernest Beazley, and not by the plaintiff.

The Recorder said this witness's evidence put the plaintiff out of court; and Dr. Blake Odgers being unable to carry the case further, the jury returned a verdict for the defendants.

Judgment was entered accordingly with costs.

CLAIM FOR ELECTRIC LIGHT.

In the Westminster County Court, on Tuesday, his Honour Judge Lumley Smith, Q.C., had before him the case of the Westminster Electric Supply Committee *v.* McColl, and Macintosh third party.

It was an action by the plaintiff's company to recover payment of an account for electric light supplied to the defendant, Colonel McColl, at Endsleigh-mansions, and the defendant's answer to the claim was that he left the place in September of last year and sublet to the third party—Macintosh.

Plaintiffs' Clerk was called and said that Colonel McColl signed a request for the supply of light in the usual way, but they were not aware that in September he had sublet his flat to Mr. Macintosh. When application was made to the defendant for payment he referred the plaintiffs to Mr. Macintosh, but at that time there was no agreement between themselves and Macintosh, and the result was that they could not get their money from either McColl or Macintosh.

Colonel McColl was called for the defence, and said he had paid the plaintiffs all that was due to them from him up to the time of his leaving the place in September of last year, and, of course, he supposed they would look to Macintosh for payment after that date.

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His **Honour** said it was quite clear that the plaintiffs were entitled to their money, and he failed to see what the two defendants were fighting about. In any event there would be judgment for the plaintiffs for the amounts claimed as against Colonel McColl, and judgment for Colonel McColl for the same amount against Macintosh, and the latter would have to pay the costs of Colonel McColl.

COMPANIES' MEETINGS AND REPORTS.

SOUTH STAFFORDSHIRE TRAMWAYS COMPANY.

An extraordinary general meeting of this Company was held on Friday at Cannon-street Hotel, London, convened to pass a resolution authorising the directors to make a new issue of debentures, and to substitute them for the present debentures, which mature on August 1 next. It was necessary to make the issue of debentures in order to carry out the arrangement, sanctioned by the shareholders at the extraordinary general meeting held on June 28 last, with the Electric Construction Company.

The **Chairman** (Mr. W. Somers L. Schuster) said the matter was fully gone into at the last meeting. The debentures which it was proposed to issue were simply in payment of those which fell due on August 1. They were of the same amount and at the same rate of interest. He moved a resolution that the directors should be authorised to create and issue mortgage debentures of the Company providing for the payment of a principal sum not exceeding £50,000, repayable on August 1, 1902, with interest as from August 1, 1897, at 5 per cent. per annum, such debentures to be in the form signed by the chairman of the meeting, or in such modification thereof as the directors might determine; also that the directors be empowered to apply such debentures, when issued, for the purposes and in the manner provided by an agreement dated June 11, 1897, made between the South Staffordshire Tramways Company and the Electric Construction Company.

Mr. S. R. Blundstone seconded the motion.

A **Shareholder** said he did not know exactly what they were doing. Was the electric light company going to have it all? Could not the debentures be taken over by the present shareholders?

The **Chairman** said that could have been done months ago if the shareholders had offered the money. The debentures were principally held in big blocks by people who could wipe out the company in August if they desired in default of the proposed arrangement. The money had been asked for on several occasions, and had not been found. The position was this: They had £50,000 debentures falling due on August 1. How did the shareholders propose to meet them?

The **Shareholder**: If the shareholders took it up, you could meet it at once.

The **Chairman**: There is £16,000 which we cannot get security for, and which would have to be found as well.

Mr. Dawson (a director) proceeded to make a lengthy speech, but was ultimately interrupted by the **Chairman**, who said that Mr. Dawson suggested that the debentures would be entirely owned by the Electric Construction Company. He desired to say that temporarily that company would hold them in exchange for the new debentures, and those who did not wish to have the new ones would receive their money, plus the interest, in cash. A great number of debenture holders would renew, and others would not.

Mr. Dawson urged that the debentures should have been officially offered to shareholders.

The **Chairman** replied that a circular was sent to all the debenture-holders asking whether, in the event of an arrangement being made, they would take up the debentures in the new company. These circulars were only replied to to a small extent.

After further discussion the resolution was adopted unanimously.

HARROW ELECTRIC LIGHT AND POWER COMPANY.

Directors: Charles Colbeck, chairman; Edmund Robert Bartley Dennis; Robert Cary Gilson; Edward William Flemyng Stiven, M.D.; Frederick Stuart Winkley. Consulting engineer: W. C. C. Hawtayne. Secretary and solicitor: R. E. H. Fisher.

Report of the directors, with abstract of accounts, presented to the shareholders at the first annual general meeting held on July 20, 1897:

In presenting their first report and statement of accounts since the Company has begun to supply current, the directors congratulate the shareholders upon the prosperity of the Company. The accounts cover a period of about 18 months, from July, 1895 to December 31, 1896, but the earnings, other than rents and interest on deposits, extend over only one week more than a quarter of a year. The electric light was first supplied on September 9, 1896, but the real working dates from the commencement of the school term on September 18. There were then 22 customers, and lamps equivalent to about 3,177 8-c.p. lamps installed, increased during the quarter to 3,900, with a list of 39 customers, besides one customer taking current for motive power. The consumption was just short of 20,000 Board of Trade units, and brought in, together with meter rents, a sum of £674. 4s. 2d. The rents of the Company's houses received since the Company's formation, with a few miscellaneous items, raised the gross receipts to £929. 18s 6d., and after discharging all liabilities, including interest on the debentures, and applying £102. 11s. 10d. to writing off preliminary expenses, etc., and forming a depreciation fund, there remains for the whole period a net profit of £92. 1s. 9d. to deal with. Out of this it is proposed to declare a dividend at the rate of 1 per cent. per annum for the year 1896, which will absorb £65 3s. 3d., and to carry forward the balance of £26 18s. 6d. Turning to the capital account, the shareholders will observe that the amount expended exceeds the amount of capital subscribed by £2 966 12s. 2d. The reason is that the operations of the Company have rapidly extended beyond the limits covered by the first estimates. The excess represents (1) extensions of mains, all bringing in a minimum profit from the first of at least 4 per cent. on their cost; (2) installations in private houses on which a rent is paid to the Company, a policy which the directors adopted in November last, and which has proved most successful; (3) working capital for house connections, meters, and instruments; (4) an outlay for fitting-up one of the cottages as offices; (5) the cost of an extra steam-dynamo as a provision for a possible breakdown and for growing demands. The Company is, in fact, doing more business than had been anticipated; it needs at once some £7,000 more capital to meet it, and the directors have accordingly already issued 1 000 more shares of £5 each, which they offer to their friends in Harrow, and propose to issue more as the works progress. The station has been worked by Messrs. Crompton and Co. under a contract which also includes cost of superintendence, repairs and maintenance of buildings, machinery, and mains. The directors are so far satisfied with the arrangement. The current has been continuously supplied, and there has from the outset to the present moment been no breakdown in the machinery or the mains. The present directors retire at this meeting, under Section 59 of the Articles of Association. They are all eligible, and offer themselves for re election. The shareholders have also to fix the remuneration of the directors, to elect auditors for the year 1897, and fix their remuneration. They are asked also to sanction the appointment by the directors of Mr. Browning, of the firm of Messrs. Jackson, Pixley, and Co., chartered accountants, as auditor for 1896.

REVENUE ACCOUNT, JULY, 1895, TO DEC. 31, 1896.

Dr.	£	s.	d.	£	s.	d.
Inclusive charge by Messrs. Crompton and Co, Limited, electrical engineers, under a working contract dated Oct. 13, 1896:						
Generation of electricity	£170	18	10			
Maintenance of station	138	9	0			
				309	7	10
Rents payable	52	2	8			
Rates and taxes	15	17	1			
				67	19	9
Salary of secretary	12	10	0			
Salary of collector	4	16	0			
Stationery and printing	30	15	10			
General establishment charges	4	9	1			
				5	10	11
Law expenses	9	15	6			
One fifth of £65. 18s. 4d. written off	13	3	8			
				22	19	2
Cost of working contract, one half written off				17	2	2
Preliminary expenses, one-tenth written off				37	6	0
Depreciation in respect of leasehold land	25	0	0			
Depreciation in respect of accumulators	10	0	0			
				35	0	0
Insurance	18	13	11			
Repairs to property	4	2	9			
Discounts allowed to customers	16	1	2			
				38	17	10
Total expenditure				581	3	8
Balance carried to net revenue				348	14	10
				£929	18	6

Cr.	£	s.	d.
Sale of current per meter at 8d. per B.T.U.	675	11	7
Sale of current per meter at 5d. per B.T.U. for motive power	4	16	3
Rental of meters on consumers' premises	9	17	6
Rents receivable	228	0	2
Transfer fees	0	5	0
Fine for damaging property	0	10	0
Sundry receipts for work done	10	18	0
	£929	18	6

GENERAL BALANCE-SHEET.

Liabilities.	£	s.	d.
Capital account—amount received	17,267	9	10
Sundry tradesmen and others, due on construction of plant and machinery, to Dec. 31, 1896	4 654	8	8
Sundry creditors on open accounts	842	3	6
Net revenue account	92	1	9
Depreciation fund account	35	0	0
	£22,891	3	9

Assets.	£	s.	d.
Capital account—amount expended for works	20,234	2	0
Sundry debtors for current supplied to Dec. 31, 1896, and meter rents	690	5	4
Other debtors	49	13	0
Cash at bankers and on deposit—London and County Bank, Harrow, £917. 3s. 5d; on deposit with the Cunningham Permanent Building Society, £1,000	1,917	3	5
	£22,891	3	9

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The first annual general meeting of the shareholders of the above was held at the Company's offices on July 20, under the presidency of Mr. C. Colbeck, chairman.

The report of the directors, which we give herewith, was taken as read :

The **Chairman** said the position of the Company was in some respects a little more complicated than they had anticipated, but he was quite sure it was a great deal stronger than it would have been had their first annual general meeting been held sooner. With regard to their prospects, they had now 57 customers and had installed 4,475 lamps. Before next September 5,000 lamps would be installed, and 6,000 at Christmas, and reckoning the 8-c.p. light as worth 10s. a year, they would have an income of £3,000 a year. In addition there would be the meter rents. There was this important fact, that as soon as they got to 6,000 lamps, unless his figures were very wrong, they would have reached a stage when, unless their capital was largely increased, they could reduce the price of the unit from 8d. to 7d. They would then compare most favourably with Harrow gas. He was very confident as to those anticipations being realised. Their position with regard to those who asked the Company to carry their mains to them was this: They said to all people, "We will go anywhere where we can see an immediate return of 4 per cent. upon the outlay on the mains alone." In consequence of that, they had been able to carry out various extensions. Their policy of installing at a rental had been most successful, and it had created a demand among the smaller householders. He believed it would bring them in a large income. To-day the Free Wiring Company was on the market, and this did at a higher cost what the Harrow Company had been doing for months past. Mr. Tate did the work for them, and the company received a small percentage from him. They had employed about £900 capital in that way, and very likely before they met again the amount would be £2,000. Further than that, there was the question of introducing the penny-in-the-slot system.

Mr. Gilson seconded the motion, and it was carried.

The directors were re-elected, and the auditors re-appointed.

CITY AND SOUTH LONDON RAILWAY COMPANY.

The twenty-sixth half-yearly meeting was held at Winchester House yesterday (Thursday), Mr. C. G. Mott presiding.

The **Chairman**, in moving the adoption of the report and accounts, said he was glad to be able to say that the general progress of the Company had been fully maintained during the past half-year. Their work was also progressing, and the driving of the tunnels had commenced With regard to St. Mary Woolnoth, that difficulty had been settled. From the outside of the church they were led to believe that it was a substantial building, but they found it was a very flimsy and poorly constructed building, and there was a good deal of scamped work about it. If they did not take great care they would have the whole thing falling about their ears. The receipts per train mile had increased from 2s. 2½d. to 2s. 4d. in the present year, and the receipts per passenger had increased from 1·89d. to 1·90d. They ran 2,669 more trains in the half-year than in the corresponding half of last year, and for the same period they had run 7,149 more train miles. Notwithstanding the increase in trains, the number of passengers by each train had increased from 44·59 to 46·54 per train.

The report was adopted.

NATIONAL TELEPHONE COMPANY, LIMITED.

The report of the directors for the half-year ending June 30, 1897, was presented to the shareholders at the twentieth ordinary general meeting of the Company, held at Winchester House yesterday, at 1.30 p.m. The gist of this report appeared in a note in our last issue.

Mr. James Staats Forbes, the president of the Company, took the chair promptly to time, and gave a lucid explanation of the financial statements in the report. He pointed out that the annual receipts are rapidly approaching the sum of £1,000,000, and that the amount annually transferred to the Government is now nearly £100,000, which is no inconsiderable burden on the industry. He also referred to the fact that the interim dividend recommended was at the rate of 6 per cent. per annum, as against 5 per cent for the same period, and he quite expected this would not affect the 6 per cent. declared for the second half of the year. He also explained that, in order to strengthen the financial position of the Company and to provide for present and prospective needs, the Board have recently issued the balance of the 5 per cent. third preference shares to the nominal amount of £653,830. The average price realised was £5. 16s. 6d. per share, resulting in a premium of £107,882. 6s. 5d. This afforded an opportunity for dealing with the premium account, which stands in the last balance-sheet at £37,911. 12s. 6d.; and the Board have decided to apply the amount now available in extinguishing the payment of £121,295. 9s. involved in the redemption of the 4½ per cent. debenture stock in 1894. The relations with the Post Office continued to be of the most satisfactory kind, and the harmonious working of the two establishments had resulted in the overcoming of many of the serious initial difficulties consequent upon the dual system involved in the transfer of the trunk service to the State. He proposed the adoption of the report.

Lord Harris seconded the resolution, and referred to the criticism lately appearing in the public Press. Such criticism, when based on fact, was valuable as an incentive to progress, as the Board had to weigh between the interests of the shareholder, the requirements of the Post Office, and the convenience of the public. Still, criticism without a previous knowledge of the grounds on which criticism was offered was absolutely useless, and he regretted to say that much of the matter appearing in the daily Press was of that order.

In reply to **Mr. Hall**, the **Chairman** said that about half a million new capital would be expended in the ensuing year, of which a certain sum would be due to putting the wires underground.

Another question called for some remarks on the character of the telephone service as compared with that of other countries, which we hope to reproduce somewhat more fully next week.

Mr. Forbes pointed out that while the Post Office last year transmitted 75 million messages by telegraph at ½d. per word, the Telephone Company had produced means for 415 million conversations at an average cost of 5·4d. per conversation.

The report was passed unanimously, and the retiring directors and auditors were then re-elected. The meeting then terminated with the usual vote of thanks.

BRITISH THOMSON-HOUSTON COMPANY, LIMITED.

The second ordinary general meeting of this Company was held last Tuesday at their offices, 83, Cannon-street, E.C., Mr. E. A. Lazarus in the chair.

Referring to the satisfactory state of the Company's business, the **Chairman** stated that a considerable improvement had taken place in the sales department, particularly during the 12 months ending March last. The profits, after deducting general and technical expenses, discounts, and interest, amounted to £22,576. Of this sum £3,634 had been absorbed in expenses and allowances in connection with the winding-up of the old company and the formation of the new one, including liquidators' remuneration and £1,000 paid to the late directors. The Board felt, while not agreeing with the management of the old company, that they could not treat the directors of it in an unfriendly way, and they hoped the shareholders would approve of what had been done. Also £4,255 had been applied in writing off an estimated further loss in respect of the Bristol and Dublin contracts taken over from the old company, and a sum of £4,693 had been written off goodwill, patents, and licenses. These amounts, together with two other small items, accounted for £13,162, leaving an available balance of £9,414, of which it was proposed to transfer £1,128 to the reserve fund and to pay a dividend of 5 per cent. on the £40,000 A shares fully paid, on the £40,000 B shares fully paid, and on the £160,000 B shares £5 paid up, carrying forward to the next account £285. He then moved the adoption of the report, which was seconded by **Sir Thomas Thompson** and carried.

The auditors, Messrs. Price, Waterhouse, and Co., were then re-elected.

ELECTRIC CONSTRUCTION COMPANY, LIMITED.

The annual general meeting was held on Thursday at Winchester House Mr. James W. Barclay presided, in the absence, through illness, of Sir Daniel Cooper.

The **Chairman**, in moving the adoption of the report, said the net profit for the 11 months ended May 31 had been £17,399, to which had to be added for dividend purposes the amount brought forward, £13,297, making together £30 696. They recommended a dividend on the preference shares at the rate of 7 per cent. per annum, and on the ordinary shares at the rate of 5½ per cent. (equal to 6 per cent. per annum), free of income tax After paying these dividends a balance of £16,499 would remain to be carried forward. They would thus pay the dividends out of the profits of the 11 months, and add £3.201 to the sum carried forward. These results, he believed, would be satisfactory to them, especially when it was considered that the plant and buildings had been fully maintained, and that £5,000 had been set aside for depreciation account out of the 11 months' revenue. The amount at the credit of this depreciation account was now £18,000, and there was no doubt that, for profit-making purposes at least, the property, without taking into account the new buildings, was of as much value as it was four years ago. The accounts showed general progress in the development of the business; they had been producing more, and they had been able to do so at less cost. Their customers, the men employed, the output of manufactured goods, and the gross profits all showed important increases, and there were at present in the workshops as many orders as they cared to have and at prices which ought to yield at least their usual profits. Since their report was issued they had secured the contract for the electrical equipment of the Halifax tramways, and were thus obtaining their share of electrical traction work. The expenditure was much the same as it was last year. They had endeavoured to make reductions, but, if they were to maintain the efficiency and reputation of their establishment, they could make little further progress in that direction. They looked for improved results to an increased output, and in that object they had the full co-operation of their staff and employés. One important cause of their large expenditure was the necessity of making up tenders and estimates of cost, involving designs, drawings, etc., free of expense to the enquirers, while of the work dealt with in these tenders and estimates only a small proportion would necessarily come to them. This practice was one of the necessities of the business, and they made no complaint, but it accounted for a considerable portion of the cost of their staff. Under the head of expenditure, there was an item for commissions and foreign agency charges of £839. Nearly the whole of this sum had been expended in establishing foreign agencies with the view of increasing and

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widening their connection, but time was necessary to develop business. This expenditure might have been placed to a suspense account, but the whole had been charged against the revenue of the year. The addition to capital had been chiefly in providing large tools necessary for manufacturing the machinery now required by electrical engineers. One result of this expenditure was the order from the Corporation of Manchester for a multipolar dynamo three times greater in capacity than any hitherto built in this country. He thought he could safely add that they were now in a position to construct plant of any power which electrical engineers might require. Some progress had been made in realising the shares and debentures of other companies, and they hoped to make further progress during the current year. With respect to the further issue of capital, and the contemplated reduction of interest on the debentures, they had resolved to offer to the shareholders 8,657 preference shares at 15s. premium. The outstanding debentures could not, of course, be dealt with except by consent of the holders, but as they were repayable at par in less than 3½ years some arrangement might be made for substituting a long-dated debenture at a lower rate of interest with satisfaction to both parties. The shareholders would be glad to hear, in these times of strikes and lock-outs, that they had no trouble whatever with their people at Bushbury.

Sir Henry C. Mance seconded the motion, which was adopted.

DIRECT UNITED STATES CABLE COMPANY, LIMITED

The fortieth ordinary general meeting of this Company was held on Tuesday, at Winchester House, under the presidency of Mr. E. M. Underdown, Q.C., who said that he thought on the whole the result of their operations would be regarded as satisfactory. The half-year's revenue, after deducting out-payments, amounted to £43,892, as compared with £42,456 for the corresponding period of 1896, being a difference of £1,435 in favour of the half-year under review. The working and other expenses for the same period, including income tax, but exclusive of cost of repairs of cable, amounted to £19,559, leaving a balance of £24,332 as the net profit of the half-year, making, with £4 843 brought forward from the previous half-year, a total of £29,176. Three quarterly interim dividends of 2s. each per share, amounting to £22,766, had been declared and paid during the financial year, and a final dividend of 2s. 6d. per share was now proposed, together with a bonus of 2s. per share, making, with the three interim dividends, 3 per cent. for the year, being a total distribution of £36,426. After transferring £4,000 to the reserve fund account, the balance of £3,927 on the revenue account was proposed to be carried forward. He moved the adoption of the reports and accounts, which was seconded by Sir J. Pender, M.P. In the course of the discussion that followed, the chairman alluded to the fact that there were now no less than 11 cables across the Atlantic, which was a very different state of things from what existed when this Company was formed, and the traffic receipts had to be divided amongst the various companies. Accidents were sure to occur to cables in shallow water, and the cable often got fouled with anchors. The Company paid the fishermen for the loss of an anchor if they cut the line and left it, rather than drag it up to the injury of the cable. The directors could not see their way to shift the position of the cable at the present time.

The report was adopted, and the dividend and bonus approved.

GLOBE TELEGRAPH AND TRUST COMPANY.

The **Marquis of Tweeddale** presided on Tuesday at Winchester House over the twenty-fourth ordinary general meeting of this Company, and, in moving the adoption of the report and the payment of the dividends recommended, stated that the receipts for the year ended the 18th inst. had amounted to £186,582, being an increase of £1,359. This increase, although not very great, was important, as it was mainly owing to an improvement in the traffic across the Atlantic—an improvement which, he believed, was being still maintained, but the full benefit of which would not be felt until the end of the current year. He referred to the change made in presenting the accounts relating to their investments, and remarked that shortly after the trust was formed it was determined, after careful consideration, that any loss resulting from the sale of an investment should be added to the cost of the security purchased with the proceeds. There was a good deal to be said in favour of this mode of rendering the accounts, but it had recently been subjected to considerable criticism, and, after due deliberation, the Board determined in future to enter purchases of stocks at their absolute cost price, and to show under a separate heading the profit or loss involved in the transactions. He believed they would approve this change. Undoubtedly, under the old system the mode of charging the loss on the sale of one security to the price of another was rather complicated, and, to a certain extent, misleading. The figure of £193,778, which appeared as loss on sales of stocks, seemed very large, but it must be remembered that this loss had accrued, not in a year or two, but during the whole continuance of the trust. Moreover, it must be remembered that the depreciation on the stocks of the Anglo-American Telegraph Company had been well known to the shareholders of the Globe Company for a very long time. When the Anglo-American stocks were taken into the Globe their value was somewhat inflated, but the chief reason of the depreciation or the fall in the value of these stocks was owing to the extremely keen competition which sprang up in the Atlantic after the Globe Company was formed.

The report was adopted.

EASTERN TELEGRAPH COMPANY.

The fiftieth half-yearly ordinary meeting of this Company was held on Thursday at Winchester House, the Marquis of Tweeddale presiding.

In moving the adoption of the report, the **Chairman** said that the gross revenue for the half-year amounted to £479,822, being an increase of £13,729. The traffic with India, and also with South Africa, had shown a tendency to decrease, but on the other hand the receipts from all other classes of traffic had been fairly maintained, and in some instances they had somewhat improved. During the late war between Greece and Turkey, a temporary increase in the traffic had occurred, but this had now fallen below normal proportions. Now that peace, however, was assured, there was every reason to suppose they would have a recovery in the traffic. The total working expenses amounted to £110,109, as against £99,151, or an increase of £10,958. Considerable reductions had lately been made in their rates, varying from ½d. to 4s. 4d. per word. They carried the substantial sum of £220,000 to their general reserve fund, as against £125,000 in the corresponding period last year, and in this connection he reminded the shareholders that there would be a heavy charge against this fund next half-year for the cost of the cable between Vigo and Gibraltar.

Mr. J. Denison Pender seconded the resolution, which was carried.

A resolution was also carried contributing 100 guineas to the Prince of Wales's Hospital Fund.

EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY, LIMITED.

Fourteenth annual report of the directors for the year ending June 30, 1897, to be presented to the shareholders at the ordinary general meeting to be held at the Cannon-street Hotel to-day, July 30, at 2 p.m.:

The profit and loss account shows a credit balance of £34,850 2s. 2d. Providing for the interest in respect of the debenture stock, there remains a balance of £29,584. 13s. 3d. available for distribution. An interim dividend at the rate of 5 per cent. per annum having already been paid in respect of the first half-year ending December, 1896, a further payment, at the rate of 6 per cent. per annum in respect of the second half, is recommended; the balance of £8,493 7s. 6d. being carried forward, as against £5,352 14s. 9d. in the preceding year. The amalgamation of the Manchester Edison-Swan Company, Limited, as agreed upon and approved by the shareholders at the special meeting on November 24, 1896, has been completed, and their factory at Broadheath and other effects have been taken over, as well as their interest in the Altrincham Electric Supply, Limited. In accordance with the resolution passed at the meeting of shareholders on November 24, 1896, due notice was given to the holders of the £100,000 4½ per cent. debenture stock, that that stock would be redeemed on June 30, 1897, which has been done. To provide for this and for the extension of business, £200,000 4 per cent. debenture stock has been issued and subscribed at par. The business of the Company during the past year has been largely extended, and considerable additions to the shops and plant have been made. James Staats Forbes, Esq., and the Earl of Lichfield retire by rotation from the Board, and offer themselves for re-election. Messrs. Welton, Jones, and Co., the auditors, offer themselves for re-election.

PROFIT AND LOSS ACCOUNT FOR YEAR ENDED JUNE 30, 1897.

Dr.	£	s.	d.
Stock on hand, July 1, 1896	93,707	4	3
Wages, purchases, etc.	149,418	9	5
Salaries, directors' remuneration, rent, office expenses, insurance, income tax, general and law charges	10,667	14	0
Depreciation on plant, etc.	6,397	18	2
Balance	34,850	2	2
	£295,041	8	0

Cr.	£	s.	d.
Balance brought forward	5,352	14	9
Sale of lamps, fittings, royalty on holders, etc.	172,115	16	9
Interest, etc.	2,010	9	3
Stock on June 30, 1897	115,562	7	3
	£295,041	8	0

Dr. BALANCE-SHEET, JUNE 30, 1897.	£	s.	d.
Share capital—17,139 A shares of £5 each, fully paid	85,695	0	0
99,261 A shares, £5 each, £3 paid	297,783	0	0
	383,478	0	0
23 564 B shares, £5 each, fully paid	117,820	0	0
4 per cent. debenture stock	122,793	0	0
Sundry credit balances	175,226	11	7
Reserve fund	82,577	2	10
Profit and loss as per appropriation account, £34,850. 2s. 2d.; less interim dividend, paid on Feb. 18, 1897, £9,586. 19s.; and interest on debentures for six months paid Dec. 31, 1896, £2,250	23,013	3	2
	£904,907	17	7

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Cr.	£	s.	d.
Cost of establishing the business, goodwill, remaining patents, etc., as per last balance-sheet	281,147	13	3
Further expenditure thereon	41,667	7	11
	322,815	1	2
Amount of B shares of this Company, issued as per contra	117,820	0	0
	440,635	1	2
Altrincham Electric Supply, Limited	23,146	0	0
Freehold and leasehold property	63,284	19	4
Plant and stock	191,814	0	5
Debtors	89,876	0	1
Investment National Telephone Company, Limited, 5 per cent. non cumulative third preference shares at cost	25,000	0	0
Cash at bankers and in hand	71,151	16	7
	£904,907	17	7

ANGLO-AMERICAN TELEGRAPH COMPANY, LIMITED.

The report for the first half of 1896, to be submitted at the half-yearly meeting to be held in London on Friday next, states that the total receipts, including the balance of £369 brought forward, amounted to £166,558. The traffic receipts show an increase of £5,935, as compared with the corresponding period of last year. The total expenses, including the repair of cables, etc., amounted to £53,301, being a decrease of £3,728. The directors, under the powers conferred upon them by the articles of association, have before declaring the net profits, set apart the sum of £12,000 to the renewal fund, leaving a balance of £101,257. One quarterly interim dividend of 12s. 6d. per cent. on the ordinary and of £1. 5s. per cent. on the preferred stock, was paid on May 1, absorbing £43,750; and a second quarterly dividend of 14s. per cent. on the ordinary and £1. 8s. per cent. on the preferred stock, amounting to £49,000, will be paid on July 31, leaving a balance of £8,507 to be carried forward. The Company's repairing ss. "Minia" has been employed in the repair of cables belonging to the Direct United States Cable Company and the Western Union Telegraph Company, the payments for which are included in the revenue account. She is now engaged in the repair of the 1880 cable, broken 170 miles from Newfoundland, and also on the Irish coast. The other cables and land-lines of the Company are in good working order.

CENTRAL LONDON RAILWAY COMPANY.

The half-yearly report of the Central London Railway Company states that the expenditure during the half-year amounted to £338,894. 1s. 7d., making the total outlay £1.146,220. 11s. 1d. As a result of further negotiations which have taken place in connection with the station and street improvements at Davies-street, the works at that point, as authorised by the Central London Act of 1891, will be carried out; consequently, the Bill introduced into Parliament seeking for power to acquire a site on the north side of Oxford-street has been withdrawn. The Company's engineers report that satisfactory progress has been made with the tunnelling during the past half-year, and that the important works at the Bank Station are also being pushed forward as rapidly as possible.

WATERLOO AND CITY RAILWAY COMPANY.

The half-yearly report of the Waterloo and City Railway Company states that the accounts show an expenditure of £80,079. 6s. during the six months, making a total outlay of £360,605. 14s. 5d. up to June 30. The fourth call upon the share capital was due on February 1, and was paid up in full. The fifth and final call will probably be required in October next. Every effort is being made to complete the railway, and it is hoped that it may be opened for traffic by the end of the year. Under the agreement, the rolling-stock will be provided by the London and South-Western Railway Company, who have ordered the necessary vehicles for the working of the railway. The contracts for the generating station and electrical appliances referred to in the last half-yearly report have been let, and satisfactory progress has been made with these works. The London and South-Western Railway Company's Bill in Parliament, including powers for a street diversion and the acquisition of further property in Lambeth, has passed through both Houses, and now only waits the Royal assent.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Manchester.—The Town Hall Committee invite tenders for electric light fittings for the Hulme Town Hall. Particulars can be obtained on application to Mr. Rison, Town Hall, Manchester.

Hackney.—The Guardians of this Union invite tenders for providing a fire-alarm system at the Hackney Union Schools at Brentwood, in the county of Essex. For further particulars see advertisement.

Hapton (Lancs.).—The Parish Council invite tenders for lighting Hapton township with electricity from September 1 to April 30. Endorsed tenders to be sent to Mr. Ed. O'Shaughnessy, clerk to the Council, St. Anne's-terrace, Padiham, by August 2. Full particulars on application.

Oldham.—Tenders are required for the construction of the permanent way of about eight miles of electric tramways, for the Oldham, Ashton-under-Lyne, Hyde, and District Electric Tramways Company. Specifications, plans, quantities, and form of tender may be had on deposit of £5, which will be returned on receipt of a bona fide tender, from the Secretary. Tenders, endorsed "Tender for Oldham, Ashton, Hyde, and District Tramways Permanent Way," are to be delivered to Mr. C. Walmsley, secretary to the British Electric Traction Company, Limited, 1 and 2, Great Winchester-street, London, E.C., by 12 noon on August 6.

War Office, S.W.—Tenders are required for the supply of specific quantities of the undermentioned articles during the next 12 months—namely, electrical instruments (submarine mining), indiarubber goods, metals (copper, lead, tin sheet, zinc sheet), and telegraph cable and wire. Manufacturers who may wish to be applied to when tenders are required should address Mr. A. Major, director of army contracts, War Office, Pall-mall, S.W., by letter, stating the particular articles which they manufacture, and the names of at least two well-known firms or public bodies who have purchased from them, and are in a position to certify as to the quality of their productions.

Ludlow.—The Corporation offers a prize of £20 for the best and most economical scheme of electric lighting for the borough. The scheme must deal exhaustively with the whole matter, and give definite information of the cost of steam and water power for the purpose of comparison with the total cost of the undertaking and working expenses. Schemes to be delivered at the offices of Mr. John Herbert Williams, town clerk, Ludlow, marked "Scheme for Electric Lighting," before 4 p m. on September 1. Should the Corporation employ the engineer whose scheme is awarded the prize to carry the work out, then the £20 will merge in the commission to which he would then be entitled to.

Egypt.—The Secretary of State for Foreign Affairs has received a despatch from her Majesty's Agent and Consul-General at Cairo, drawing attention to a notice published in the *Official Journal* of the Egyptian Government of 23rd ult., in which it is stated that tenders are invited by the Egyptian Government for Welsh coal for the use of the Administration of Railways and the Port of Alexandria. Tenders should be sent under cover by registered post, and should reach the President of the Administrative Council by October 15 next. Such further particulars as have been received may be seen at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 6 p.m.

St. Pancras.—Tenders are required by the Vestry of St. Pancras for the supply of Welsh and other steam coal for use at the Regent's Park and the King's-road electricity stations for nine months. Delivery to be made as required. Average about 100 tons per week. Copies of the specification, conditions of contract, and form of tender to be obtained upon application at the Electricity Department Offices, 57, Pratt-street, Camden Town, N.W., on payment of a deposit of £1. 1s, which will be returned on receipt of specification, accompanied by a bona fide tender. Tenders to be sent to Mr. C. H. F. Barrett, vestry clerk, Vestry Hall, Pancras-road, endorsed "Tender for Coal," by 12 noon on August 9.

London, N.W.—The Vestry of St. John, Hampstead, require tenders for the supply of best Welsh smokeless or other coal to their electric lighting station, Lithos road, Finchley-road, N.W., for one or three years from Sept. 29. Specification and forms of tender may be had, and further particulars obtained, at the Vestry Hall. Tenders to be addressed to the Vestry Clerk, and endorsed "Tender for Coal," and to be delivered at the office of Mr. Arthur P. Johnson, vestry clerk, Vestry Hall, Hampstead, by 4 p.m. on August 5. No tender will be received unless accompanied by £10 in cash or bank notes—not to be enclosed—as an evidence that the tender is made bona fide, and the amount will be returned to each person whose tender is not accepted, but will be retained in the other case until the contract (and bond, if necessary) is duly signed. The expenses of preparing and stamping contract (and bond, if necessary) to be paid by the contractor.

Carlisle.—Tenders are invited by the Corporation for the following work in connection with their electric lighting station in Carlisle: (Contract No. 1) boilers (Lancashire) and mechanical stokers; (2) engines, dynamos, condensers, pumps, etc., steam, exhaust, feed, and drain pipes; (3) storage battery; (4, section A) switchboard for dynamos and feeders (section B) boosters and switchboard for batteries and boosters; (5) arc lamps and their erection; (6) feeders, mains, and arc lamp leads. In contract No. 2 it is a condition that the dynamo makers must have already constructed dynamos of at least 100 units capacity. Copies of any of the specifications, with forms of tender and general conditions, can be obtained on payment of £1. 1s. each (to be returned on receipt by the Corporation of a bona fide tender), at the office of Mr. Henry C. Marks, city surveyor, Fisher-street, Carlisle; or Dr. A. B. W. Kennedy, 17, Victoria-street, Westminster, London, S.W. Tenders, on the prescribed forms, enclosed separately in sealed envelopes, and marked "Electric Lighting, Tender for Contract No. —," must be delivered at the office of the City Surveyor, Carlisle, by August 12.

Islington.—The Vestry of St. Mary invite tenders for an installation of electric light at the Caledonian-road Baths, Caledonian-road, N. Specifications and particulars may be obtained from Mr. A. Hessell Tiltman, architect, 6, John-street, Bedford-row, W.C., on payment of a sum of £2. 2s., which will be returned on receipt of a bona fide tender. Persons tendering must annex to their tender a schedule of wages relating to their trade, and will

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be required to make a declaration that they do and will during the continuance of any contract they may enter into with the Vestry continue to pay the trade union rate of wages as in practice obtained, and observe the conditions and hours of labour prevalent among the several classes of labour they may employ. They will be required to enter into a contract and to find one surety for the execution of the works, and they must also agree not to sublet or assign over their contract or any partnership without the previous consent of the Vestry. Tenders, sealed and endorsed "Tender for Electric Light Installation at Caledonian-road Baths." must be sent to Mr. William F. Dewey, Vestry Clerk, Vestry Hall, Upper-street, N , by 12 noon on August 5.

Sedgefield (Durham).—The Visiting Committee of the Durham County Asylum, Sedgefield, having decided to instal the electric light in the Winterton building at the Sedgefield Asylum, invite tenders with specifications for the work. Each firm will be at liberty to suggest its own method, power and arrangement, and number of lights. The building for the housing of the machinery will be erected by the Visiting Committee on plans to be arranged with the firm whose proposal for the installation is accepted, and will be on such a scale that additional machinery can be placed therein so as to provide for the lighting of the main building when that project is decided on. As a guide to firms it may be stated that from 500 to 550 16-c.p. lights will probably be required for Winterton, and a larger number for the main building. Plans of the buildings can be seen at the office of Mr. Crozier, county engineer, Shire Hall, Durham, and the buildings may be inspected and further information obtained upon application to Dr. Smith, the resident medical superintendent at the asylum. Tenders, addressed to Mr. A. O. Smith, clerk to the Visiting Committee, Durham, will be received at his office, 19, Elvet-bridge, Durham, up to noon on August 7.

Madras.—Tenders are invited for the utilisation of water flowing from the Periyár Lake for purposes other than irrigation and not incompatible with the use of the water for drinking. The irrigating season extends over nine to ten months, during which time the discharge is likely to be from 1,100 to about 500 cubic feet a second, according to the demands for irrigation and the available quantity in the lake. Subject to the risk of interruption by accident or drought, supply can be given throughout the irrigation season. No supply can be guaranteed at other times, but, so long as water is available, the Government will be prepared to issue it in such daily quantities as may seem to it advisable with reference to the time which is likely to elapse before the supply is replenished by the setting in of the rains. The fall from the tunnel to the foot of the hills is approximately 900ft., and the distance measured along the course of the stream about 6,800ft. One cubic foot per second falling 900ft. is estimated to produce over 60 effective horse-power. Intending lessees should state the quantity of water required in cubic feet per second and the annual rent offered for each cubic foot per second. No rent will be charged for the first year from the date of the concession ; for the second year the charge will be one-fifth, and an additional charge of one-fifth will be made every year until the full rent is reached. The whole or part of the concession may be surrendered on a year's notice being given. Lessees will construct at their own expense, on plans to be approved by Government, all the weirs and other works required to divert the water from the river below the tunnel. For further information, application may be made to the Chief Engineer for Irrigation, Madras, by whom tenders will be received up to October 31, 1897.

Port Elizabeth (Cape Colony).—The Town Council of Port Elizabeth (Cape Colony) invite tenders for lighting the streets and municipal buildings of Port Elizabeth by electricity, in consideration of the grant of a concession for the exclusive right of supplying electric current through the streets and roads of the town, to private houses, stores, etc., for terms of 5, 15, 20, 25, or 30 years respectively. There are approximately about 54 miles of streets in the town, as follows: main thoroughfare, 5 miles 1,196 yards ; principal streets, 16 miles 1,433 yards ; minor streets, 32 miles. The streets of the town are at present lighted by 380 gas lamps of reputed 16-c.p. The municipal buildings consist of town hall municipal offices, morning market, feather market, wool market, and museum. The main streets are to be lighted by arc lamps, and the side streets and municipal buildings by incandescent lamps. Tenderers must state at what sum per annum they are prepared to adequately light the streets and municipal buildings for the various periods mentioned above, if they are granted a concession for any one of the periods referred to. The concession will provide, inter alia, that the particular system and plant to be adopted by the concessionaires shall be subject to the approval of Council ; the charge for supplying current to private houses shall not exceed 1s. 9d. per London Board of Trade unit ; and that the Council will have the option of taking over the whole undertaking, etc., at a valuation to be made in case of difference by two arbitrators or their umpire at the end of the period of the concession at the then value of the plant and mains. Tenders, endorsed "Port Elizabeth Electric Lighting," should be delivered to the agents of the Municipality, Messrs. Davis and Soper, 54, St. Mary-axe, London, E.C. (from whom further information may be obtained), on or before September 21.

RESULTS OF TENDERS.

Southampton.—The Town Council have accepted the tender of Messrs. Babcock and Wilcox, at £7,718, for carrying out contract No. 3 of the electric lighting works, that for boilers and mechanical stokers. Three tenders were received, the lowest being for £7,363. 15s,

Paisley.—At a meeting of the Town Council the Electric Lighting Committee's recommendations to accept the following offers were confirmed : Messrs. P. and W. Maclellan, Glasgow, two boiler feed-pumps (Cameron type), at £71 each ; Messrs. Walter Macfarlane and Co., Glasgow, 61 arc lamp pillars, at £10. 17s. 6d. each ; Brush Electrical Engineering Company, Limited, London, transformers.

Wakefield.—The Guardians have accepted offers for the following work for the new infirmary : Electric lighting plant, combined steam-engine and dynamo, belt-driven dynamo, motor-dynamo, motor, switchboard, storage cells, etc.—Cox Walker, Darlington ; complete system of wiring for the electric light, also bells and telephones, vertical steam-engine, feed-water heater, tank, pumps, and pipe work, etc.—F. B. Welch and Co., Manchester.

Kensington.—The Special Purposes Committee of the St. Mary Abbott's Vestry report that they have had before them estimates which have been invited from the following firms for carrying out the necessary alterations to the fittings at the Town Hall to allow of the pressure for the supply of electricity being increased from 100 to 200 volts, which was sanctioned by the Vestry on May 11, 1897 :

	Works.	A. Each.	B. Each
	£ s. d.	s. d.	s. d.
Rashleigh, Phipps, and Co.	143 0 0	... —	... —
Warbury. Dymond, and Co.	127 0 0	... 5 9	... 3 0
Haine and Co.	98 17 0	... 2 9	... 2 3
A Grundy	96 15 0	... 1 3	... 2 3
W. V. Scott and Co.	75 19 8	... 2 6	... 2 0

They recommend that the tender of W. V. Scott and Co. be accepted. A. Lamps and shade holders. B. Ceiling roses.

BUSINESS NOTES.

Traffic Receipts.—The traffic receipts of the Cuba Submarine Telegraph Company for April were £3,835, against £6,133.

Financial.—Letters of allotment and regret for shares in the National Electric Free Wiring Company, Limited, have been posted.

Perth.—At a special meeting of the Town Council, a committee was appointed to make enquiry so as to guide the Council as to the advisability of introducing electric lighting.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended July 25 amounted to £1,472, as compared with £1,301 in the corresponding week of the previous year, being an increase of £171.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended July 23 were £2,707. 14s. 11d., compared with £2,445. 6s. 8d. for the corresponding period of last year, being an increase of £262. 8s. 3d.

British Aluminium Company.—The British Aluminium Company, Limited, announce that warrants for the payment of an interim dividend at the rate of 7 per cent. per annum on the cumulative preference shares of the Company have been posted.

Leeds Electric Tramways.—Another trial trip of the electric tramways has been made along the whole of the route from Kirkstall to Roundhay Park. The trip was a complete success, and it is expected that the formal opening will take place in a few days.

Greenock.—The Town Council have decided to apply for electric lighting powers. Feeling outside the Council has, on the whole, been in favour of this move, and the applications of two companies for power to light the town by electricity has brought matters to a head.

Personal.—Mr. John Newlands, late assistant superintendent in the Edinburgh Telegraph Department, has just been promoted to the vacancy recently created by the retirement of Mr. A. Gray, controller. The appointment is subject to a probation of six months.

Monterey (Cal.).—An American company has just purchased and consolidated the street railways of the city of Monterey, and will take steps to at once equip the system with electric power. The amount of money involved in the transaction is said to be £1,200,000.

Rotherhithe.—The Vestry have resolved not to take any action in relation to the application of the London and Brush Provincial Electric Lighting Company and the Bourne and Grant Electric Supply Company, for provisional orders to supply electricity in Rotherhithe.

Amalgamation.—Another important amalgamation has been arranged, that of the Maxim-Nordenfeldt Company with Vickers, Sons, and Company, Sheffield, whose shares are to be given in payment in certain proportions to the shareholders of the former undertaking.

Electric Lighting Loans.—It was agreed at the meeting of the London County Council, upon the recommendation of the Finance Committee, to lend the Islington Vestry £7,000 for an electric light installation at Eden-grove and £40,450 for general electric lighting purposes.

Penzance.—A letter was read at the Town Council meeting from the Imperial Electric Light and Power Company, giving notice of their intention to apply to the Board of Trade for a provisional order to operate in this district. The letter was referred to the Highway Committee.

Westminster Electric Supply Corporation.—The Board of the Westminster Electric Supply Corporation, Limited, have declared an interim dividend at the rate of 8 per cent. per annum for the

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half-year ended June 30 last, payable on September 1 to all shareholders on the register.

Llandudno.—The engineer reported at the Urban District Council meeting that the plans of the electric lighting work would be ready for the Local Government Board that day. The clerk was instructed to forward the same to the Board in due course.

County of London and Brush Provincial Electric Lighting Company, Limited.—The warrants in payment of the interim dividend to June 30, 1897, on the first and second issue of the 6 per cent. preference shares of the Company were duly posted on Wednesday evening, July 28.

Venezuela Telephone and Electrical Appliances Company.—Coupon No. 14 of the 5 per cent. mortgage debentures, due on 31st inst., will be paid from that date at the Capital and Counties Bank, 39, Threadneedle-street, E.C., and at Messrs. Westendorpand Company's Bank, Amsterdam.

Aberystwith.—At the Town Council meeting, Mr. Williams proposed that the town clerk should communicate with the Aberystwyth Improvement Company as to the terrace lamps, some of which were frequently not so bright as they should be. Dr. Harries seconded. The motion was agreed to.

Liverpool.—At a special meeting of the Tramways Committee of the Corporation it was decided to recommend the Council to lay down the tramways from St James's Church past the Custom House, up Park-lane to the Dingle, and up Warwick-street to Prince's Park Gates, on the overhead electric system.

City and South London Railway.—The returns for the week ended July 25 were £889, compared with £813 for the corresponding period of last year, being an increase of £76. The total receipts for the half-year 1897 amounted to £3,666, compared with £3,488 for the corresponding period last year, being an increase of £178.

Private Bills.—In the House of Commons on Friday the Lords' amendments to the Brompton and Piccadilly-circus Railway Bill were considered and agreed to. The King's Lynn Corporation, the Bradford Corporation Tramways and Improvement, and the Colwyn Bay and Colwyn Urban District Council Bills were read a third time.

Walsall.—At the Rural District Council meeting, the Clerk announced that he had received notices of the intention of the Midland Electric Corporation and the South Staffordshire Blast-Furnace Power Syndicate to apply for power to supply electricity in the district. It was resolved to refer the matter to the several Parish Councils.

Bournemouth.—The Town Council have instructed the town clerk to write Mr. F. E. Stuart, C.E., fire brigade electrician, Ealing, asking upon what terms he would inspect and report upon the system of call bells in use in Bournemouth, and advise as to what should be done to make the system satisfactory, and also enquiring how soon he could come down to make the inspection.

Liverpool Overhead Railway Company.—The accounts for the past half-year show an available balance of £13,410. The directors have resolved to recommend a dividend of 5 per cent. per annum on the preference shares, and 3 per cent. on the ordinary shares, as against 2¾ per cent. per annum on the ordinary shares for the corresponding period last year. The balance carried forward is £3,810, as against £2,897.

Carbide of Calcium.—The Acetylene Illuminating Company, Limited, informs us that, as anticipated in their recently issued pamphlet "Carbide of Calcium and the Petroleum Acts," it has been prescribed by an Order in Council held on 7th inst. that 5lb. of carbide of calcium may be kept without a licence, provided it be kept in separate substantial hermetically-closed metal vessels containing not more than 1lb. each.

Improved Electric Communication with Paris.—As the result of an agreement concluded between the French and British postal and telegraph administrations, two new cables have been laid across the Straits of Dover. One of the results of this step will be that a third telephonic circuit and two fresh telegraph lines will be available between Paris and London. A fourth line will be ready for use in the course of the present year.

Bromley.—It was reported at the meeting of the Rural Highway Board that the draft of the application of the Board of Trade by the Chislehurst Electric Lighting Syndicate had been submitted to the Chislehurst Parish Council and approved. The General Purposes Committee recommended that no objection be made to the order, but that the Council reserve to themselves the right to take objection in detail before the enquiry if necessary.

Brighton.—The re-opening of the Brighton and Rottingdean Electric Railway has been attended with great success. The car has been well patronised, as many as 120 passengers being conveyed in one trip to Rottingdean and back on one afternoon. Crowds of sightseers are attracted to the Paston-place groyne to watch the arrival and departure of the car. All who have had a ride on the car seemed pleased with their novel experience.

Ventilating and Electrical Specialities.—Messrs. Matthews and Yates, of Swinton, Manchester, have forwarded us a catalogue of their ventilating and electrical specialities, and ask us to state that a copy will be sent to anyone who applies for it. It is wonderfully well produced, and the illustrations are very clear and effective, and are of sufficient size to give one a good idea of the various articles they represent. Useful details and prices are given in full.

Wakefield.—The electric light for the city is being seriously affected by the Leeds engineers' dispute. Progress is being made with both the central electric lighting station and the sub-station in Westgate, but the fitting-up of the engines is delayed for want of men. The Electric Light Committee are determined, however, to have one engine fixed at once, so as to enable them to carry out their contracts for the illumination of the new county offices and West-parade Chapel.

Islington.—The following resolution was carried at the Vestry meeting: "That the members of this Vestry, having read with much interest the accounts of the opening of the combined dust destructor and electric light station recently erected by the Vestry of Shoreditch, would be glad to have an opportunity of inspecting it if such opportunity could be afforded at a convenient date, and that the Vestry clerk be requested to forward a copy of this resolution to the Shoreditch Vestry."

Cambridge Electric Supply Company, Limited.—An extraordinary general meeting of this Company will be held at the offices, Thompson's-lane, Cambridge, on Tuesday, August 3, at 12.30 p.m., when the following resolutions will be submitted for adoption: (1) That the capital of the Company be increased to £100,000 by the creation of 5,000 new ordinary shares of £10 each; (2) that the articles of association, Nos. 13, 14, and 26, be cancelled for purposes of quotation on the Stock Exchange.

Morley.—Colonel A. G. Durnford, R.E., has held an enquiry with respect to the application of the Corporation to the Local Government Board for sanction to borrow £19,500 for purposes of electric lighting and £1,000 for the erection of stables, storerooms, and other buildings. Mr. R. B. Hopkins, town clerk, opened the case for the Corporation, and Mr. R. Hammond, of London, explained the details of the scheme, which had been designed by himself. Evidence was also given by Mr. M. H. Sykes, borough surveyor.

New Electric East-End Line.—Lord Morley's Committee of the House of Lords have passed, as an unopposed measure, a Bill incorporating a new company with powers to construct an underground electric railway from a junction with the Metropolitan and Metropolitan District Railways at Whitechapel, to a junction with the London, Tilbury, and Southend Railway at Bromley. The authorised share capital of the company is £660,000, with £220,000 borrowing powers. The Bill has now been sanctioned by both Houses.

Carbons.—Messrs. J. Lyell and Co., electrical engineers and agents, of 55, Victoria street, S.W., send us a copy of their latest price-list of Berne carbons (Carré make) for arc-lighting batteries, telephone transmitters, smelting, etc. The advantages claimed for these carbons are that they are perfectly straight, free from impurities, slow burning, and give a pure white light. The arc-lamp carbons are more tenacious and rigid than the ordinary ones, and do not fly to pieces or crack when lighted. They burn more evenly, and are 25 per cent. more luminous.

Change of Address.—Mr. John Lavender, M.S.T.E. (late of the Postal Telegraphs), has removed his office from Catherine-chambers, to 41, Halliwell lane, Cheetham Hill, Manchester. Mr. Lavender is the telegraph engineer to the West Lancashire Railway Company, the Mersey Tunnel Railway Company, Liverpool the Southport and Cheshire Lines Extension, and contractor to the Lancashire and Cheshire Telephone Company. He undertakes contracts for the erection and maintenance of telegraph lines, wiring, electric bells, alarms, tell-tales, and similar machinery.

The History of Electric Light.—In connection with the Imperial Victorian Exhibition at the Crystal Palace, the Edison and Swan United Electric Light Company, Limited, are publishing a historical review of the introduction of the electric light into England. Judging from the advance copy of a small portion of this pamphlet which we have received, the company are turning out something exceptionally good, both as regards the reading matter, the illustrations, and the whole "get-up," and we await with interest the production of the completed article.

Crieff.—The Town Council visited Loch Turret and made their annual inspection of the waterworks last week. At a luncheon which was given during the afternoon, reference was made by Provost Finlayson to the generous offer of Sir Patrick Keith Murray, Bart., in regard to the proposed electric light, and Mr. D. K. Murray, factor for Ochtertyre estate, explained that what Sir Patrick Murray wanted was the town to make due enquiries into the motive power of the Turret, so that nothing could be said afterwards if things did not come up to expectations.

King's Norton.—At the Rural District Council meeting the clerk (Mr. E. Docker) reported that the protracted negotiations between the Parliamentary Committee and the Birmingham City Tramways Company had at length ended in the company's solicitors undertaking, in writing, to insert in the Bill a clause investing the Council with absolute rights as to the mode of traction to be used, and power to make by-laws in respect to any new lines laid down in their district, whilst, in respect to the existing lines, all powers possessed by the Council under the standing orders were retained.

Paisley.—The Callender Cable and Construction Company, Limited, London, have now commenced laying the electric light mains in connection with the municipal electric lighting scheme. A start has been made in Wellmeadow, and the cables will be carried in an easterly direction down High-street to Garthland-street. The copper conductors will be capable of supplying a current to about 1,400 lights of 16 c.p. Messrs. Callender's contracts includes the whole of the cables required by the scheme, and the work is to be supervised by their chief engineer, Mr. W. Douglas Reid.

Electricity in Calcutta.—We see that the Indian Electric Supply Syndicate has been satisfactorily launched in England, says the *Indian Engineer*, and will, we presume, soon set to work

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in laying down plant for the supply of electricity for lighting and other purposes in Calcutta. Messrs. Kilburn and Co. are the local agents, and they deserve credit for having carried their cause to a successful conclusion. The pity is that arrangements have not been found possible for using electricity in connection with the Calcutta Tramways. The opportunity was a golden one, and even now it is not lost.

The Chili Telephone Company, Limited.—The report for the year ended March 31 states that the net income in Chili from all sources was 237,707dol., an increase of 2,861dol. The average rate of exchange for the year was 17·47d., as compared with 17·27d. in the previous year. The balance to the credit of the revenue account, including £557 brought forward, was £12,878, of which £3 351 had been carried to reserve for depreciation and renewals. The directors recommend a dividend of 4s. per share, less tax, being at the rate of 4 per cent. per annum, leaving a balance of £1,020 to be carried forward.

Newington.—A letter was read at the Vestry meeting from Mr. Moore, solicitor to the County of London and Brush Provincial Electric Lighting Company, giving notice of their intention to apply for a provisional order during the next session of Parliament, empowering them to supply electric light in the parish of Newington. On the motion of Mr. Cole, the communication was referred to the Electric Lighting Committee. The Clerk stated that he had just received a telegram announcing that the Vestry's provisional order had passed the second reading in the House of Commons without opposition.

Edison and Swan United Electric Light Company.—The directors of the Edison and Swan United Electric Light Company, Limited, have decided to recommend the payment of a dividend in respect of the six months ending June 30 last at the rate of 6 per cent. per annum on the "A" share capital of the Company as now paid-up, carrying forward about £8,500, as against £5,300 in the previous year. The above distribution, together with the interim dividend at the rate of 5 per cent. per annum already paid in February in respect to the first half-year, will be equal to a dividend of 5½ per cent. for the entire year. The dividend warrants will be posted on August 12.

Southport.—Councillor Hesford, in proposing the adoption of the minutes of the Electricity Committee at the Town Council meeting, said he was glad to state, and he was sure that the members of the Council would be glad to hear, that the estate was making good, steady progress. They were not going up by leaps and bounds, but with a progress which spoke well for the future prosperity of the estate. During the quarter ending June, 1896, their private consumers were supplied with 13,000 units, while in the quarter ending June, 1897, they had sold 30,000 units, being an increase of nearly 2½ times. The motion was seconded by Councillor T. Jones, and carried.

Yarmouth.—The Surveyor reported at the Town Council meeting that since the opening of the electric works to March 31 last the rates had contributed £1,492 to meet deficiencies. The cost of capital and sundry charges now amounted to £170 per month. The capacity of the works is 12,000 lights; 10,000 are connected. It was resolved to increase the borough surveyor's salary to £550 per year, and pay him £200 in respect of special work connected with the electric lighting and sewerage works. In future there will not be any special payments. Mr. Williment, who was alone in opposing, observed that it was improbable the Council would be bound by the decision not to make special grants.

Tunbridge Wells. — The subject of electric lighting was vigorously discussed at the meeting of the Tradesmen's Association, and the only complaint made was that the Town Council were not going ahead fast enough. They were not sufficiently enterprising. No one in the town who is in a position to judge seems to doubt that the electric light will be a great success, and towns of similar size and population who have adopted a hesitating policy would do well to send a deputation round the country with strict injunctions to call at this inland watering-place. They will find, if they move about, that there are more things in heaven and earth than are dreamt of in their philosophy, and the lesson will be a valuable one.

Electric Railways.—For two years or so the Manhattan Railway Company of New York has been considering the question of motive power with the view to the abandonment of steam on its elevated system, and has at length decided to adopt electricity. The success which followed the experiment of President Clark, of the New York and New England Road, in testing the merits of electricity for practical railway business, seems to have so convinced the Manhattan people that they have already invited tenders from the electrical companies for the equipment of their roads with the third rail. The outlay, it is estimated, will be £1,400,000; but nearly £200,000 will be saved annually by the change in working expenses.

Wrexham.—A letter was read at the Town Council meeting from the Local Government Board stating that they had had under consideration the report made by their inspector, Colonel Marsh, after the enquiry with reference to the application of the Council for sanction to borrow £8,200 for the purchase of the Willow Brewery for the purpose of being used for public baths, depôt, gymnasium, and other purposes. Before further considering the application, the Board wished to be furnished with an estimate of the cost of providing baths, electric installation works, corporation yard, offices, and a gymnasium, on the site, as compared with the cost of providing these buildings independently. It was resolved to discuss the matter in committee.

Bristol.—The question of electricity cropped up during the examination of the Bristol Boundaries Bill before the Committee of the House of Commons. Mr. Pembroke Stephens, Q.C. (representing the Stapleton Urban District Council), said they had been told it was the intention of the Corporation to light Stapleton Asylum by electricity, and he asked for a clause providing that in the event of that being done they should light the roads at Stapleton with electricity. As controllers of the roads, the Urban District Council would have had power to make that requirement, and they wanted their rights reserved. Mr. Pope, Q.C. (representing the promoters of the Bill), said it was not proposed to extend the mains to Stapleton, but to supply the asylum with electric light by plant within the institution. The clause was not accepted.

Durham.—At a County Council meeting the Visiting Committee of the County Asylum reported owing to the defective supply from the gasworks, they had reconsidered an old proposal to adopt electric light in part of the building. The electrical engineer whom the committee had employed estimated that the cost of an installation to light the Winterton buildings and the church would be £2,587, which sum did not greatly exceed the necessary cost of the extension of the gasworks in case the electric light was not employed; and having regard to the fact that the substitution of electricity for gas, as the medical officer had from time to time urged, would have a beneficial effect upon the health of the inmates, the committee had determined to adopt the electric light for lighting the Winterton buildings at an estimated cost of £2,500.

River Plate Telegraph Company. — In the House of Commons on Friday, Mr. Renshaw (Renfrew, W.) asked the Under Secretary of State for Foreign Affairs whether the River Plate Telegraph Company, Limited, a British company with lines between Buenos Ayres and Monte Video, has, through no fault of its own, had its entire service suspended by the Argentine Government since January 30 last, whilst a native opposition telegraph company has been permitted to continue working. Mr. Curzon (Lancashire, Southport) replied that the circumstances were as stated by the hon. member. Her Majesty's representative at Buenos Ayres had been instructed to use his best efforts for the recognition of the just rights of the Company, and it was hoped that the representations which it had been his duty to make would suffice for that purpose.

Penny-in-the-slot Electric Supply Syndicate, Limited.—This Company has been registered with a capital of £50,000 in £1 shares to adopt and carry into effect an agreement bearing date July 19, 1897, between the Electric Lighting Extension Syndicate, Limited, of the one part, and this Company of the other part; and generally to carry on in all or any of their respective branches, in the United Kingdom or elsewhere, the businesses of producers, storers, and suppliers of electricity; to purchase, construct, manufacture, and maintain all necessary cables, lines, accumulators, batteries, etc.; to acquire and turn to account any patents, patent rights, and inventions; as electrical engineers, electricians, mechanical engineers, machinists, metal founders, fitters, tube makers, wire drawers; to develop the resources of land by clearing, draining, planting, farming, and building thereon, etc.

Blackburn.—At a special meeting of the shareholders of the tramways company it was agreed to sell the undertaking to the Corporation for £87,000. The subscribed capital of the company is £81,100 in £10 shares, and during the last few years dividends of 5 per cent. on ordinary and 6 per cent. on preference shares have been paid. The Corporation are paying £9 for ordinary and £11 for preference shares. The purchase is to be completed at the end of one calendar month after the Bill authorising the Corporation to carry out the agreement has received the Royal assent. In the event of the Bill not being granted by Parliament the company will surrender the lease and obtain a new lease for a further term of 22 years, the new lease to contain the permission of the Corporation for the company to use electric traction, but not to contain a covenant for its further removal.

The Engineering Strike.—At the meeting of the Joint Committee of the Allied Trades on Saturday reference was made to the denial on the part of the Jarden Arc Lamp and Electric Company, Limited, Victoria Works, that they had conceded the eight-hour day and the terms demanded by the unions. Mr. David Brown, secretary, stated that he had received the following letter from the firm expressing their willingness to grant the concessions: "Victoria Works, Old Charlton, July 20, 1897.—To the Amalgamated Society of Engineers.—Our men will work from 8.30 to 5 p.m., with one hour off for dinner. Any man employed by the hour will be paid at the rate of 9½d. per hour until further notice; price paid for piecework will not be altered, as at the price now paid the men can easily earn 1s. (or more) per hour. At our works in America and on the Continent the men turn out 10 per cent. to 15 per cent. more work than our men have done here.—(Signed) J. B. BARTON."

Appointment Vacant.—The Markets and Fairs Committee of the Birmingham Corporation require the services of a thoroughly competent man to take charge of the electric lighting installation at the new meat market, comprising three 85-h.p. gas engines, dynamos, storage batteries, incandescent lamps, arc lamps, and the system of concentric wiring in connection therewith; also to take charge of two Lancashire steam boilers and the steam and hot and cold water systems in connection with the buildings. No one need apply who has not had charge of an installation of a similar character. Wages to commence at 50s. per week, rising to a maximum to be determined by the committee. Applications, by letter in own handwriting, accompanied by three recent testimonials as to character, sobriety, and knowledge of work, and stating age and past experience, must be sent by post not later than August 5, addressed to the Clerk to the Markets and Fairs Committee, Council House, Birmingham.

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The Commissioners of Sewers.—At the meeting this week the Streets Committee, in a report relative to the expenses of the electrical department, recommended that £1,142. 2s. 7d., being the net expenses of the department up to Christmas last, should be deducted from the account of the City of London Electric Lighting Company for electricity supplied to the public lamps for the half-year to June 30 last. The Clerk read some minutes and correspondence with regard to the action of the Post Office authorities in laying tubes for the use of the National Telephone Company, and recommended that the Postmaster-General should be informed that the Commissioners did not see their way to relax or vary the conditions under which they were prepared to comply with applications for permission to open the public-ways of the City for telegraphic purposes. The Court approved.

Hornsey.—The Lighting Committee reported at the Urban District Council meeting that they had had before them letters received from the Imperial Electric Light and Power Company, of Amberley House, 12, Norfolk-street, Strand, W.C., and the Bourne and Grant Electricity Supply Company, Limited, of 55, Chancery-lane, W.C., giving notice of the intention of the companies respectively to apply to the Board of Trade for provisional orders for electric lighting in the Hornsey district, and in the case of the first-named company applying for the consent of the Council to the proposed application. The committee recommended that a reply be made to the Imperial Light and Power Company that the Council do not consent to the company's application for a provisional order, and also recommend that the necessary steps be taken for an application to be made on behalf of the Council for a provisional order, with a view to the protection of the interests of the Council. The report was agreed to.

Portsmouth.—The Electric Lighting Committee, at their meeting, had before them a notice from Messrs. Ferranti and Co., the electric light machinery firm, to the effect that they were involved in the strike of engineers, and that as they could not be certain of being able to deliver the machinery they were under contract to make for Portsmouth within the stipulated time, they must bring the strike clause of the contract into operation. Four engines are being made by as many contractors for the Portsmouth works, but Messrs. Ferranti and Co. are the only firm who have sent in a strike notice, the other firms being apparently unaffected. This occurrence is causing some alarm in the town that the works may be delayed, and local authorities who put off ordering their machinery till the last moment should in future not let the probability of strikes escape their consideration. A wide margin should be left between the completion of preparations to meet an enlarged demand, and the time when that demand is expected.

Shoreditch.—The Electric Lighting Committee reported at the meeting of the Vestry that they had, at the request of the Electric Lighting Extension Syndicate, Limited, reconsidered the terms of the agreement between them and the Vestry for free wiring, and with a view to safeguarding the consumer of the Vestry's electrical energy, the agreement as now amended and sealed by the syndicate provides that the consumer shall not be charged more than the maximum rate as fixed by the Vestry from time to time except where the difference between the price paid by the syndicate to the Vestry and that received by them from the consumer is less than ¾d. per unit, in which case the syndicate may charge the consumer such an amount above the maximum rate fixed by the Vestry as will make up such difference to ¾d. per unit. The agreement was signed and sealed. The Vestry also approved the plans and estimates for the resewering of the Acton division of the parish. Tenders are to be invited for the work, which is estimated to cost £11,830.

Huddersfield.—At the meeting of the County Borough Council the Electrical Engineer reported that on the 7th inst. the number of consumers had increased during the month from 459 to 473, and the number of lamps connected from 33,511 to 33,987. The units metered in the month of June were 14,929, as compared with 7,583 during the corresponding month of last year, an increase of 7,346, which was equal to 96 per cent. As compared with the month of January, the number of consumers had increased 88, and of lamps connected 5,004. The units metered during the first six months of 1897 were 192,708, as compared with 135,571 during the first six months of 1896, an increase of 57,137, and equal to 42 per cent. The works were inspected by Major Cardew, one of the Board of Trade inspectors, on the 16th ult. Mr. French, assistant-engineer at the works, had resigned, and the following appointments have been made: Mr. C. R. Brown, of Sunderland, assistant-engineer, at a salary of £104 per annum; and Mr. Paul Thompson, of Huddersfield, junior engineer, at 25s. per week. Permission has been given to the engineer to take two additional pupils.

Electrical Works Destroyed by Fire.—A fire broke out early on Saturday morning at the Woking factory of the International Electric Supply Company. It began with an explosion, caused, it is thought, by the mingling of the gases of certain chemicals stored on the premises. The force of the explosion blew from the boiler-house into the yard outside a young fellow named Ward, without, however, seriously injuring him. The local fire brigade were quickly in attendance, but the building and its contents were of such an inflammable nature that it was impossible to save either, and the brigade directed their efforts to safeguarding adjacent stores. Among the things destroyed were about £2,000 worth of electrical instruments and large quantities of machinery and tools. Celluloid, gelatine, and other inflammable materials were stored on the premises. The damage is covered by insurance. We learn that, although the fire gutted one of the main buildings, most of the machinery will be at work again in a few days' time. The only inconvenience will be the delay in the delivery of orders, which is unavoidable owing to the large quantity of stock and raw materials destroyed.

St. Paul (Deptford).—At the meeting of the Vestry Mr. King moved a resolution authorising the Commissioners of Public Baths and Wash-houses to borrow £2,200 (the borrowing of which has been sanctioned by the Local Government Board) for electric lighting at the baths, to be repayable with interest in 10 years. This was explained to be in addition to the sums of £29,645 and 7,500, the borrowing whereof by the Commissioners for the Baths has already been authorised by the Vestry. Mr. Clegg seconded the motion. The Chairman said that it was desired to make the new baths in every way a credit to the town, and in order to do so they desired to adopt the most approved method of lighting in modern times. The amount asked for, he thought, could not be deemed excessively large. Mr. W. T. Smith believed there should be further consideration before the Vestry sanctioned the borrowing of so large a sum, and he moved that the matter be referred to a committee for further consideration. Mr. Boot seconded the amendment. Only four members voted for the amendment—which was defeated by a large majority—and the resolution was passed with one dissentient.

Leicester.—The Gas and Electric Lighting Committee reported, at the Town Council meeting, that the total output of electric current from the central station, for the half-year ending June 10 last, was 145,341 Board of Trade units, as against 95,958 units in the corresponding period last year, being an increase of 49,383 units. The number of consumers was 286 Alderman Lennard, in moving the adoption of the report, said the electric lighting department showed a very substantial increase, practically 50 per cent., the output being 145,341 units for the past half-year; and the committee confidently anticipated that the consumption for the current half-year would show another increase of 50 per cent., something like 225,000 units. In consequence of the reduction in the price of the light, there was not a corresponding increase in the revenue of this department, the accounts showing a loss, as a result of the reduction, of £500 or £600. When a larger number of consumers adopted the electric light, a still further reduction would be made, but not until the department had been put on quite a paying footing. Councillor Billings seconded the resolution, which was adopted.

Hampstead.—The Lighting Committee recommended at the Vestry meeting that the engineer be instructed to fix a number of Wright's demand indicators, not exceeding 50, upon the services of a selected number of consumers, and that the engineer be instructed to supply the indicators free where such are requested by consumers. They recommended that a low-tension main be laid *vid* Gayton road to Foley-avenue, Well-walk, at an estimated cost of £150, and that a low-tension main for the supply of private consumers be laid in Merton-road, at an estimated cost of £82. The committee also reported that they had instructed the architect of the new buildings to prepare two estimates of the cost of replacing the wood floor in the present engine-room—viz., (1) by iron joists, with tiles in concrete, and (2) by iron joists with wood blocks in concrete, and that they had instructed the engineer to dispose of the surplus (waste) oil from the engine-room at the price of not less than 4d. per gallon. They also recommended that the engineer be authorised to obtain a weighing machine, also fuse-boxes, meters, etc., as mentioned in a list submitted to the committee, at an estimated cost of £93, and that the Vestry do advertise for tenders for the supply of coal to the electric lighting station, the existing contract expiring in September next. This report was adopted, but it was decided to refer back to the committee a recommendation that the Vestry should charge for consumption of electricity in connection with the indicators as follows: for the first two hours, 6d. per unit; afterwards, 2½d. per unit.

New Engineering Company.—The Russian Engineering Company, Limited, is an undertaking with a capital of £300,000, in 15,000 6 per cent. cumulative preference and 15,000 ordinary shares of £10 each. The preference shares are repayable at a premium of 10 per cent. in the event of liquidation for the purpose of reconstruction. The company has been formed to acquire the whole of the shares, with the exception of the qualification shares for officials, in a Russian company, recently founded under Imperial decree as "The Phœnix Engineering Company," established 1868, to carry on in the Empire of Russia the business of general, hydraulic, and electrical engineers. The Russian company acquires the business and assets of the Phœnix Company, with works situated upon freehold land in the Wiborg district of St. Petersburg, and covering an area of 5½ acres. The Russian company also acquires the Russian business of the firm of Greenwood and Batley, Limited, of Leeds, of which Mr. Arthur Greenwood and Major-General Micklem, two of the directors of the company, are shareholders and directors. The agreed price to be paid to Messrs. Muirhead for their interest in the Phœnix Company is £106,666. Of this they agree to accept £91,300 in fully-paid shares of this company; the balance, £15,366, "will be applied by this company in the discharge of a mortgage for that amount at present outstanding on the freehold property." The price to be paid to Messrs. Greenwood and Batley, Limited, for their interest in the Russian company is £20,000, in fully-paid shares of this company.

Electric Light on the Embankment.—Reporting on the decision of the London County Council to light the embankment and bridges by electricity, the Highways Committee recommended at the last meeting of the Council that they should be authorised to invite tenders by public advertisement for the erection of the generating station and for the supply of the necessary machinery, mains,

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lamp standards, and other plant for the installation. Upon the reception of the report, Lord Mountmorres asked whether it was proposed to retain the gas lamps on the embankment wall. He hoped they would do so, because the line of the lights was at night one of the prettiest sights in London. Lord Russell (chairman of the committee) said he could not say. Lord Mountmorres then moved that the report should be referred back. Mr. Fletcher seconded, and said he hoped that electricity would be substituted for gas on the wall. At present the gas which escaped from the pipes through the soil was slowly killing the trees. The gas companies might place their mains in the subway, but they refused to do so, and the Council had no power to make them. Mr. Yates protested strongly against any generating station being placed upon the embankment. Such stations, he declared, were worse to live near than the noisiest railway. Mr. Alderman Dickinson said there was nothing the Council's reputation depended upon more than their treatment of the embankment. He was convinced that if they lighted the embankment in the way proposed they would regret it. The chimney of the generating station would have to be higher than the top of the railway bridge at Charing Cross, and, if that were to be an accomplished fact, they would have the whole Press of London condemning them. Mr. E. Jones objected to any further postponement. The matter, he pointed out, had been discussed for the past four or five years, and if the members did not know what they wanted now they never would. The Council by a large majority referred the matter back to the committee.

The Waterloo and City Railway.—The following report of the progress made in this undertaking has just been issued by the engineers: "The northern or up tunnel has now been completed throughout, including the station and siding tunnels at the Mansion House. The City station tunnel for the south or down line of rails has still to be executed, but the shield is in position, and driving will be commenced this week, and the work will, we expect, be finished by the middle of September. The first instalment of the permanent-way materials has been delivered to the contractors, and the road-laying has been commenced. The inclined passage from the City station to the subways of the Central London Railway is in progress. The platform wall of the up line City station is being built. The whole of the underpinning of the piers and buildings at the Waterloo Station has been safely completed, and no settlement whatever has occurred in the South-Western Company's station works or offices. The inclined roads and subways between the high and the low level stations at Waterloo are well advanced, and the platform walls of the latter have been built. The retaining walls around the site of the terminal sidings south of Aubyn-street are finished, and the excavation of the enclosed area is in hand. The engine house of the generating station has been carried up to roof level, so far as it stands upon land already acquired by the Company. Possession of the remainder of the land is expected in the course of the next 10 days. The manufacture of boilers, engines, and dynamos, and other electrical work was commenced early in the year, and has now far advanced, the fire engine and dynamo being ready for testing. Arrangements have been made for the electrical contractors to follow on the permanent way at once with the conductor rails and cables. The cables themselves are finished and ready for laying, and the work generally is well forward, both as to the machinery for the power-house and the remainder of the electrical equipment."

Rowley Regis.—At the District Council meeting the Chairman said that at a previous meeting the members had some talk about the Midland Electric Corporation for Power Distribution, Limited, which proposed to provide electricity for lighting and power over a quadrangular area, including Wolverhampton, Smethwick, Walsall, and Halesowen at the four corners. He ventured to state on that occasion that any supply of electricity would be a benefit to the district, and that the Council ought to facilitate the formation of the company as much as possible. They had that day another application before them from the South Staffordshire Blast Furnace Power Syndicate, which proposed to do very much the same thing. The latter company, however, proposed to establish very extensive works in that particular parish, not only for manufacturing electricity, but for other purposes as well. While being formerly disposed to give his support to the first company, he now felt compelled to speak in favour of the second, because of the important fact that its works would be put in that parish to rate upon. If the Midland Company generated their electricity somewhere else, the Council would have nothing to rate upon worth mentioning, but in supporting the other company they would have a most desirable addition to the ratable value. He had seen a prospectus that morning, and it seemed to him to point to a very important concern indeed. He had been asked to become a shareholder of the Midland Company, but he had declined, doubting whether or not it was of a practical nature. So far as his ability went, the Blast Furnace Company seemed much more practical, and was likely to lead to the employment of a large number of men in that parish. He should therefore give it his support. Councillor B. Priest: I think it will be to our interest to do so. The Chairman: We are going to get from one what we can get from the other, and a great deal in addition. What is the notice? The Clerk: It is a preliminary application. The Act requires them to give notice. The Chairman: Then it will be wise to say nothing further in the matter at present.

Norwich.—At the Town Council meeting, Mr. Hackblock, the chairman of the Law and Parliamentary Committee, presented a report upon the present position of the Corporation with reference to the Norwich Electric Tramways Bill. He said that since the last meeting of the Council the committee had continued their labours and conferences with the promoters of the Bill and other parties interested in it. The Bill had passed through the House of Commons, and was now in its last stage in the House of Lords. The Bill had received a very large number of amendments, one of the most important of which was that which related to the sum to be spent by the Corporation in respect of the scheme. Now, instead of the Corporation having to find a sum up to £110,000, the promoters had agreed to raise two-fifths of that amount, the Corporation being responsible for the other three-fifths. The Corporation would be liable for a sum not exceeding £66,000, and the promoters of the Bill would be liable for a sum up to £44,000, and all sums over it. If the amount that was necessary for the widenings and street improvements fell short of £110.000, the promoters would contribute their two-fifths and the Corporation its three-fifths. The accounts would be kept separate, and each party would pay their own rates and their own interest on the borrowed money. They had done much to simplify matters, because it got rid of the troublesome questions of guarantees for the payment of the interest and capital of the company, it being at one time discussed whether the Corporation would not be liable for the whole if the company should come to grief. The Corporation would get the city streets widened with a cost to the city of two-thirds, and if the amount came to anything like what was estimated by the City Committee, the company would pay to the Corporation a sum of £40,000 or more for the use of the streets for tramways, in addition to the advantage which the city would have in a system of improved circulation. A resolution was passed approving the action of the Law and Parliamentary Committee.

Cheltenham.—Colonel J. O. Hasted, R.E., an inspector to the Local Government Board, has held an enquiry concerning the application of the Town Council for the sanction of the Board to the borrowing of £4,765 for the purposes of electric lighting. Among those present at the opening of the enquiry were Alderman Norman (chairman of the Electric Light Committee), Councillors Griffith and Skillicorne, Mr. E. T. Brydges (town clerk), Mr. G. E. Brydges (assistant town clerk), Mr. Kilgour (electrician), and Mr. Hall (borough surveyor). The Town Clerk said that the proposed loan of £4,765 was made up of three separate sums of £3,515, £500, and £750 in pursuance of various resolutions of the Town Council, mainly for the extension of street lighting. The total amount of loans previously sanctioned for electric lighting purposes was £42,790, of which the bulk had been already expended. In reply to the inspector's questions, Mr. Kilgour gave particulars as to the manner in which the money had been expended. General Babbage then cross-examined Mr. Kilgour, and asked him what was the total amount of expenditure contemplated upon the whole scheme of electric lighting for the borough. Mr. Kilgour replied that, including the loan now applied for, the amount was £47,500. General Babbage repeated the question with reference to further contemplated extensions; to which Alderman Norman replied that perhaps another £10,000 would be required during the coming winter, while the total cost in years to come might possibly amount to half a million. The cost would, of course, increase with the increased demand, and the scheme would not be completed until there was a main in every street in the borough. General Babbage elicited by further questions that the present length of cable was about 30 miles, but could get no answer to his query as to what length of cable would be required to complete the whole scheme. He then complained to the inspector that the Council had launched the ratepayers upon an indefinite scheme, and they did not know where they were going to financially. He further complained that Board of Trade regulations had not been complied with, but the Inspector pointed out that he had nothing to do with the Board of Trade; and the enquiry then closed.

Larne.—The question of the public lighting of the town from August 1 next was again brought under discussion at the meeting of the Town Commissioners. It will be remembered that the Larne Electric Light Works, Limited, London, having refused to enter into a contract for a period under three years, the tender of the Larne Gas Company, Limited, for the lighting of portions of the town at the rate of £1. 18s. 6d. per lamp, was accepted at the Commissioners' meeting on the 12th inst. A letter was read from Mr. M. G. Smyth, manager of the electric light works, requesting permission to attend the meeting, as he had an important communication to make. It having been decided to hear Mr. Smyth, he appeared before the Board and stated his company are now prepared to send in an amended tender for the lighting of the town with electric light for three years from August 1 next—*i.e.*, if the Board was willing to receive it. They now proposed to make the alterations asked for in Main-street and erect the 12 incandescent lamps throughout the town free of charge, merely charging the cost of lighting. These alterations would mean an expenditure on the part of the company of about £145. Mr. Foster remarked that had the company made that proposal when first applied to, they would have saved a lot of unnecessary trouble. Mr. Smyth having withdrawn, it was pointed out that the gas company had been written to informing them of having obtained the contract. Mr. Hay said he did not think there would be any trouble with the gas company. Mr. M'Gregor and himself had voted in favour of the gas company when they should have refrained from doing so owing to their position as shareholders. So far as he knew, the gas company would not insist on their right to carry out the contract; in fact, they would only be losing money by so doing. What had been done, although illegal, had made matters a little easier for the ratepayers. Mr. M'Gregor: Through the action of Mr. Picken, the ratepayers have saved £50 at least. In reply to the chairman, Mr. Hay undertook to have a letter sent from the gas company

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releasing the Commissioners under the circumstances, and stating they had no desire to take up the contract. It was arranged that on receipt of the amended tender from the Larne Electric Light Works, Limited, the clerk should call a special meeting of the Board.

Swansea.—Councillor Aeron Thomas has been interviewed by a local newspaper with respect to the rejection of the Swansea triple scheme and the consequent acquisition of power by the tramway company to work its system by electricity. He said he could not help reflecting on the huge mistake the town has made in the whole matter. The tramway company, by the additional powers they have just obtained—powers to work the system by electric traction—have naturally enhanced the value of their undertaking considerably, and if the Corporation want to purchase now they will have to pay for it. It may be said that the Corporation can exercise their compulsory powers to purchase, and that the price, in the event of a dispute, must be fixed by an arbitrator appointed by the Board of Trade. But under the existing Acts these powers cannot be enforced till 1906, and even then the price, in the event of a dispute, will be based, according to a case decided recently, upon the original cost less reasonable depreciation. It will, therefore, be seen that even if the tramway company do not keep the streets in proper repair—as they have to if they are to take advantage of electric traction—the value of the property will be enhanced, and the Corporation will have to pay a greater price on that account. He often heard it said that, so long as they had electric trams, what did it matter who ran them? It did matter. Under the triple scheme they had hoped for a cheaper and better light for the town, and a more sanitary method of disposing of the town refuse. Now the position is that the electric installation by the tramway company will be for the specific purpose of generating power for the tramways alone, and not for the combined purpose of supplying light for the town, so that it can readily be seen what a good customer the Corporation has lost in the matter of the supply of electricity. He still hoped some arrangement could be made with the tramway company, and quickly, too, whereby the Corporation would have the supplying of the electric power to the tramway company. At the same time, he felt that the company, with its present powers, had the whip hand over the Corporation in the matter, as they were not bound to come to terms at all. He predicted that in 12 months, or two years at the outside, there would not be an intelligent or unprejudiced ratepayer in Swansea who would not be sorry that the triple scheme was defeated by what he believed to be vested interests and ignorance, with, unfortunately, a little jealousy and spite round the Council chamber.

Bath.—Alderman Sturges, in moving the adoption of the minutes of the Electric Lighting Committee at the Urban Sanitary Authority meeting, said no answer had yet been received from the Local Government Board with regard to the application for leave to borrow £6,780 for mains and £3,750 for repairs at the works. Formal notice, according to the minutes, had been given to Mr. Metzger to leave, and this, said Alderman Sturges, was done with the idea of considering his salary, which was a very complicated affair at present. The committee was not satisfied with the arrangement continued as from the company, and this notice was simply to let Mr. Metzger know that at Christmas—the earliest opportunity—they would reconsider his salary with the object of making it into one payment. There was an item of 12 guineas for the men's outing. He had heard gentlemen say it was an extravagant sum. He did not think so, and, besides, it was no more in proportion than was given to the police. As to extensions, there were two recommended, one up Bathwick-hill and the other up Zion-hill. The usual 10 per cent. guarantees had been given. Mr. Waldron seconded, and called attention to the fact that Manchester Electric Lighting Committee had just handed over £10,000 to the relief of the city rates. Mr. Oliver alluded to the recommendation that the Gordon Hotel Company be informed that the committee is now considering the question or charges to be made for the supply of energy to hotels, restaurants, public houses, clubs, and billiard-rooms, at a reduction of not less than 25 per cent. from the present charge of 6d. per unit, but that until the works now in progress are completed no public announcement will be made on the subject. He moved that this recommendation of the committee be referred back, with power to act. These people, he said, would probably be the largest consumers of electric light in the city. Unless they came to some definite understanding with the company, they would immediately incorporate in their plans plant for the supply of the electric light to the hotel and to the gardens. If action was not taken, the Corporation would be very likely to lose good customers. Alderman Taylor said the committee were under the impression that they could give a greater reduction than 25 per cent. Alderman Sturges said he should be glad to accept the suggestion. Alderman Clark: Of course, you are not going to give this company an advantage which other ratepayers do not possess? Alderman Taylor said it was a well-known fact that those persons who used the electric light at a time when it was not heavily used could have it at a cheaper rate than others. The report, with this amendment, was carried.

Plymouth.—The question of electric traction for the trams has been discussed at a meeting of members of the Plymouth Incorporated Mercantile Association. There is a difference of opinion in the town on the merits of the overhead system which the Corporation have approved, and a sub-committee was recently appointed to investigate, view, and obtain information on the modes of traction in existence. The report presented by this committee stated: "Your sub-committee announce that in carrying out their instructions they have carefully investigated reports prepared by various corporations as the result of personal inspection both in England and on the Continent, including, amongst others, the views of deputations prepared for the corporations of Birmingham, Sheffield, Glasgow, Leeds, Bolton, and Plymouth; also reports and enquiries of the Bristol Electric Tramway Company and Hartlepool Electric Tramway Company. Your committee have personally viewed and ridden upon the trams named respectively under Bristol, Birmingham, Walsall, and Wednesbury. With regard to 'horse cars' there is no need to comment. The present 'accumulator' cars, as working in Birmingham, are undoubtedly most unsatisfactory. 'Steam cars,' we believe, would not be tolerated in Plymouth for 24 hours. The 'cable' system has much to recommend it, but in case of a 'break' the entire service is stopped for some hours. Both the 'cable' and 'conduit' are severely handicapped in cost of construction, interruption to traffic for laying and repairs. We believe the Bristol overhead electric system, improved by such alterations and modifications as are suggested by the Plymouth Committee, to be, everything considered, the most desirable. The one great, and practically the only, serious objection urged against the overhead wires, is their appearance. We started our investigations more or less in sympathy with this objection, but are bound to admit that what we have seen has modified these views. In our opinion the wires give but slight offence to the eye, and a few hours' familiarity renders them still less of an eyesore. The advantage of one post combining the duties of carrying the overhead wire, and a lamp for street lighting, with its brilliant illuminating power, should reconcile residents in streets affected to the posts, brackets, and wires. Your committee feel the suggested unsightliness may be still further removed by residents *en route* acceding, where required, to the fixing of rosettes to their houses by means of which the number of posts might possibly be reduced to only those requisite for street lighting. Your committee do not say the 'overhead electric' is altogether an ideal system, but are strongly of opinion that it is at present the only system that can be worked with the hope of financial benefit to the town. In discussing this matter it must be clearly pointed out that probably at no distant date a mode of traction—improved accumulator or some other form—will probably supercede either overhead or underground traction. Finally, 'The advantages of the electric overhead wires, as compared with the present horse traction for tramcars, are overwhelming.'" This report was adopted by a large majority.

Edinburgh.—At a meeting of the Town Council, after it had been stated that there was a deficiency on the electric lighting estimates, Mr. Mackenzie, convener of the Electric Lighting Committee, explained that in reality, instead of a deficiency, they had a much larger profit than they estimated. The number of consumers of electric light at May 15, 1896, was 452; the number on May 15, 1897, was 900, an increase of nearly 100 per cent. The number of lamps, reducing them to 8 c.p., connected on May 15, 1896, was 57,690. The number at the corresponding date in 1897 was 91,977, an increase of nearly 60 per cent. The total units sold during the year ending May 15, 1896, was 888,335. The total units sold during the year ending May 15, 1897, was 1,721,557, an increase of nearly 100 per cent. Coming to the money expended and received, they estimated to sell about 1,500,000 units, and that this would cost £10,730, exclusive of interest and sinking fund. They sold 1,721,557, an increase of 15 per cent. over their expectations, and at a cost of only £10,019—£711 less for the larger output than they estimated for the smaller output. They estimated their revenue from private lighting for the year at £16,500. They actually received £20,434—nearly £4,000 more than expected—an increase from private lighting more than estimated of nearly 25 per cent. From public lighting they estimated an income of £7,250. They only got £6,325, because, owing to the delay in getting delivery of high-tension machinery, they were not able to supply the high tension lamps. Their net increase of income over their estimate was thus £2,978, which, with the £711 less expenditure, made a total balance in favour of the undertaking of £3,689 more than they estimated. The total income for the year was £26,828; total expenditure, including interest and sinking fund, was £19,404, leaving a profit in favour of the undertaking in its second year, notwithstanding the low charges both for public and private lighting, of £7,423. The Council had decided out of this sum to set aside £4,050 to a reserve fund, to pay back to the treasurer's department £2,000, the balance owing of interest and principal incurred before the undertaking was started, and the remainder of £1,373 went to the rates. The Council had good reason to congratulate itself on the continued success of the undertaking, which had been really phenomenal, and taking into account the price at which the current was sold was beyond doubt the most successful in Britain, probably in the world. The current year promised to be equally successful. The number of applications were, as far as they had gone, more than for the corresponding period of last year. The members of the Council could not forget that from May 15 last the charge for private lighting had been reduced from 5d. to 4d.—a reduction of 20 per cent. The charge for motor power had been reduced from 3d. to 2d., or 33 per cent., and for public lighting from £18 to £16 per lamp. With these deductions they still calculated on a profit of £5,085, and he felt quite sure the profit would be more, just as last year he ventured to predict that they should have £2,000 or £3,000 more than the engineer's estimate. This year he thought their profit would be at least £7,000, which would give £4,000 to reserve and £3,000 to the rates. Altogether the outlook of the undertaking was very encouraging, and reflected the greatest credit ou the officials in charge. The Cleaning, Lighting, and Electric Lighting Committees of the Council recommended the introduction of the electric light into Portobello.

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Mr. Mitchell Thompson moved approval of the recommendation, and argued that electric lighting was more needed in Portobello than in any other district. The total cost would be £13,500. Bailie Kinloch Anderson seconded. Mr. Mallinson suggested that consideration of the subject should be delayed till next meeting of Council. This was agreed to.

PROVISIONAL PATENTS, 1897.

JULY 19.

17025. Apparatus for measuring the phases of alternating currents. Joseph Tuma, 28, Southampton-buildings, Chancery-lane, London.

17026. A new galvanic element. Charles Denton Abel, 28, Southampton-buildings, Chancery-lane, London. (Constantin Nikolajewitsch Sedneff, Russia.) (Complete specification.)

17029. Improvements in or relating to electric lighting. Oliver Prescott Macfarlane, 7, Hartham-road, Camden-road, London. (Richard Joseph Crowley, France.)

17032. Improvements in and connected with the utilisation of electrical energy as the heating agent in the melting apparatus of linotype machines. The Linotype Company, Limited, John Place, and Mark Barr, 22, Southampton-buildings, Chancery-lane, London.

JULY 20.

17075. Improvement in collectors applicable to electric railways or tramways and the like. Henry Schuster Cowx, 4, St. Ann's-square, Manchester.

17081. Improvements in and connected with electrical furnaces. Francis Jarvis Patten, 70, Market-street, Manchester. (Complete specification.)

17105. Improvements in primary batteries. Wallace James Lambert Sandy, 90, Brayard-road, Peckham, London.

17113. Improvements in underground systems of electrical distribution. William Lloyd Wise, 46, Lincoln's-inn-fields, London. (Alvaro S. Krotz, William P. Allen, and Oliver S. Kelly, United States.) (Complete specification.)

17142. Improved electro-mechanical apparatus for the control of electric motors. Julien Dulait, 322, High Holborn, London.

17143. Improved automatic braking mechanism for electric cars and the like. Julien Dulait, 322, High Holborn, London.

17158. Improvements in electric batteries. Walter Rowbotham, 18, Southampton-buildings, Chancery-lane, London.

17161. Improved means applicable for use in the electrolysis of salts. James Hargreaves, 191, Fleet-street, London.

JULY 22.

17266. Improvements relating to the starting switches of electromotors. Frederick George Robinson, 10, St. George's-crescent, Liverpool.

17307. Improvements in or relating to multiple telegraph apparatus. Jules Daumarie and Abel Louis Doignon, 111, Hatton-garden, London.

17315. An improved process for electrolytically purifying and filtering saccharine liquids or solutions. Claude Achille Meygret, 45, Southampton-buildings, Chancery-lane, London.

17316. Improvements in accumulators. Luis Gumiel Garcia, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

17319. Improvements in plates for secondary batteries. William Joseph Starkey Barber-Starkey, 322, High Holborn, London.

17331. An improved casing for electric wires. Richard Pearson and George Doe Dennis, 53, Chancery-lane, London.

17333. Improvements in and connected with apparatus for lighting and extinguishing gas-jets by means of electricity. Walter Whitington and Henry Brinsley Sheridan, 11, Furnival-street, Holborn, London.

JULY 23.

17386. The electro-submersive amalgamator. Alfred Andrew Lockwood, 39, Gunterston-road, West Kensington, London.

17390. Improvements in or connected with commutators for dynamo-electric machines and electric motors. Charles Joseph Ferguson, 4, South-street, Finsbury, London.

JULY 24.

17425. Improvements in telephones. Herbert Godsal, 4, Temple-gardens, London.

17426. An improvement in electromagnetic motors. James Paulinus Jones, 23, Frederick-street, Sunderland.

17434. Improvements in electro-mechanical devices for producing corresponding positions in transmitting and receiving apparatus. Archibald Barr and William Stroud, 154, St. Vincent-street, Glasgow.

17470. Automatic transformer-switch apparatus. Alfred Schlatter, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

17451. Improvements in portable electric lighting apparatus Adolph Richter, 37, Essex-street, Strand, London.

17471. Improvements in electrical furnaces. Charles Denton Abel, 28, Southampton-buildings, Chancery-lane, London. (Siemens and Halske, Germany.) (Complete specification.)

SPECIFICATIONS PUBLISHED.

1894.

17357.* Arc lamps. Allin and Wood. (Amended specification.)

1896.

10304.* Electric railways. Lake. (Johnson and another.) (Amended specification.)

14848. Electric induction coils and transformers. Apps.

16057. Electrolytic apparatus. Kellner.

17103. Phonographs. The Edison-Bell Phonograph Corporation. Limited, and Strob.

18551. Suspension or supporting of engines or motor-carriages. Clubbe, Southey, and the Electric Motive Power, Company, Limited.

18867. Electric trolley mast. Scott.

19207. Starting, speed regulating, reversing, stopping, and steering mechanism for mechanically-propelled vehicles. Clubbe, Southey, and the Electric Motive Power Company, Limited.

19316. Electric lamps. Jackson and the Acme Electric Lamp Company, Limited.

20242. Appliances for rendering astatic galvanometer needles independent of disturbances by earth magnetism. Siemens Bros. and Co., Limited. (Siemens and Halske.)

20243. Appliances for protecting electrical measuring instruments from external influences. Siemens Bros. and Co, Limited. (Siemens and Halske.)

25365. Electrode for secondary batteries. Woodward.

1897.

7522. Electrically-propelled cars and like vehicles. McElroy.

10429. Underground conduits or trenches for electric railways and the like. Griffen and Small.

10494. Electric gas lighters. Borradaile.

11119. Telegraphic apparatus. Eaton.

12455. Prepayment devices for use with telephones. Silberberg.

13221. Electrical cut-outs. Dorman and Smith.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	9½-9¾
Brush Company, Ordinary	8	1⅛-1¼
—— Non. Cum., 6 per cent. Pref.	2	1⅛-1¼
—— 4½ per cent. Debenture Stock	100	105-109
—— 4½ per cent. 2nd Debenture Stock	100	93-97
Callender's Cable Company, Debentures	100	108-113
—— Ordinary	5	6½-7½
Central London Railway, Ordinary	10	9¾-10¼
——	6	5½-6½
Charing Cross and Strand	5	13-14
Chelsea Electricity Company	5	9¾-10¼
—— 4½ per cent. Debentures	100	110-113
City of London, Ordinary	10	23½-24½
—— 6 per cent. Cumulative Pref.	10	16½-17½ xd
—— 5 per cent. Debenture Stock	100	129-134
City and South London Railway, Consolidated Ordinary	100	62-64
—— 4 per cent. Debenture Stock	100	137-139
—— 5 per cent. Pref. Shares	10	15½-16
County of London and Brush Provincial Co., Ordinary	10	12⅞-13½
—— 6 per cent. Cum. Pref.	10	15-15½ xd
—— 4½ per cent. 2nd Debenture Stock	10	15-15½ xd
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1⅛-1⅜
—— 5 per cent. Debentures	—	88 93
Edison and Swan United Ordinary	3	2⅛-2⅜
—— 5 per cent. Debentures	5	3⅛-4⅛
Electric Construction, Limited	2	1⅛-2
—— 7 per cent. Cumulative Pref.	2	2⅜-2½
Elmore's Copper Depositing	1	1-1
Elmore's Wire Company	2	1⅜
W. T. Henley's Telegraph Works, Ordinary	10	18½-19½
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	108-113
House-to-House Company, Ordinary	5	8½-9
—— 7 per cent. Preference	5	10½-10⅝
India Rubber and Gutta Percha Works	10	20½-21½ xd
—— 4½ per cent. Debentures	100	105-108
Kensington and Knightsbridge Ordinary	5	13-13½
—— 6 per cent. Pref.	5	8-8½
London Electric Supply	5	1⅛-2
Metropolitan Electric Supply	10	16½-17½
—— 4½ per cent. First Mortgage Debenture Stock	100	118-122
National Telephone, Ordinary	5	6¾-7½
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	15-17
—— 5 per cent. Non. Cum. Third Pref.	5	6-6½
—— 3½ per cent. Deb. Stock	100	105-110
Notting Hill Company	10	15-16
Oriental, Limited, £1 shares	1	1⅛-2
—— £5 Shares	5	8½-8¾
—— £4½ shares	4½	7¼-7½
Oriental Telephone and Electric Company	1	1-1
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	102-104
St. James's and Pall Mall, Ordinary	5	15½-16½
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	36-39 xd
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	3	10⅜-11⅛
Westminster Electric Supply, Ordinary	5	15-16
Yorkshire House-to-House	5	8-8½

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NOTES.

Royal Archæological Institute.—The summer meeting of the Royal Archæological Institute is being held this week at Dorchester.

The Third-Rail System.—It is reported that the third-rail electric system will be adopted on the elevated railways in New York and Brooklyn.

Electrical Train-Lighting.—The Furness Railway is to have some new rolling-stock, and we note that the carriages are to be lighted electrically.

"**El Telegrafista Espanol,**" in praising the administration of our General Post Office, compares our rate of 6oz. for 1½d. with the Spanish one of 1s. 5½d. for the same weight.

Prize Competition.—Prizes of £100 and £50 are advertised for proposals to increase the traffic upon the Wannsee Railway. Full particulars of the competition may be obtained upon application to Dr. Boethke, Apostelkirche 11, Berlin, W.

SS. "Faraday."—This historical cable-ship, owned by Messrs. Siemens Bros. and Co., started for the Amazon on Saturday last. We understand that repairs will be made to the cable laid on the last trip, and that some further extensions will also be laid.

The Institution of Junior Engineers.—The summer meeting will this year be held in Ireland from August 14 to 17 at Dublin, and from 18th to 21st at Belfast. Full particulars may be obtained from the secretary, 47, Fentiman-road, London, S.W.

Vacant Positions Abroad.—The *Electrotekhnischer Anzeiger*, Berlin, July 18, contains a very large number (about 30) of advertisements for engineers. It is surprising what a lot of Englishmen are now holding good responsible positions in electrical establishments on the Continent, and there is no reason why others should not follow suit.

The Australian Cable.—A Reuter's telegram, dated New York, July 30, states: According to advices received here from Honolulu to the 21st inst., her Majesty's surveying vessel "Penguin" has arrived there, and reported having struck a reef off Palmyra Island. It was alleged that she was making surveys at the time in connection with the proposed Australian cable.

Electrical Printing Presses.—Mr. John M'Dougall, J.P., states that the *Galway Express* and all the machinery in the *Express* office has been worked by electricity as the motive power for the past three years. Mr. James Perry, M.E., M.I.C.E., county surveyor, put up the motive power three years ago, and it has worked without a hitch since. He claims that the *Galway Express* was the first Irish paper to be printed by electricity.

Crystal Palace School of Engineering.—The committee of directors hold to-day their annual function for the award of certificates for the summer term. We have been invited to inspect the several departments of the school, situated at the base of the South Tower, and to be present to hear the list of certificates awarded by the examiners read. Sir Allen Sarle, J.P., will take the chair in the lecture theatre of the school at 12 precisely.

Prize Competition.—The municipality of Chemnitz, in Germany, intends to build several new lines of electric tramways and to let the same on lease, they are advertising that the conditions of a prize competition will be supplied free on application to the Town Council. The competition will close on October 1, 1897, and extends not only to the supply for the whole of the labour and material, but also to the concession or lease of working the whole of the lines.

Yet Another.—Since writing the note on the Diatto system of electric traction, we have heard from Mr. J. G. W. Aldridge that he has worked out a new system of traction. He does not give us details, but as Mr. Aldridge is to read a paper upon the subject before the British Association at their Toronto meeting, we may soon have an opportunity of describing and criticising the arrangements, which we trust will add to the general knowledge on such subjects.

Artificial Rubies—Gin's Patent.—The patentee has succeeded, as stated in *Aluminium*, in producing rubies in pieces of several hundredweights each by mingling vapours of oxide of aluminium with vapours of other substances in an electric stove. Rubies consist of oxide of aluminium coloured with potassium combined with chromic acid. The latter also enters into korund, sapphire, topaz, amethyst, and emeril stone. Probably the worth of Gin's rubies will consist in being able to take the place of the latter only.

New Knights.—Amongst the first batch of recipients of Queen's birthday and Jubilee honours who travelled to Osborne on Tuesday last was Mr. (now Sir) Alexander R. Binnie, chief engineer of the London County Council and architect of the Blackwall Tunnel. The party went to Portsmouth in the Privy Council's special, and the new knights received the accolade by her Majesty, to whom they were presented by the Home Secretary. Prof. Crookes, F.R.S., was at the same time given his new title, and became Sir William Crookes.

London University Commission Bill.—At a meeting of the Technical Education Board of the London County Council, held recently, the following resolution was unanimously adopted: "That the Board, being satisfied that the Bill now before Parliament makes adequate provision for inclusion within the scheme of the university of duly-qualified teachers and students in the polytechnic institutes (and other institutions aided by the Board), and that the special interests with which the Technical Education Board is concerned have been duly safeguarded, hereby approves the Bill, and expresses its desire that it may be passed into law this session."

Military Cable.—Great excitement prevails in Spain and Italy over the recent exploits of an English company in the Mediterranean. It is stated that the company, under pretext of testing the Vigo-Lisbon cable, have (at night, guided solely by the light of the lighthouses) connected Gibraltar by cable with the coast of Vigo near the Cies Islands. This is looked upon as a purely military cable, in order to enable the garrison at Gibraltar to communicate with a fleet anchored near Vigo. Whilst the Italian Press is quizzing the Spaniards as being "bamboozled" by the English, the Spanish papers head their articles "Does the Government know?"

Switzerland.—Apparently there are not lakes enough in Switzerland to suit everybody's taste, for the firm of L. Brunner, of Vienna, are about to construct another one in the canton of St. Gallen, between the towns of St. Gallen and Herisaw. This firm is at the head of a syndicate which proposes to erect dynamos of 2,500 h.p. for the purpose of supplying power to electric light and railway companies within a radius of about 20 miles. The power will be derived from the little River Urnasch. An interesting feature of the enterprise will be an artificial lake of about 50 acres surface, containing 1½ million cubic yards, to which the water is to be conducted through a tunnel of about 4,000 yards in length.

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New Submarine Telegraph.—Mr. Ader has communicated to the Académie des Sciences, in Paris, the details of a new self-registering apparatus for submarine cables. The current passes through a wire, which forms part of a diminutive dynamometer, placed in a powerful magnetic field formed by a permanent magnet. The oscillations are photographically recorded. This apparatus has already been tried between Brest and St. Pierre, and on the Marseilles-Argelia cable, demonstrating, it is said, that the number of signals transmitted per minute exceeded from 1·5 to 2·7 the maximum obtained with the Kelvin recorder. The question of the length of cables on which the tests were made may, however, largely interfere with similar results being obtained elsewhere.

Cheap Electricity.—We have received a pamphlet with the above title from the County of London and Brush Provincial Electric Lighting Company, Limited, which gives the prices at which electrical energy is now obtainable throughout the parishes of St. Luke, Middlesex, and St. James and St. John, Clerkenwell. We note that this company have laid down separate continuous-current mains for power purposes, and that the Brighton system of charging has been adopted. Hence for lighting and heating the charges will be as follows: 2 hours' average use per day, 7d. per unit; 3 hours, 5⅔d.; 4 hours, 5d.; 6 hours, 4⅓d.; 8 hours, 4d.; 10 hours, 3⅘d.; and 12 hours, 3⅔d. For power from the company's continuous-current mains, 2 hours' average use per day, 4d. per unit; 3 hours, 3⅓d.; 4 hours, 3d.; 6 hours, 2⅔d.; 8 hours, 2½d.; 10 hours, 2⅖d.; and 12 hours, 2⅓d.

Fire Rules.—The rules and requirements of the National Board of Fire Underwriters for the Installation of Wiring and Apparatus for Electric Light, Heat, and Power (American) have been printed, and they are approved by the representatives of the following societies: the American Institute of Architects, the American Institute of Electrical Engineers, the American Society of Mechanical Engineers, the American Street Railway Association, the Factory Mutual Fire Insurance Companies, the National Association of Fire Engineers, the National Board of Fire Underwriters, the National Electric Light Association, and the Underwriters' National Electric Association. The uniformity so obtained is worthy of an effort, and we wish a similar compromise could be effected in England. Perhaps the choice of a name so long as the above for the rules has much to do with concurrence, as the delegates would not have much energy left for discussion after wading through the title.

Royal Indian Engineering College.—The annual distribution of prizes to the students of the Royal Indian Engineering College, Coopers-hill, Egham, took place on the 28th ultimo. Before the distribution of the prizes by Lord George Hamilton, Colonel Pennycuick, president of the college, gave a short record of the year's work. He mentioned that the college that day completed its twenty-sixth session. At its commencement the number of students in residence was 122. There were 35 leaving that day, all of whom had obtained the college diploma. Of these, 13 were entering the engineering branch of the Indian Public Works Department, two the accounts branch of the same department, two the traffic department of the State Railways, three joined the Telegraph Department, and five the Forest Department, making 25 in all who entered the service of the Government of India. For the remainder suitable employment had been found in other directions.

National Physical Laboratory. — The *Times* announces that the Treasury have appointed a small committee "to consider and report upon the desirability of establishing a national physical laboratory for the testing and verification of instruments for physical investigation, for the construction and preservation of standards of measurement, and for the systematic determination of physical constants and numerical data useful for scientific and industrial purposes, and to report whether the work of such an institution, if established, could be associated with any testing or standardising work already performed wholly or partly at the public cost." The following will be the members of the committee: Lord Rayleigh, D.C.L., F.R.S. (chairman), Sir Courtenay Boyle, K.C.B., Sir Andrew Noble, K.C.B., F.R.S., Sir John Wolfe Barry, K.C.B., F.R.S., W. C. Roberts-Austen, Esq., C.B., F.R.S., Robert Chalmers, Esq., of the Treasury, A. W. Rücker, Esq., D.Sc., F.R.S., Alexander Siemens, Esq., T. E. Thorpe, Esq., F.R.S.

Factory Power.—The Institution of Mechanical Engineers last week made an excursion to Walsall to visit works there. Amongst other manufactories visited was the clothing and woollen warehouse of Messrs. John Shannon and Son. This factory for turning out ready-made clothes is driven entirely by electricity. The necessary boilers, engines, electric lighting machinery, and motors for driving sewing machines were designed by Messrs. Lea and Thornbery, of Birmingham. The new factory is a building of five storeys and basement, 150ft. long and 54ft. wide, and containing 50,000 square feet of floor area. The juvenile machine-room has accommodation for 400 workpeople, and is capable of turning out 10,000 garments per week. It is fitted with Singer's sectional benches driven by electric motors, and contains a number of Barran pressing machines heated by Dowson gas, and worked by girls; also machines for sewing on buttons, each capable of attaching 10,000 buttons per week. The necessary electrical power is generated by Parsons turbines in the basement of the building.

Russia.—The longest canal in the world has been commenced, and is to be completed before the end of 1902. This is no less a project than to connect Riga, on the East Sea, with Cherson, on the Black Sea. Extensive harbour works have been begun at both these ports. All the survey, etc., is completed, and the length of the canal is to be 1,600 km., the width 65m. on the surface and 35m. at the bed, depth 8·5m. The actual canal work is between Duenaberg and Lepel, 120 km. (120,000 yards). The rest is simply an occasional deepening and regulating of the Rivers Duena, Beresina, Dnjeper, etc. Nineteen new harbours, including Duenaberg, Kiew, and Jekaterinoslaw, are planned. A large basin will be constructed near Pinsk on the left side of the Pripet, a tributary of the Dnjeper, which will connect the town direct with the canal. Short canals will connect the Weichsel and Niemen Rivers. The largest steamers will be able to traverse the distance at a speed of six nautical miles per hour, and as the electric light will be kept going during the night, six days will be the limit of the journey from sea to sea. The estimate is 20 million sterling.

Electric Lighting at Lyons.—A joint paper by Messrs. A. Bèrges and L. Bravet was read in May before the Société des Ingenieurs Civil de France on "a combined scheme for draining Lyons and for providing it with electric light and power." It seems a funny combination at first sight, and after reading the whole paper the link between the two parts of the scheme is found not to be a very strong one. We gather from the paper that at present the cesspool system of drainage is most largely used in Lyons, and that it is proposed to replace this unsatisfactory method by constructing sewers. The sewage would then have to be lifted up to the ground on which it is at present treated.

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For this latter work electricity may be used. The electric power will be taken from the Rhône by the "Société Lyonnaise des forces motrices du Rhône" at a spot where some 16,000 h.p. are available. It will be conveyed to the town by a three-phase alternate-current system at 3,500 volts. Underground conductors will be used. It is hoped that the cheap light and power thus obtained will revive some of the languishing industries of the town. The authors describe the scheme very fully and give illustrations.

Electric Light in Russia.—Mr. M. Lutoslawski, in an article on the above, printed in the *Electrical World*, gives a most unfavourable view of the progress of the electric lighting industry in Russia. It seems that, with the exception of two or three large cities, a demand for electric light plants has only very recently been felt. In order to supply this apparent demand for progress some local companies have been formed for the purpose of competing with the agents of foreign firms. These are generally German firms, which so far have held the trade without competition. The author proceeds to give details which, for the credit of the electric lighting stations, we hope are not universally correct. He says that the annual expenditure on street-lighting in a town of 20,000 inhabitants may perhaps reach some £150 to £200, but that the light equivalent to the sum is not supplied. In fact, that the lights burn only on the nights and at the hours when there is no moonlight indicated on the calendar, and burn during the prescribed hours only when a higher Government officer may be present who is not accessible to the usual limits of corruptibility, or if any other important personage of rank is expected.

An Electric Clock.—We read in the *Scientific American* of a clock now working in the tower of Grace Chapel, New York, which is driven entirely by electricity. The usual weights and gears are dispensed with, and replaced by a small motor. The motor shaft carries a small grooved pulley, from which a coiled wire belt runs to a friction pulley on the arbor or shaft of the escapement gear, which is thus subjected to a steady pull, answering to the pull of the weights in an ordinary clock. Every movement of the escapement allows the shaft to rotate the required amount, and the resulting movements of the clock are transmitted by light hollow shafting to the tower clock dials. A cam on the minute shaft makes an electrical contact once a minute, and sends a current to a contact disc on the hour shaft. This disc is furnished with four contact points, which operate every quarter of an hour, to throw in a magnetic clutch and start the "Westminster Chimes" barrel. We notice that the bells are chimed by the action of solenoids, or movable iron cores, which, we think, is not a very economical arrangement. Accumulators are used to supplement the supply from the isolated plant in the building, but it is supposed that otherwise the town mains would give the necessary power. What a harvest of new consumers with a 24-hour full load this will open out!

Paris Electric Lighting Orders.—We gather from *L'Etincelle Electrique* that Mr. E. Crégy thinks that the charges of the Parisian electric lighting ventures are not above criticism, and that they also have reason to complain on account of the short duration of their concessions, which expire in 1906. It seems that the companies in question are already trying to move the authorities to grant them an extension till 1920 or 1925. If this is given, they offer to immediately reduce their charges for electric energy by 30 per cent. Our contemporary says that the Council intends, however, to take possession of all the lighting systems of Paris in 1906, as the gas concessions expire in that year also. Hence it is likely that the consumer will continue to pay from 1s. to 1s. 3d. per unit up to that date. The next hardship complained of is that the meter rents are excessive, and that the consumers are not allowed to purchase their own meters even if an approved type should be selected. It seems that the meter rents are at least 30 per cent. of the value of the metres. The author of the article then goes on to criticise the various systems of the supply, but we do not think he makes out his case against the companies in these respects. Then, he considers it a hardship for certain consumers to have to wire their buildings on the three-wire system, and forgets that the extra cost of so doing is compensated by a better distribution of voltage over their buildings.

Leeds Tramways.—The formal opening of the Kirkstall and Roundhay electric section of the Leeds city tramway, which took place on June 29, attracted considerable attention in that city, if the large crowds which welcomed the journey of the three inaugural cars may be taken as any criterion. The usual luncheon followed, at which Councillor T. Hannam, chairman of the Highways Committee, presided, supported on the right and left by Sir James Kitson and Sir Charles Skelton. After lunch, the Lord Mayor formally declared the tramways open. Sir James Kitson stated that the city had laid 23 miles of new track within the last 11 months, and had close upon 1,000 men working on three or four sections of the city on other lines. They were doing so with the view that the Council at some future time—and he hoped in some near future—would give the Tramways Committee the power to have the electric system which they now possessed extended to every part of the city. They had, in their Act of Parliament of this year, provided for 24 miles of intended extension, and had only about five miles to complete under the 1896 Act. Therefore he contemplated that they would be able to start in 1898 the provisions made under the 1897 Act. He had seen a statement that that work would be going on for eight or ten years. He ventured to predict that within the next three or four years they would have, added to what was already laid down, 70 miles of track in the city of Leeds.

Municipal Stations in Canada.—A paper recently read before the Canadian Electrical Association by Mr. F. C. Armstrong, on the subject "Why some lighting plants do not pay," is perhaps hardly applicable to this country. We regard it with interest because of the hints to be gathered as to the author's opinion on the practice in electric lighting matters in Canada. He divides the stations into five classes, as follows: Firstly, those in charge of a superintendent specially trained for the work, and devoting his whole time to it; secondly, those whose trained manager has other interests of his own to attend to as well as the station; thirdly, a large class of small stations which manage themselves; fourthly, electric light stations run as appendages to gasworks, which are treated as an evil, and some justify their treatment. Finally he says, "We have that Ishmael amongst lighting stations, which its enemies say always, and its exponents say never, comes under the caption of this paper. I mean the municipal plant. In it we have quite often an ingenious combination of all possible methods of mismanagement. Speaking generally on this point, it will, I think, be admitted that there is to-day no industry representing an equivalent money investment, and possibility of public service, which is so generally managed by men who know little or nothing about it. But the special knowledge and training which comes with experience is in a new business not readily obtainable. The ideal manager will come with time; some of him is here to-day."

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Egypt.—The new by-laws published by the Department of Public Works, Cairo, referring to tenders read as follows: "No tender made to the Public Works Ministry in the name of more than one person, or of a firm, will be accepted unless accompanied by a certified copy of the act of association. This act must indicate clearly the name, nationality, and residence of each partner in the society, the amount of capital contributed by him, together with his powers as regards securities to be made, contracts to be signed, etc. As a guarantee of good faith, each tender must be accompanied by a declaration from a bank or Government Treasury to the effect that it holds a sum at the disposal of the Ministry of Public Works equal to 10 per cent. of the calculated total value of the contract at the rates tendered. This guarantee will not be accepted in any other form but the above. Cash or bonds will be refused. On a tender being accepted, a security deposit, either in cash or in Egyptian bonds calculated at 10 per cent. of the total value of the contract, must be paid into the Government Treasury within one week from the date of the acceptance of the tender. The guarantee declaration will then be returned. The value of the Egyptian bonds will be calculated at par. No tender will be accepted which is received later than the hour fixed for the adjudication, as specified below. The lowest tender will not of necessity be the one accepted, and all may be rejected if considered unacceptable."

Still They Come.—We have personally inspected during the last few years at least four new contact or conduit systems of electric traction, besides others that have been revived from the lumber of the past. This week *L'Energie Electrique* has provided us with a description of the "Diatto" system of traction. It commences, as usual, with a *résumé* of the ills of the trolley system, and illustrates them by a picture of a street-crossing in Brussels. It does not, however, inform its readers that the overhead wires in the photograph did not show, and hence had to be darkened in till they represented in the foreground bars at least 1in. thick. In the background they are as thick as lamp-posts. Still, perhaps, this is the fault of the block-maker, and not an emphasis of the excellencies of the "Diatto." This system consists of a number of street contacts which are put into connection with the line wire by the attraction of a long magnetised bar, also used as a collector. The system may be worthy of attention, but we doubt if in any case it can compare with some others we have seen. The details as at present developed are, however, quite unsuitable for regular work. The contact is only given by a mushroom plunger being pulled up against the lower surface of the street contact, and would soon partake of the nature of an electric arc. The editor of the above paper has seen the system at work on a trial line, and it was entirely to his satisfaction. It only remains to be said that a company is to be formed in Paris with a capital of £200,000 to work the system. We should say more if the capital were sought in London.

The Telephone Question.—We wish that the correspondents to the daily Press who write letters on the telephone question had been present last week to hear Mr. J. S. Forbes's criticisms on their critical remarks. He did not blame the editors generally, who had to fill their columns, but the writers of letters. He had, however, noted an editorial comment in a pink paper which was to the effect that this country was behind every other civilised country in the world with regard to the telephone. He questioned if those who made these criticisms had lived in every other civilised part of the world. Thus, it was stated that the annual rent of a telephone instrument in London was £20; in Manchester, £12; in most other cities and towns, £10; and in Sheffield and Cardiff, £8; and it was said that they were in this country beyond every other country in the world as regarded the price charged for the telephone. What, however, was the truth? The average annual subscription in London was £14. 2s. 8d., and in Manchester and other great towns it was £8. 10s. 10d. Those who wrote the criticisms referred to did not descend to details. It was truly said that in Paris the rental had been reduced from £24 to £16, but this £16 compared with the £14. 2s. 8d. charged in London. London, however, was larger than Paris, and the telephone business in London, badly as it was done, was done relatively much better in London than in Paris, and at much less cost. This was in spite of the fact that the telephone company in Paris, which was the Government, kept the whole £16 that was charged, while in London, out of the £14. 2s. 8d., they had to pay 10 per cent. to the State. The French Government, too, had an almost absolute right in Paris to carry their wires wherever they pleased, without paying a farthing for compensation or rental. As he had said, they kept the £16 entirely, whereas the 10 per cent. royalty paid in London amounted to £1. 8s., and they also had to pay over £1 out of the charge for wayleaves. The interest, the very being of the company, depended not only on the efficiency of the service they gave, but also on the moderation of their charges. Up to the 30th ult. they had 681 towns and places supplied with the telephone, in spite of the terrible obstructions which had been thrown in their way; and they also had 757 exchanges open. They had 100,555 lines at work, which meant subscribers, and they had 116,631 telephone sets in use. He understood that the Post Office transmitted last year 75,000,000 messages at ½d. a word, whereas during that year this company transmitted by telephone 416,000,000 messages, each of which was estimated to consist of 100 words, which were spoken at a cost of ½d., the precise figure being ·54d.

Liquid Air as a Reducer of Resistance.—Prof. Elihu Thomson has written to the Boston daily Press on the above subject, and has made some startling statements. He refers to the diminution of resistance with temperature, and argues as follows: The well-known effect of cooling by liquid air or like gases on a conducting metal like copper is to almost abolish its resistance. Consequently a conductor so cooled is able to carry very much larger currents with less loss than at ordinary temperatures. It has recently been found that liquid air is one of the most perfect insulators, and that most insulating materials cooled to the temperature of liquid air are greatly improved in insulating qualities. It is known, also, that cooling renders it more difficult to cause a spark to occur between oppositely electrified conductors, the striking distance for a given pressure being diminished. The stability or permanence of liquid air in bulk, even when it is fully open to the ordinary atmosphere or kept at atmospheric pressures, is, of course, simply dependent upon the heat insulator provided, and if this could be made perfect the air would never evaporate. On this basis the professor proceeds to build up ideas of how much power could be saved if the Niagara lines were at some abnormally low temperature. He makes no computation whatever as to whether the power required to produce the requisite quantity of liquid air would be within the limits of the power saved. Neither does he give us any idea of how a buried column of liquid air will behave. We see no reason why a constant temperature throughout the column should be automatically maintained, and fancy that the liberation of gaseous air in the centre of the pipe would be inconvenient When the author begins on the transformer question, however, he does give detailed reasoning which can be

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definitely criticised. He says the limit to the capacity of an electric transformer to transfer energy from its primary to its secondary circuit is found in the heating and loss involved in the copper conductors comprising these circuits, and upon the nearness with which the two circuits may be placed one to the other, which is in turn governed by the insulating material used to separate them. Could the conductors be kept cool by liquid air, and thereby their conductivity and insulation greatly increased, the work of transfer in a transformer could be much greater for a given size than it now is, or the loss could be made even less than it now is, although but 3 per cent. is sacrificed in ordinary practice. Transformers in liquid air might be made entirely of copper without iron, and their light load efficiency become nearly equal to full load efficiency. A transformer without iron would avoid the loss in the air, and would permit such a saving in material that changes in design or disposition of the copper could be made to suit the condition of absence of the iron. Prof. Thomson does not consider what kind of a power factor his new transformer without iron would have, or appreciate the fact that with the best design the no-load current would much exceed the value of the working power or current.

The Resistances of Gases during Oscillatory Discharges.—The June number of the *Technology Quarterly* of Massachusetts Institute of Technology has just reached us, and we note with approbation the careful way in which it is edited. The last 50 pages contain abstracts of results of American chemical researches, which are well written. The abstract of Mr. J. Trowbridge and Mr. T. W. Richards's recent work on the temperature and ohmic resistance of gases during oscillatory discharges is as follows: "The resistance which a rarefied gas offers to the passage of an oscillatory discharge is very much less than that which it offers to a unidirectional one. The authors have determined the resistance of a Plücker's tube to an oscillatory discharge in the following way. Many hundred photographs of the oscillatory sparks of condensers of different capacities discharged through variable known resistances were taken as viewed in a very rapidly revolving mirror. A curve was then constructed with resistances as abscissæ and the corresponding number of half oscillations determined from the photographs as ordinates. Plücker tubes were then substituted for the known resistances, and the spark again photographed. From the number of oscillations thus determined, the corresponding resistance of the tube was interpolated from the plot. The results of a large number of experiments with nitrogen and hydrogen are summarised as follows: (1) the resistance of a gas at low pressure to the oscillatory discharge is very small (five to ten ohms); (2) the resistance is in general greater, the less the quantity of electricity; (3) down to a very small pressure this resistance decreases with the tension of the gas; (4) the form of the tube has an important effect on the resistance of the gas; (5) with the oscillatory discharge it is evident that the electrodes produce far less effect than with the continuous discharge The authors then discuss the cause of the different types of spectra produced by direct and oscillatory currents, favouring the view that the continuous discharge is the result of a 'polarised condition in which the molecules are in some way bound together by the electric energy striving to force itself through them,' while the oscillatory discharge is accompanied by dissociation of the molecules. For the production of such dissociation an enormously high temperature is required, which, however, is entirely outside the bounds of measurement, owing to the brief period of the discharge. Bolometric measurements in a vacuum tube gave no indication of what this may be, as in such measurements only the mean temperature of the gas in the neighbourhood of the bolometer is measured. The reviewer raises the question whether the colour and spectrum of a discharge may not be the result of a transformation of electrical energy into radiant energy, either directly or perhaps intermediately through chemical energy, rather than of a very high temperature arising from the transformation of the energy of the discharge into heat, especially in view of Pringsheim's experiments on heated gases and vapours, which go to show that gases cannot be brought to incandescence by heat alone."

Ignition by Electric Spark.—Lord Kelvin sends to the *Times* the following interesting letter: "As a warning that may possibly be useful in preventing the recurrence of any such terrible accident as that which recently happened through the ignition of an inflammable hairwash, it ought to be generally known that the faintest electric spark suffices to ignite an inflammable mixture of a combustible gas with air. This is illustrated in elementary lectures on electricity by 'Volta's cannon'—a little varnished brass gun, mounted on a glass pillar, and having a wide touch-hole plugged with sealing-wax, in the centre of which is mounted a brass wire carrying a little brass knob outside and projecting inside to within $\frac{1}{20}$in. of the end of another brass wire fixed to the metal of the gun. The gun is filled with an explosive mixture of oxygen and hydrogen, and its muzzle is plugged with a cork. The varnished outside is struck with a piece of catskin, and, thus electrified, the gun is left insulated on its glass pillar. To fire it, all that is necessary is to touch the protecting knob with the finger. This causes discharge of the electricity by two exceedingly faint sparks, one barely, if at all, perceptible by the finger before contact with the knob outside, the other in the $\frac{1}{20}$in. air-space within the explosive mixture inside. A loud explosion is heard, and the cork is projected with sufficient violence to tear a canvas picture if it chances to touch one. Ignition of vapour of benzine by electric spark is well known to dyers in their process for cleaning silks and other fabrics by boiling in large cauldrons of liquid benzine. When the goods are taken out of the cauldron and spread out to dry on a table explosions have often taken place, and I believe it is quite certain that an electric spark, caused by some slight friction between dried or partially dried portions of the fabrics, is the incendiary. We all know how readily electric sparks, visible in the dark, and perceptible to the ear by slight crackling sounds, are produced by drawing a hand over very dry hair or the teeth of a comb through it. In the recent inquest it was stated that the merit of the hairwash was that it dried so readily. The hairdresser said he felt the hair warm in his hand and immediately after that all was enveloped in flames. The fact that the hair seemed warm to the hand was due, not to the beginning of some kind of spontaneous combustion, as must, I believe, have been imagined by many readers of the report. It showed merely that the part of the hair touched had quickly become dry. Very slight friction of the hand on the dry hair would suffice to produce an electric spark; and the explosive atmosphere of air mixed with combustible vapour, from the portions of the hair not yet dry, was there. The conclusion of the inquest shows that no gas was burning in the neighbourhood, and that no lucifer matches were lying about on the floor which could have been ignited by being trodden on. A gas flame within a yard or two of the place would certainly have been dangerous, but far less apt to produce the disaster than an electric spark from the hair in the very place of greatest liability to the presence of an explosive mixture.

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THE MECHANICAL CONSTRUCTION OF ELECTRICAL MACHINERY.

BY F. M. WEYMOUTH.

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THE DYNAMO.

(Continued from page 111.)

Bearings (continued).—Figs. 248 to 251 show another self-oiling bearing, designed by Messrs. Ernest Scott and

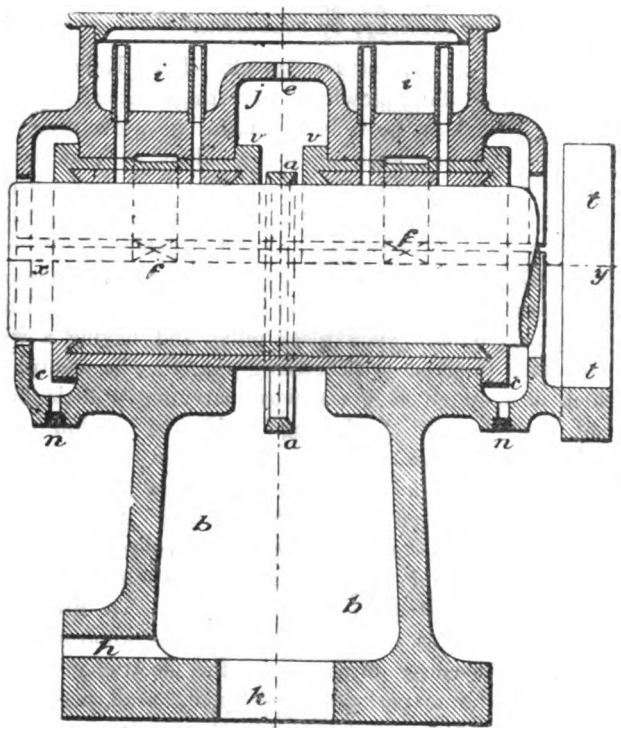

FIG. 248.

Mountain, Limited, Newcastle-on-Tyne; and we have to thank that firm very much for the drawings on which our illustrations are based. It will be remembered that Figs. 216 to 219 also showed a bearing by that firm. There will

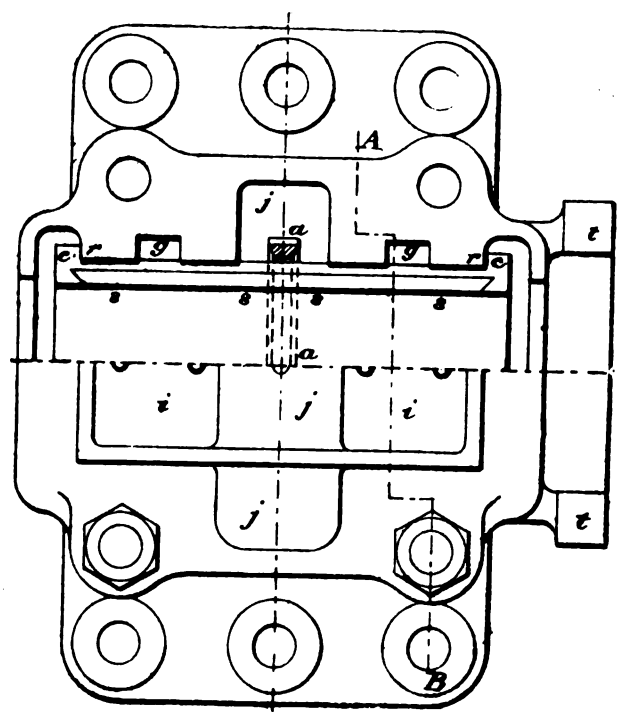

FIG. 249.

thus be noticed a further difference between this present design and the former one, that beside being self-oiling this has a flat base instead of a curved base. The bearing now before us, however, is more especially intended for heavy work in large machines.

Comparison between this bearing and the last we illustrated will show that this is distinct in various particulars. This may, in fact, be better described as a compound bearing in respect of the lubrication: for the oiling ring is merely here an additional feature; and the method of lubricating by syphon wicks is adopted with it, as may be seen clearly in Fig. 248. It will thus be noted that there is but one ring here, as compared with three in the last design, wherein the rings were entirely depended on for the lubrication. The ring, lettered *a a* in all the views, has an internal diameter just sufficient to allow it to pass over the flanges of the bottom brass, *c c*. It will be observed that there are here three brasses, one long one at the bottom, and two short brasses above, each of which is lined with white metal as shown; and the two upper brasses will, of course, be put in place subsequently to the ring.

The special feature in the general design of the stationary parts that differentiates these from the parts of an ordinary bearing with syphon lubrication, is the cylindrical portion, or chamber, *j j*, introduced to give room for the loose ring, and the internal diameter of which is so extended that the ring can in no direction touch the cast iron. This, as will be observed in the longitudinal section, Fig. 248, practically divides the bearing into two sections right and left of the ring. A small hole, *e*, at the top of the chamber, *j j*, allows of additional oil being poured into the well, *b*, as may be required, while the machine is running.

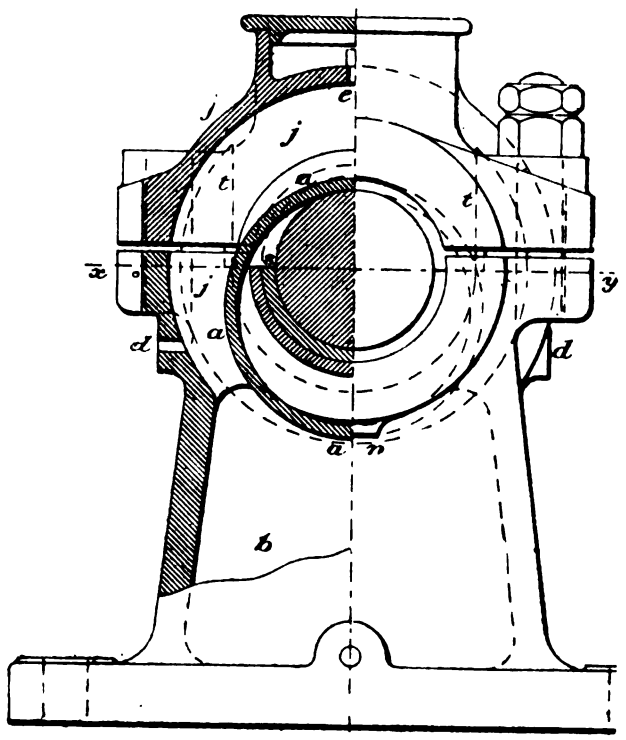

FIG. 250.

Other holes, *d d*, at the sides will admit either of an overflow above that level, or else a gauge glass may be attached showing any rise above the same level. It will be observed that waste oil from the bearing, caught in the hoods at the ends, does not here flow back into the well, *b b*, but is drained away entirely, as indicated at *n n*. The well itself can also be drained by a tap at the hole, *h*: while the hole *k*, required for coring the well, will be plugged.

A proper maintenance of oil level in the well is, of course, important. Sufficient height of oil for the ring to reach down into it is obviously necessary. On the other hand, in bearings wherewith the oil drains direct from the hoods into the well, a too great height of oil in the well may cause the oil to flow back into the hoods and flood them, and perhaps get outside on to the commutator, which would not be a desirable result. A peculiarity of the design now before us, thus, is that supposing the holes *d d* to be stopped, and assuming that all joints are oil-tight, there is no direct connection between the well and the hoods, and consequently the former could be filled quite up to the parting between the base and the cap.

The brasses are prevented from rotating by snugs, *f f*,

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shown in section in Fig. 251. These it will be seen are here formed on the upper brasses, and they are made to fit notches cut in the base, as shown at *g g* in the plan, Fig. 249, which latter represents a whole view with one-half of the cap removed, and the cover to the oil box, *i i*, also removed. It will thus be noticed that, as in the other bearing made by this firm that we have illustrated (Figs. 216 to 219), the upper brass is steadied endways by its flanges becoming engaged with the base at the corners *r r*; and they become steadied sideways by a fit of the outer ends of the snugs, *f f*, in the notches, *g g*, as well as by the fact of their lower edges all round being engaged within the jaws of the base. The cap is steadied by the upper brasses, excepting in so far as this may depend on a fit on the studs. As will be evident from Fig. 251, the brasses here form butt brasses, meeting on the horizontal centre line, *x y*, and the cap may be bolted hard down. This latter point, however, is rendered optional by the presence of the lock nut on the cap studs. It does not appear to be any part of the original design in this case to make the hoods oil-tight where the parting between the cap and the base passes through them, this parting being an open gap as shown. Such gaps may, of course, be filled up with leather or wood or red-lead cement or other means if desired.

It will have been observed in Fig. 245 that the oil from the ring was caught by the brass bush at a point, *e*, which was some little way up the side. A difference thus in the present case is that the oil is not caught till it reaches the horizontal centre line. This might possibly seem some

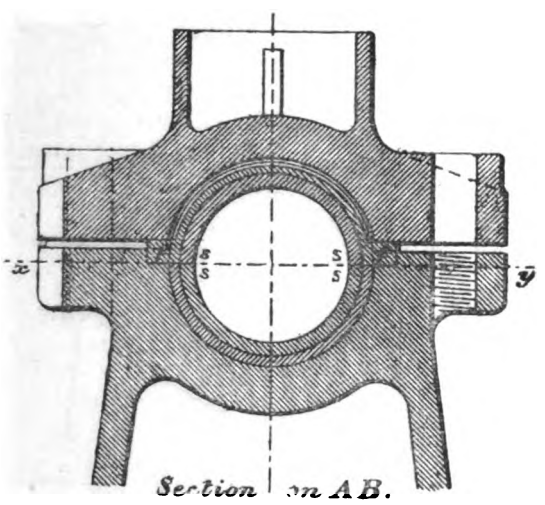

FIG. 251.

detriment, especially in view of Fig. 247, as regards the inner edge of the brass, as at *s s*, which would seem calculated to scrape the oil off as fast as it accumulated. It has to be remarked here, however, as we have formerly pointed out, that in practice the brasses at the sides of the journal are eased away by scraping and filing, so that for some few degrees above and below the horizontal plane through the joint they are not in actual contact with the shaft. An interstice at the side is thus formed: and this being done in the case before us, it will be seen that the oil brought on top the journal by the ring will by the rotation of the shaft be carried down into the interstice, and so be made to lubricate more immediately the lower brass.

In Fig. 245 the oil well was comparatively shallow, a horizontal diaphragm being cast in the bearing not far below the journal: but in this present case it extends to the bottom of the casting. This bearing, however, does not stand so high as that last shown. As will be seen, this bearing is fitted for carrying the brush gear, for which purpose horns, *t t*, rise from the base in the manner and for use as already explained in connection with Figs. 216 to 219. It will be noted that by simply making these horns detachable from the pattern, the same pattern will do for casting the bearing, or bearings, at the other end of the machine.

Both the self-oiling bearings we have hitherto dwelt on have been complete in themselves, and as such were removable from the dynamo or motor bedplate and of these the first was solid, and the second a split bearing with a cap. We now approach, in Figs. 252 and 253, a self-oiling bearing whereof the lower portion or base is an integral part of the machine. This is an example taken from an alternate current polyphase motor designed by Mr. C. E. L. Brown,

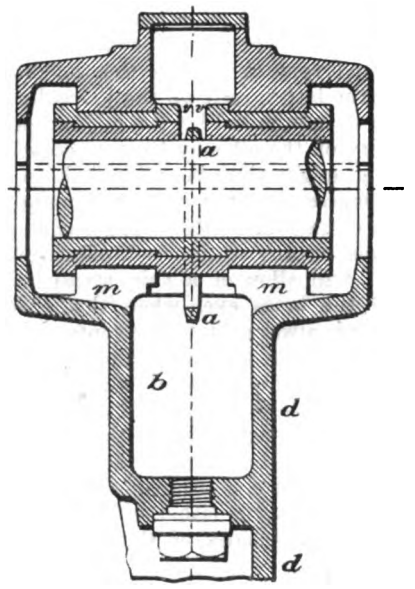

FIG. 252.

and illustrated in Prof. S. P. Thompson's "Dynamo-Electric Machinery," fifth edition. The parts lettered *d d* appertain to the framework of the motor. It will be observed, however, that, as regards the general arrangement of the oil-ring, *a a*, and the brasses, there is much resemblance to that last shown. But the one oiling-ring is apparently here entirely depended on for the lubrication, though it may be remarked that this journal is as long in proportion to its diameter as in the latter case, each being nearly three diameters in length. Of course, a difference in speed and load may exist. There are also here passages, *m m*, draining the hoods directly into the well, *b b*, in consonance with the practice of Mr. Brown, as already illustrated to some extent in Fig. 228. It is evident, however, that by somewhat exaggerating the interstice at the sides, as at *s s* in Figs. 249 and 250, and therewith discussed, and by suitable oil grooves cut in the upper brasses, a very free flow of oil through the bearing may be rendered possible; and its maintenance would be, so to speak, guaranteed by the fact that the height of the oil in the well, *b b*, would be kept constant owing to the fact of the

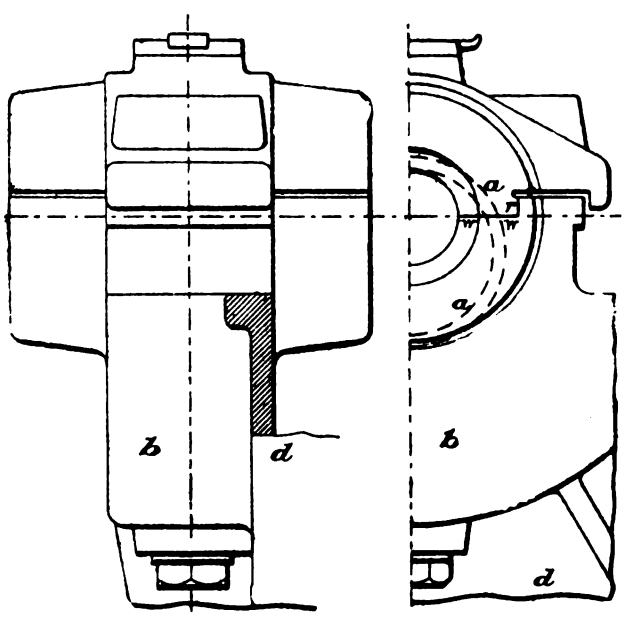

FIG. 253.

oil flowing back there as fast as it exudes from the brasses.

The internal diameter of the ring is just sufficient to enable it to pass over the flanges of the brasses, as in the

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previous design. It may be noted that both in this case and the last the section of the ring is tapered: only in this case the inner periphery is the wider one, and the outer periphery was the wider in the last. Either of these sections will prevent the ring offering a flat side to the brass ends liable to become stuck to them by oil between, thereby retarding a free rotation of the ring. For this rotation is of course entirely dependent on the extremely slight frictional contact due to the weight of the ring itself, where the latter rests on the journal; and even this little friction is minimised by the oil, excepting in so far as the viscidity of the oil may have a contrary effect. A flat-sided ring might thus become stuck to the flange of one of the brasses, as at *v v*, by the mere adherence of wet surfaces, quite sufficiently to prevent its proper action. Taper sections, or any section not offering a flat side to the brass end, will allow of a thin stream of oil between the ring and the brass even when these are in contact; and thus there is always oil to feed into grooves that may exist in the upper brasses, which grooves would be liable to become blocked by a flat-sided ring.

Before leaving these views it may be noted that, as shown in the end view, Fig. 253, the cap, although completely covering the base in one sense, is only in actual contact therewith at *w w* on the horizontal centre line, and at the vertical joint, *r*, on either side. This vertical joint continues through the sides of the hoods, and so helps to keep these oil-tight.

(To be continued.)

THE SS. "DRESDEN."

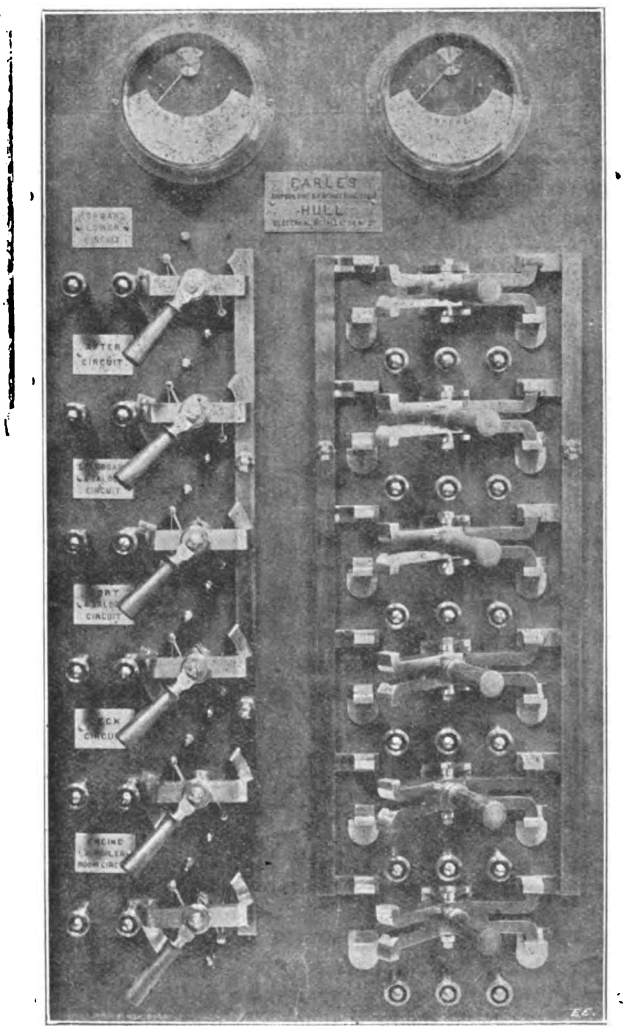
In one of our issues for December last (vol. xviii., p. 659), we described the electric lighting apparatus on this new steamship, owned by the Great Eastern Railway Company. Now, through the courtesy of Mr. Holden, we are able to give photographs of the various parts of this ship. A brief recapitulation of the previous article will hence not be out of place, as further details are also to hand. The "Dresden" is built with a long partial awning deck and poop and a raised forecastle, in the former of which are situated the first-class dining-saloon, ladies' room, staterooms, lavatories, and the accommodation for officers. On the lower decks, and entirely forward of the machinery and boilers, are the first-class staterooms, and in the large deckhouses are the saloon entrance, captain's cabin, and eight staterooms. The smoking-room is on the awning deck, with a spacious trunk skylight for light and ventilation to the saloon.

The total number of first-class passengers provided for is 226, and the whole of the fittings and equipment for these are of the most modern and complete description, every detail which might add to the comfort of the passengers having been carefully considered. These arrangements include a handsome special stateroom intended for the accommodation of distinguished passengers. An efficient system of fan ventilation is adopted so as to obtain a most ample supply of fresh air to the various spaces. Thus each cabin has a ventilator running up on to the upper deck to admit fresh air, whilst the foul air is exhausted by means of the fans. Steam-coil stoves are also provided for heating the vessel throughout. The second-class accommodation is very comfortable. It is situated in the poop and after 'tween decks, and provides for 64 passengers. The vessel is schooner rigged, with two light pole masts, to which are fitted Tate's patent derricks and gear for the rapid handling of cargo and baggage, in addition to three powerful steam-winches and steam windlasses. Water-ballast tanks are provided for trimming purposes, and also water-tanks for the supply of fresh water for wash-basins in berths and lavatories, whilst the sanitary arrangements have had special attention—closets, urinals, etc., having a constant supply provided by a pulsometer fitted in the engine-room.

The dining-saloon is handsomely panelled in birdseye maple and satinwood, the furniture being of oak upholstered in green Utrecht velvet. The whole of the fittings, electric and oil, are of Basilaus metal, which greatly adds to the smart appearance of the saloons, staterooms, etc.

The boats, eight in number, six of which are steel life-boats, are stowed on the hurricane deck, and are all fitted with De Vos's patent gear for readily swinging them out and in board, and with Hill and Clarke's patent detaching gear. This deck also forms a shelter for passengers the whole length of the awning deck, whilst forward of the funnels is a convenient promenade bridge deck, with house containing telemotor gear, on top of which is the flying bridge, steering gear, telegraph and speaking tubes, etc., for the captain and officers' look-out.

The chief points in the steering arrangement of the "Dresden," as compared with the previous steamships of the Great Eastern Railway Company, and which is known as Brown's patent and hydraulic telemotor, is that the engine is attached directly on to the rudder head, thus dispensing with all chains, rods, etc., leading to steering engine amidships, as in other gears. Apart from the danger of the chains and rods breaking, there is no



The Circuit Board, ss. "Dresden."

obstruction on the deck, and, what is more, there is no objectionable noise accompanying the working of it. The communication to the telemotor on the bridge is by means of very small copper pipes led from the engine. These pipes are filled with glycerine and water, and the telemotor, acting on these, opens and shuts the valves of the engine.

The electrical installation on this vessel has been carried out entirely by the electrical department of Earle's Shipbuilding and Engineering Company, Limited, Hull, by whom the ship and her machinery have also been constructed. The electric generating plant is situated in a compartment at the bottom of the ship, immediately abaft the engine-room, and consequently contiguous to the starting platform, which enables the engineer on watch to have a constant eye on it without leaving his station. It consists of two separate and independent sets of engines and dynamos, supplied by Messrs. G. E. Belliss and Co., Limited, Birmingham, each capable of supplying the whole of the lighting of the ship, so that in case of

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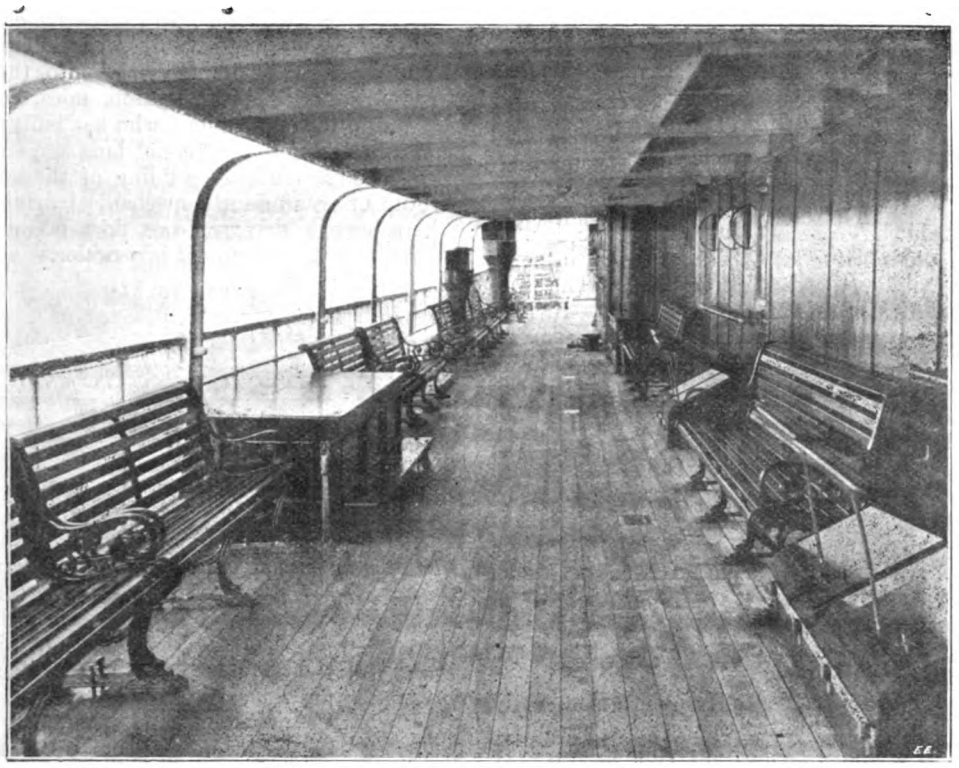
either an engine or a dynamo breaking down no inconvenience will be suffered by the passengers. The engines are of their well-known patent closed self-lubricating and noiseless type, coupled direct to the dynamos, which have been made by Messrs. Thomas Parker, Limited, of Wolverhampton. These coupled sets are designed to give an output of 300 amperes at 50 volts. The engines give an output of 25 b.h p. at 500 revolutions per minute, and are specially balanced for high-speed running. The lighting is arranged on the double-wire distributing-box system, the wires being lead-cased, and the distributing boxes made of cast metal, specially designed, and absolutely watertight. By this system branch joints, etc., and their attendant evils are very largely obviated. Every part of the ship, from stem to stern, is lighted with electricity, including the masthead and side lights. Very powerful cluster lamps are provided, suspended over the passengers' luggage space and gangways.



View of the Promenade Deck, ss. "Dresden."

The First-class Saloon, ss. "Dresden."

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ON TOOTHED ARMATURES.*

BY MICHAEL V. DOLIVO-DOBROWOLSKY.

Considering the speed with which the use of large currents has advanced up to the present date, it is not at all astonishing that some of the most elementary phenomena and facts have remained either totally unnoticed, or at least without sufficient explanation. Many technologists who like to deal with the theory of the lines of force with a few words or illustrations, pass such points over in silence if they cannot at once be made clear by these methods. An endeavour is made in the present essay to consider a few of these "ticklish" cases, because the mere fact of clearing them up and putting them straight may in some cases be of considerable value and importance. The well-known electrician, Mr. W. M. Mordey, has lately revived the statement formerly made by Prof. S. P. Thompson, as well as by Mr. James Swinburne—namely, that there is no considerable force acting upon the copper wires of the toothed armatures—that is to say, that if copper conductors are embedded in iron the force acts on the iron direct. The only remarkable fact about this appears to be that it should still be an "open question," considering we are now writing 1897—20 years after the birth of dynamo design. It is a pity, but it is so. Mr. Mordey's assertion, and especially his experiment, startled not a few, and caused much opposition amongst the men interested in that special branch of the science. Everybody tried to discover some flaw in the arrangement of his experiment. "There must be a fault somewhere," they said, for otherwise a belief which had existed for 20 years was completely knocked over, meaning the destruction, not of a complicated theory, but of a simple elementary view in everyday use.

Now, although it is a matter of regret that the elementary knowledge which we had, and made use of so long, should have been based upon such weak foundations; Mr. Mordey was right, nevertheless, and there is no flaw in his experiments. Only he did not produce any strong proof for his assertion, for pictures illustrating the path of lines of force are no proof; and as I consider that the matter has not been settled by him, I desire to supply the omitted proof, hoping thereby to settle the "question" definitely and for all time.

Let us consider a toothed armature while at rest, and suppose a continuous current passing through winding *a* (Fig. 1), which is placed in a pair of notches, and is capable

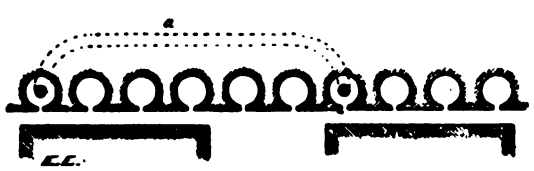

FIG. 1.

of a small movement in them. The armature iron and the magnet poles are fixed. Now we move the winding only as far as the dimension of the notch permits. We observe at once that the number of lines of force enclosed by the winding remains entirely unaltered, because the teeth being unsaturated all lines of force are contained in them, and the holes have practically no lines of force in them. The wire, whilst we are moving it from side to side within the notch, does not cut any lines of force, from which follows that thereby is no E.M.F. induced, and that no work is done or absorbed. If that is the case, then the wire carrying the current, if left alone, will not even move towards either side of the notch, much less bear against the sides and exert pressure. Where no E.M.F. is created even with motion, there is certainly no latent torque. Yet there is in the above arrangement a strong turning moment between armature and field. For if we turn the whole armature towards the poles, even the smallest movement will at once alter the arrangement of the magnetic field enclosed by the winding—*i.e.*, there is E.M.F. induced, and consequently work is done. The whole armature, therefore, exerts force, and as the copper wires are not affected by it, the force must be acting direct on the iron.

* From the *Elektrotechnische Zeitschrift*.

The significance of this knowledge is of the utmost importance to the constructors of dynamos and motors: In the case of toothed armatures, it is only necessary to guard the embedded wires against centrifugal force without considering tangential effort. In alternating-current machinery, with stationary armature cores, it is not necessary to press the high-tension winding firmly into the notches, nor is the insulating material (cotton, mica, etc.) subjected to mechanical force. Anyone who has built similar machines should have found all this out long ago simply by observation, since the mode of building of these machines hardly permits of a sufficiently mechanical driving of the wires. Where such a driving force does occur, faults would be found which are not found in practice.

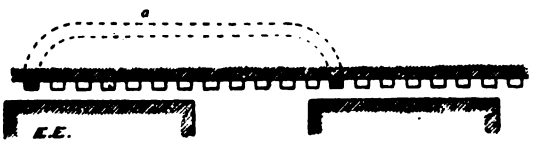

FIG. 2.

That the driving force acts direct upon the copper wires in the smooth-core apparatus has been known previously, and is easily demonstrated by the above described experiment. Fig. 2 represents a smooth core. In this case the number of lines of force enclosed is changed not only when the whole armature is turned, but also, in the same measure, if the winding is moved on the surface of the core, the latter remaining stationary. In both cases the same work is produced, and, therefore, the same force exists. The latter, therefore, acts upon the copper wire, as many practical experiences with smooth cores have unfortunately demonstrated.

Another oft-discussed question is the following: experience shows that thick massive conductors upon the surface of smooth cores are strongly heated by eddies, and thereby cause considerable loss of power, while they remain perfectly free from eddies if embedded in the notches of the armature iron, always supposing that the iron teeth are only moderately saturated.

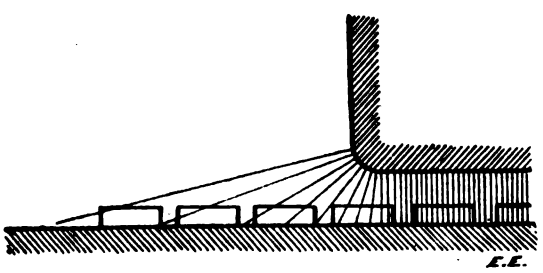

FIG. 3.

The origin of eddies in the smooth-core class of dynamos is probably sufficiently well known, but is shortly recapitulated here on account of its connection with the argument.

Fig. 3 shows the position of the conductors, which are upon the surface of the core. In consequence of their thickness, they are, when entering the pole, in a non-homogeneous field—*i.e.*, the right side of the conductor is in a denser field than the left. The different parts of the conductor (or, rather, of the winding), taken each by itself, link or unlink lines of force at a different rate, and, therefore, unequal E.M.F.'s are generated in them, which, of course, must cause eddies.

Now with regard to the same question, as far as toothed cores are concerned. Fig. 4 shows a toothed core in various positions.

As long as the teeth are unsaturated the lines of force take their path through the teeth, thus leaving the notches free of field practically in every position. The known laws of magnetic resistance permit us to ascertain and to follow the paths of the lines of force for any given position of the core. The moment the position of the latter is changed ever so little, there ensues at once a corresponding change in the field before and behind a notch. The change in the number of lines of force encompassed by a winding is, therefore,

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throughout a steady one if the total magnetic resistance of the system remains approximately constant in consequence of number and size of the notches. The change of lines of force enclosed in the winding can, therefore, be shown by the same curve as in the smooth core. But it must not be concluded from this that the lines pass gradually over the notch, nor may one assume that they with great velocity "jump over" it, as many have asserted. The motion of the core causes gradually the various conditions which we have shown to exist when the machine is not in motion, and since the lines were in no position whatever inside the notches (even counting the smallest possible turning of the core), it proves that when in motion the lines can never pass or "jump" the notches. (The condition of rest is, in fact, only an especial case *vice* that of an infinitely small velocity.) In order to produce such an effect it would be necessary to have ampere-turns at points opposite to the notches, which, as the case contemplated (the condition of rest) shows, are insufficient to produce measurable flux in the notches. If the ampere-turns which serve to overcome the resistance of the teeth, therefore existing on the notches, are small when at rest, there is no reason to suppose that they should increase at the motion of the core. One has only to consider the field is changing constantly as the core turns, and that in respect to the notches, decreasing before and increasing behind each of the latter. The notches are therefore to be regarded as free from flux, not only in every given position, but also during the motion of the armature.

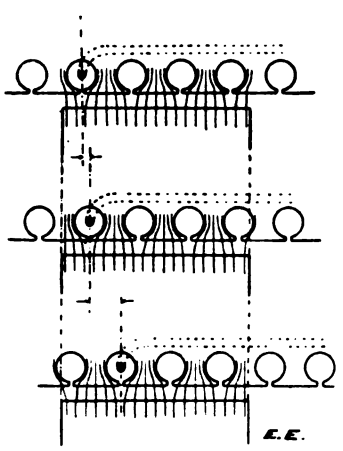

FIG. 4.

This conclusion fits in excellently with the above proved action of the conductors carrying current when in the notch as far as the turning force is concerned. Any conductor not in field exerts no force. Moreover, it follows from the fact that the notches are free from flux that no eddies can be caused in the conductors embedded in the same, since the latter are caused by the non-homogeneous condition of the field at the edges of the poles. As long as the teeth are unsaturated there is no field in the notches. This is the simple explanation for both peculiar properties of the toothed core. The contention that induction is caused through change of the field which is enclosed by the windings, and not through lines of force cut, should not be regarded as a contradiction of the physical laws. This contemplation demonstrates clearly that the term "lines of force" means direction and quantity of the magnetic field, and that this expression must be used very cautiously if applied to anything else, or if intended to mean more. For example, these lines must not be thought of as real threads, as this would convey to the mind an idea of something transitory, something changing from one state into another. When we speak of a certain position of the lines of force, we use simply an abbreviated and inexact expression in order to describe the temporary direction and force of the magnetic field at a given point.

Telephony in Finland.—The little town of Mariehamn, in Finland, claims the distinction of having the most extensive telephone system on record, as there is one telephone to every 13 inhabitants, counting men, women, and children.

WATER-DRIVEN PLANTS.*

BY JOHN MURPHY.

As close regulation is the most important point in the operation of any electrical plant, I will endeavour to show how this can be accomplished best in a water-driven plant, and, as so much depends on the manner of installation, I will dwell for a moment on the importance and method of properly equipping the waterwheel gate. I take it for granted that the waterwheel itself was placed in position by a competent engineer, due provision made to cope with low water, anchor ice, and the many other troubles inherent in the use of water power. This having been done, the gate and all its connections, from the waterwheel to the hand-wheel in the dynamo-room, should be so constructed as to move quickly, positively, and easily, so that the instant the regulator is actuated by a variation in speed the waterwheel will receive its greater or lesser supply of water, and thus be enabled to maintain a constant speed. An arc plant with its automatic current controllers, driven by a waterwheel equipped as indicated above, will run for an indefinite period with little or no attention, but incandescent lighting and power machinery require somewhat more supervision. I hold it is a mistake to attempt to supply power from a lighting circuit except in very small units. One of the greatest recommendations for the incandescent lamp as an illuminant is its steadiness, but this quality is almost unknown when motors which are frequently started and stopped are run on the same circuit. The separately-driven exciter is a great boon to water-power users whose loads are subject to great variations. Its many advantages are so apparent that it seems unnecessary for me to do more than merely mention it in passing. Another arrangement, the utility of which speaks for itself, is the automatic field controller, which strengthens or weakens the generator field circuit according as the potential on the line falls or rises.

An incandescent lighting plant requires a certain amount of hand regulation, although the apparatus just referred to is useful within certain limits. All hand regulation necessary on a lighting circuit should be done, figuratively speaking, as far away from the lamp as possible; in other words, it is the field circuit of the exciter that should be varied when it is necessary to change the potential on the line. The exciter field rheostat should be of large range and divided into a great many sections, so that the movement of the rheostat arm from one point to another would cause such a slight change in field current as to make a scarcely perceptible difference in the brilliancy of the lamps. Where large generators are used and many circuits are run; the use of the individual circuit regulators becomes imperative.

I wish to call your attention to two pieces of mechanism. The first device is an automatic speed indicator and alarm, which points out the speed at which the machinery is running, and also rings a bell at every change of speed. The other is to close the waterwheel gate the instant the speed rises above a predetermined point. It consists chiefly in a pair of friction pulleys mounted on a frame. One of the friction pulleys is continuously driven from the machinery to be controlled, and the other is connected to the gate-closing apparatus. These friction pulleys are normally placed apart and are brought into contact by a weight or spring, which is released by a lever attached to a pair of governor balls. The instant the speed rises a certain percentage above the normal, the governor balls move the lever, and the weight or spring being released, the frictions are pulled together and the gate is immediately closed.

It would hardly seem correct to leave the subject of the operation of water-power plants without at least mentioning that bane of water-power users—anchor ice. If wheels are favourably situated—that is, if they are supplied from a large pond in which there is little or no current, and if there is an overflow or by-wash into which most of the floating ice can be diverted—by extreme watchfulness a complete shut-down can be prevented. But if the wheels

* Abstract by the *Canadian Engineer* of a paper read before the Canadian Electrical Association.

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have no steel pond from which to draw their water supply, it is prudent to resort to the auxiliary steam plant as soon as there is the least suspicion of anchor ice.

MECHANICAL FEATURES OF ELECTRIC TRACTION.*

BY PHILIP DAWSON.

Introductory.—Previous to discussing certain special mechanical features which enter into the design and construction of an electric traction system, a few figures may be quoted for showing the importance of the subject in general. Table 1 shows the mileage of tramways in America for the six years 1890-5.

TABLE 1.—Mileage of Tramways in America, and Number of Cars, during Six Years, 1890-95.

Mileage.	1890. Miles.	1891. Miles.	1892. Miles.	1893. Miles.	1894. Miles.	1895. Miles.
Electric	2,523	4,061	5,939	7,466	9,008	12,583
Horse	5,400	5,302	4 460	3,497	2,243	1,232
Rope	510	594	646	657	662	599
Steam	604	642	620	566	614	519
Total miles	9,037	10,599	11,665	12,186	12,527	14,933

Number of cars.	Cars.	Cars.	Cars.	Cars.	Cars.	Cars.
Electric	5,592	8,892	13,415	18,233	24,849	36,121
Horse	21,970	21,798	19,315	16,845	11,507	5,420
Rope	3,795	4,372	3,971	4,805	4,673	4,871
Steam	751	815	698	616	639	2,857
Total cars	32,108	35,877	37,399	40,499	41,668	49,369

TABLE 2.—Mileage of Electric Tramways in Europe, and Number of Cars and Horse-Power, at end of 1896.

Country.	Miles of tramway.	Number of cars.	Horse-power.
Germany	618	1,545	13,810
France	67	180	4,200
Great Britain and Colonies	167	269	9,617
Austria and Hungary	120	265	5,060
Italy	50	149	2,460
Switzerland	30	83	1,570
Belgium	90	157	2,550
Russia	30	87	1,150
Other countries	30	50	111

TABLE 3.—Comparison of Railways and Tramways in America and in England.

	Railways R Tramways T	Capital expenditure. £	Total mileage	Gross receipts. G £	Total expenses. E £	Ratio E to G per cent.	Passengers carried.
America	R	2,354,200,000	240,000	219,000,000	154,000,000	70	544,000,000
	T	280,000,000	14,000	32,850 000	22,700,000	68	3,000,000,000
U. Kingdom	R	880,000,000	20,000	77,025,000	40,100,000	52	775,200,000
	T	13,000,000	1,000	3,540,000	2 640,000	75	480,000,000

It is seen that rope traction continued to extend up to 1894; since that time its importance has diminished. In San Francisco, Los Angeles, Minneapolis, Denver, St. Louis, Pittsburgh, Philadelphia, Baltimore, and other American cities, electric traction has been substituted in place of ropes. Table 2 gives the electric tramway mileage in Europe at the end of last year, 1896. It will be seen that Great Britain is yet much behind Germany. This is especially remarkable, because the regulations of German local authorities are generally much the more severe. Electric trolley roads are now to be found in the oldest and handsomest of German cities. Table 3 shows the great financial importance of tramways as compared with railways in America. The passenger traffic on the tramways is six times greater than that on the railways; and the ratio of working expenses to receipts is lower for the tramways than for the railways. The gross earnings of the tramways in the United States are approximately 50 per cent. of the passenger earnings of the railways, and 15 per cent. of the total earnings of the railways, whereas the tramway mileage is only about 6 per cent. of the railway mileage. A highly important fact is that tramway receipts are found to be practically independent of good or bad trade, and not to depend on the prosperity of the country.

TABLE 4.—Cost of Tramways in Small and Large Towns in Massachusetts.

Per mile of single line.	Springfield.	West End.
Construction and equipment	£4,939	£11,323
Other permanent property	£1,761	£7,959
Total cost	£6,701	£19,282
Capital investment	£6,197	£20,152
Passengers carried, total	10,163,011	166,862,288
,, ,, per mile	180,547	648,568

TABLE 5.—Passengers Carried on Tramways and on Railways.

	1895.	1896.
Worked by horses only ..... miles	61·799	35·132
,, electricity only ..... miles	1,002·756	1,241·363
,, horses and electricity.. miles	22·62	14 54
Total income £	2,649,274	2,980,188
Dividend per cent.	5·76	5·87
Passengers carried, total	259,794,308	292,358,943
,, ,, by electricity	205,866,134	236,544,417
,, ,, by railway	53,928,174	55,814,525
,, ,, excess by electricity	151,937,960	180,729,892

Tables 4, 5, and 6 have been compiled from the official reports of the Massachusetts Board of Railroad Commissioners. Massachusetts more closely resembles England in the habits of the people and in local conditions than any other State of the Union. Table 6 shows the rapid increase of passenger traffic and mileage. Table 4 shows the difference in cost of completely equipping tramways in small and large towns, varying from £7,000 to £20,000 per mile of single line. Table 5 shows that as passenger carriers tramways play a much more important part than railways. It is demonstrated, not only in America but also in England and on the Continent, that wherever an electric tramway runs parallel to a railway the former will secure practically all local traffic. It has been frequently urged that mechanical motive power on tramways is dangerous to the public safety. In America, where comparatively high speeds are allowed, the Railroad Commissioners report that the proportion of passengers and employés killed during the last two years of electric working appears so have been about the same as with the use of horse-power in 1888. For all practical purposes the present subject may be considered under the three headings of outside work, rolling-stock, and power station.

Outside Work—Wires.—The overhead line of conductors may be supported either by brackets attached to poles or to houses, or by a span wire stretched between poles or rosettes fixed to house fronts. For the sake both of appearances and of smooth running, the conducting wire should be strained as tight as is consistent with its tensile strength and with the minimum temperature which obtains in the locality. The best practice does not allow more than 2,000lb. strain on a No. 0 Brown and Sharpe (0·325in. diameter) hard-drawn copper wire at the lowest temperature to which it will be exposed. With this limit, the strain to be put on the wire when erected can be easily ascertained from tables. For fixing the maximum sag to be allowed in the average span of 120ft. to 140ft. the curves shown are useful. A rough but safe rule in this country, where rarely more than 20deg. F. of frost is to be expected, is a sag of 0·75 per cent. of the span at an average temperature of from 60deg. to 65deg. The trolley wire should be of absolutely even quality, and supplied in lengths of slightly over half a mile. The joints should be silver brazed in the copper ingot before it is rolled. The diameter of the wire should not be allowed to vary more than 0·0004in. The breaking strain of the wire should be at the rate of 56,000lb., or 25 tons, per square inch. In span-wire construction it is necessary to determine both the height of the eye-bolts from which the span wire is suspended and also the sag. In Table 7 are given data of galvanised-steel span wires generally used.

Poles.—Upon the amount of sag allowed for the span wires depends the strain which the side poles must stand. Round curves these strains are often great, and tubular poles composed of ordinary pipes wedged together by liners are useless. In Table 8 are given certain data of standard poles specially designed for this work. All poles must be of such strength that when in position they will stand without permanent set the greatest side strains to which they may be subjected. Terminal poles and pull-off poles on curves should be the strongest. Ordinary side poles must stand a direct strain of at least 500lb. without deflecting more than 4in. to 6in. Their strength must be sufficient to carry, besides the trolley wire itself, the additional weight when the wires are covered with ice and snow. The poles are always subject to vibration communicated from the trolley wire. It is of the utmost importance that joints should be well constructed, which renders it necessary that the several lengths of the pole should be sweated together. The joint is made by heating the outside pipe to a welding heat, slipping it over the inner pipe, and then passing the two together through

* Paper read before the Institution of Mechanical Engineers.

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TABLE 6.—GROWTH OF MASSACHUSETTS TRAMWAYS DURING TEN YEARS, 1887-96.

Year.	Number of companies.	Miles of main line.	Miles equipped for horses.	Miles equipped for electricity.	Cost of construction.	Cost of equipment.	Capital investment.
1887	44	470·27	470·27	—	£3,524	£1,666	£6,534
1888	46	533·59	533·99	—	3,384	1,464	6,461
1889	46	574·17	523·65	50·52	3,236	1,576	6,781
1890	48	612·38	451·52	160·86	3,467	2,131	7,651
1891	56	672·45	383·42	289·03	3,584	2,323	8,178
1892	61	754 85	258·55	496·30	3,904	3,043	9,230
1893	60	874·14	163·06	711·08	5,358	2,347	10,673
1894	68	938·84	103·87	824·97	5,349	2,305	10,592
1895	75	1,077·99	61·80	1,016·19	4,797	2,096	9,820
1896	83	1,276·75	25·13	1,241·62	4,679	1,961	9,278

Year.	Passengers carried.	Car miles run.	Persons employed.	Cars.	Horses.	Motors.
1887	124,787,328	20,625,846	5,222	2,633	11,874	—
1888	134,478,319	23,244,767	5,531	2,588	11,391	—
1889	148,189,403	24,259 491	6,302	2,942	11,817	—
1890	164,873,846	26,516,937	6,246	3.247	11,241	—
1891	176,090,189	27,670.166	6,449	3,494	10,640	—
1892	194,171,942	29,678,036	7,185	3 679	6,734	—
1893	213,552,009	34,507,282	8,070	4,040	3,531	3,013
1894	220,464,099	36,722,978	7,451	4,058	2,014	3,906
1895	259,794,308	43,655,560	8,048	4,426	1,436	4,704
1896	292,358,943	53,613,685	9,190	4,913	878	5,958

TABLE 7.—Galvanised Steel Span Wire.

Thickness of wire	wire gauge No.	15	12	11	10
	inch	0·070	0·110	0·120	0·135
Number of strands		7	7	7	7
Total approximate diameter	inch	¼	5/16	⅜	7/16
Weight per 100ft. run	lbs.	10	21	29	36
Tensile strength absolute	lbs.	1,600	3,360	4,640	5,720

TABLE 8.—Standard Tubular Poles.

Total length of pole	Length and outside diameter of three component pipes.			Total weight.	Free from permanent set at
Feet.	Feet. Inches.	Feet. Inches.	Feet. Inches.	Lbs.	Lbs.
29	16½ by 10	8 by 8	7½ by 7	1,503	4,500
30	17 ,, 10	8½ ,, 8	7½ ,, 7	1,552	4,400
31	17 ,, 10	9 ,, 8	7½ ,, 7	1,593	4,200
28½	16 ,, 8	8 ,, 7	7¼ ,, 6	1,193	3,400
29½	16 ,, 8	9 ,, 7	7¼ ,, 6	1,224	3,200
30	17 ,, 8	8½ ,, 7	7¼ ,, 6	1,259	3,150
28½	16 ,, 7	8 ,, 6	7¼ ,, 5	769	2 000
29½	16 ,, 7	9 ,, 6	7¼ ,, 5	991	2,000
30	17 ,, 7	8½ ,, 6	7¼ ,, 5	998	1,800
28½	16 ,, 6	8 ,, 5	7¼ ,, 4	689	1,200
29½	16 ,, 6	9 ,, 5	7¼ ,, 4	613	1,000

special rollers. After completion, if a piece is cut from the joint, the two pipes will be found solidly welded together. This is known as the "S S S" joint, the abbreviation meaning solid, swaged, and sweated. The tubes used in making poles are all lap-welded, and the larger sizes are also riveted along the seam with countersunk rivets. The lengths of pipe are so put together that the seams of each consecutive length are 120deg. apart when the poles are made in three lengths, as is generally the case. If joints are not so made, the pole, instead of bending uniformly, after a short time gives at the joints. Poles constructed with S S S joints can be accurately calculated to stand any determined strain without exceeding a fixed temporary and permanent deflection. This is not possible with other joints, which always give trouble sooner or later. For the standard poles used at Bristol and Dublin five sizes are required, all 31ft. long, and set in the ground to a depth of 6ft. No. 1 has to stand a lateral strain of 350lb. applied at top, with maximum temporary deflection of 6in., and a strain of 700lb. with maximum permanent deflection of ½in. For the four others the corresponding limits are :

No. 1.	350lb.	with 6in , and	700lb.	with ½in.
No. 2.	500lb.	,, ,,	1,000lb.	,,
No. 3.	700lb.	,, ,,	1,200lb.	,,
No. 4.	1,000lb.	,, ,,	1 700lb.	,,
No. 5.	2,000lb.	,, ,,	2,600lb.	,,

The poles are required to be as nearly round as possible. A difference of ⅛in. between maximum and minimum diameter is all that is allowed. In order that they may all be as nearly uniform as possible, 1-16in., more or less, than the prescribed dimensions is all that is allowed. The greatest distance out of the true that is allowed at the top of the pole is ¼in. Ten per cent. of each lot of poles are tested ; should three poles fail to come up to the requirements, the right is reserved to reject the entire lot. The poles are dropped three times, butt foremost, from a height of 6ft. upon some solid substance, after which they must show no signs of telescoping or loosening in the joints.

Insulators.—Insulators must be mechanically strong, and the insulation protected by a metallic covering from external injury. Special insulators have been designed for every variety of service, samples of which are exhibited. For ordinary tramway service the wire is usually soldered into the gunmetal ears of the insulators ; but the heavy "figure 8" wire, used for light railways and high-speed lines, is supported by mechanical clips. Occasionally an extra heavy round wire is used, which is then milled out by a portable tool at the points of support, in order to afford a proper grip for the mechanical ears.

Rolling-Stock.—This can be subdivided into car bodies, trucks, motors, and their accessories. The bodies possess no special features, except that all framing must be extra strong.

Trucks.—The supply of suitable trucks for both motor and trailer cars is of the utmost importance. The introduction of electric traction has revolutionised the construction of running gear. In former days, when horses and mules were the only motive power for street cars, it was considered quite sufficient to support the car body upon a single set of springs carried by the boxes, a simple bar being often the only connection between the two sets of wheels. The adoption of the electric power and of cars equipped with single or double motors added immensely to the weight carried by the axles, and rendered it necessary to adopt efficient methods for cushioning and suspending the motors over the axles, while maintaining a rigid connection between motor and axle. At first the motors were rigidly attached to the bottom of the floor of the car body. This construction did not prove a success, for both car floor and motor deteriorated rapidly, and access to the motors was also difficult. Experience demonstrated that the only effective plan was to attach the motors to an independent truck frame, and to have all the mechanism of the car entirely independent of the car body. For this purpose an independent truck was introduced, consisting of pedestals secured by centre bars ; upon the pedestals the motors were suspended by cross-bars connecting the side frames of the truck together. While these trucks supported the motors independently of the car body, they did not properly support the car body itself, which had increased in length and width. The increased length and width of the electric car, together with the increased speed at which it ran, rendered a stronger and longer truck necessary. At first the old street-car pedestals were fastened to a separate pair of sills. The axle boxes still played up and down in these pedestals to the full extent of the motion of the car body. This device proved insufficient. The next step in advance was to secure the pedestals carrying the axle boxes to side frames, which carried the springs supporting the car body. This construction, however, allowed excessive swaying of the car body, owing to the fact of the connection between the wheels and the body not being sufficiently rigid. Moreover no provision had been made for easily removing the wheels, which required the truck to be practically taken to pieces. The brakes were hung to the upper chord of the truck, the effect of which was that, when the springs were compressed, the brake shoes dropped lower on the wheels, changing the distance between the shoe and the wheel.

The introduction of mechanical motors, occupying so little room that a capacity of 50 h.p. or 60 h.p. can readily be placed in the

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space allowed by the truck, has led to a large increase in the weight of the car body, and a consequent lengthening of the wheel base. The modern electric-car bodies carried on four wheels are seldom shorter than 18ft. over the end panels, and sometimes reach 22ft. length, exclusive of the platforms, while the whole length of the car over the platforms is from 30ft. to 32ft. This increase of nearly 25 per cent. in the length and more than 25 per cent. in the weight of the bodies has been accompanied by an increase of only about 20 per cent. in the wheel base of the trucks. As a result, a long and rigid spring base is an absolute necessity for a modern electric truck. Without this, the whole stress of carrying both the deadweight of the car and platforms and the fluctuating weight of the load would fall on the car sills and body, and the motion of the car would continually wrench and strain its framing. In the conditions met with in street service the wheel base cannot be lengthened much over 7ft. or 7½ft., and on this account a long spring base must serve the purpose of an increased wheel base for the long cars now employed. To obtain easy riding it is necessary that all the springs should be sufficiently light to obviate vertical motion in the car body, consequently these light springs, in order to prevent excessive motion of the ends of the car, must be carried out just as far apart as it would be necessary to carry the wheels if the old horse-car arrangement were adopted for the modern long car bodies. To secure the necessary rigidity of the long side frames, and at the same time keep their weight within reasonable limits, different plans have been adopted. In earlier designs it was attempted to overcome the difficulty by casting the pedestal and overhang in one piece and lengthening the joint between these castings and the bars. Another method consisted in trussing the overhang with straining-rods running over the tops of the pedestals, and provided with turn buckles for taking up the strain as the overhang worked down; but turn buckles slack off, and the bolted joints wear loose, and a continual wear and rattle was the result. Some makers constructed the side frames of the truck in one piece by bolting heavy centre bars to the pedestals. Others again forged the side frame of the truck, and welded the whole together into one piece. But these designs have not proved sufficiently strong to support properly the permanent pressure upon the ends of the overhang, when the overhang is carried out to the length of the modern car body.

The demand for this special class of work brought out a host of devices, of which 10 years' experience has sifted the useful from the useless; and it may be fairly stated that the chief principles involved in the design of a thoroughly good motor truck, fulfilling all or most of the conditions imposed by electric traction, have now been fully recognised, with the result that the electric motor truck has been matured to a standard form. Truck building has become an independent business in America, although many car works still make some form of truck for themselves. Rigid frames had been employed in trucks for cars driven by gas, steam, compressed air, or cable grip; but in all of these the conditions are entirely different from those in electric motorcars. This experience was dearly bought by some of the earlier electric tramways, as was testified by many a scrap-heap composed of trucks which, after running but a few miles, had to be discarded.

The quality of the motor trucks may mean the success or failure of an electric tramway; and to secure a good truck is quite as indispensable as to use a well-constructed and efficient motor. A motor truck comprises many parts, the most important of which are the side frames, springs, wheels, axles, boxes, bearings, motor bearings and suspension, sand-boxes, brakes. and safety appliances. The following are the essential conditions which must be fulfilled by a truck in order that it may be suitable for electric traction: (1) The truck must be as light as possible, consistently with rigidity and strength. (2) It must be thoroughly braced, so as to keep it stiff and square without having to depend in any way on the car body. The strains on a motorcar in rounding curves, and when passing a change of gradient, are extremely severe; much more so than with horse cars, where the horses pull the car round on curves, and go slower at a change of gradient. (3) The journal boxes must be self-lubricating, must require but little attention, and must be dust-proof. (4) The brake action must be simple, effective, and easily adjustable; and the brake shoes must admit of being replaced at a moment's notice, and must be mounted in such a way as not to be influenced by the vertical motion of the car. (5) The truck must be constructed in such a manner as to render access easy to all parts; and to admit of motors, wheels, and axles, journal boxes, brake gear and other parts being easily removed, without having to dismember the truck. Cross strains on bolts should be avoided as much as possible. (6) The car body must be attached to the truck in such a manner as to be readily removed on loosening a few bolts. (7) Springs must be arranged so as to render the running of the car as smooth when empty as when fully loaded, and to prevent the pitching and rolling motion to which street cars are so liable on sharp curves and rough roads. This is a highly important point, not only for the comfort of the passengers, but also to prevent rapid deterioration of the car wiring and car bodies; deterioration of the wiring is likely to cause grave results to the motors by producing short-circuits. (8) An appropriate choice of wheels is most important. There are three different kinds of trucks: the rigid four-wheel, the radial six-wheel, and the four-wheel bogie for eight-wheel cars. Of these three, however, only the first and third are generally used, the radial truck not having given the satisfactory results which were expected.

Four-Wheel Truck.—In the rigid four-wheel truck, where the wheel base is naturally restricted, it is of the greatest importance to have an arrangement whereby the car body is supported as far outside the wheel base as possible; and to diminish as much as may be, by the judicious use of springs, the destructive effect of jolting, both upon the car body and upon the motor equipment. The best modern truck, which has been employed on all the latest and best-equipped British and Colonial tramways, is the "Peckham," of which models are exhibited. It has been adopted by Bristol, Dublin, Guernsey, Clontarf, Coventry, Isle of Man, North Staffordshire, Dover, Leeds, Birmingham, Brisbane, Sydney, and other places; and in all cases has given the utmost satisfaction. The support selected as the model for a truck frame is the standard cantilever bridge truss, which experience in bridge building has shown to be the strongest form of construction. This truss principle has been closely followed in the construction of the Peckham truck; and while various modifications in detail have been made to adapt trucks to the various conditions occurring in street tramway practice, the characteristic bridge form of truss has been strictly adhered to in all of them. The cantilever truck has now come to be regarded as the standard for the best work in the United States, inasmuch as 15,000 are now in use in that country. As the length of the car body grows greater, the difficulty increases of supporting it properly at the ends without increasing the height of the car platform above the ground. The resistance offered by any truss to bending varies directly as the cube of its depth. If, therefore, the car platform were raised high enough above the street-level it would be an easy matter to support the sills of any car effectually so that it should be impossible for them to droop at the ends under heavy loads. It is an entirely different thing, however, so to support them when the height from the rail to the lower edge of the sill is limited, as it must be in street tramways. Beyond 27in., or at most 30in., every inch that the car platform is raised above the level of the street makes it so much the more difficult for ingress and egress. This is therefore practically the limit in height to which the car body used for city service can be raised. This problem has been solved by the use of extension rods in a way never before applied in street tramways. A second bridge truss is constructed by employing the extension rod as a lower member and the car sill as an upper member, and this truss is supported flexibly upon the main truck truss. The truss extension rods, instead of terminating as heretofore at the extremity of the truck frame, are carried below and around its lower member, and are stayed to the car sill by bolts passing through the truck pedestals and end springs. The angle of the truss extension rods has not been changed in any way to secure a longer support; but, as they are dropped bodily lower, they give a wider base of support to the car body than would otherwise be possible. By this method it has been found practicable to carry upon single trucks, with a wheel base of only 7ft., cars as long as 35ft. Other important improvements include the flexible gear, which is so constructed that it allows the cantilever extension truss to be built in sections, so that the portion under the journal boxes can be removed when necessary for taking out the wheels and axles, but when in place it makes a continuous truss. This gear also allows of introducing in its upper portion coil springs for supporting the truck frames flexibly upon the journal boxes, thereby relieving the truck frames as well as the car body from the rigid metal contact with the rail, and also relieving the rail from the hammer-blow which would attend a rigid connection between the rail and the car body.

Swivel Truck.—The rapid growth of inter-urban lines, upon which the tendency is to use long cars, and the desire on many tramways to use long cars for city work, have resulted in the swivel truck. This is the result not only of railway experience, but also of many years' experience of electric tramway needs. A truck so constructed runs exceedingly easy, the weight being doubly cushioned by the two elliptical springs and spiral springs over each axle-box. The brake gear is simple, and the shoes are applied with a powerful leverage. The centre of gravity of the trucks has been brought down as low as possible; with cars having straight sides, the body of the car need not be more than 27½in. above the rail. The wheel base has been kept short, and the space between the axles kept kept clear, so that it is possible to mount two motors on the truck without difficulty. The arrangement of the springs on the trucks renders it possible to remove the bolster and elliptic springs quickly and easily, whenever it becomes necessary to examine and overhaul the motors. When this has to be done, the car body is simply jacked up with the bolster, and the truck frame can then be run out from under the car. The rivets used in the construction of all these trucks are driven in hot by means of pneumatic riveters under 30 tons pressure.

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Motors.—In the early days the motors were all used with double-reduction gearing, with consequent great waste of power in a double transformation of the high armature speed to the low speed of the car axles, an efficiency of 60 per cent. being rarely obtained. At present, good design, workmanship, and materials have brought about such a change for the better that under most conditions an efficiency of 80 per cent. is attained, which remains constant with widely varying loads. When the application of electricity for propelling street cars was first practically attempted, it was endeavoured to apply the existing stationary motor to the existing running gear. The motor and axle were connected by means of belts, sprocket chains, friction clutches, and other mechanical devices, all of which, with few exceptions, have now been abandoned, on account of the great expense of maintenance and their low efficiency. Double-reduction spur gearing was first introduced on the experimental line at Woonsocket, Rhode Island, which was jointly equipped in 1886 by the Thomson-Houston and Bentley-Knight companies; and the advantages of a specially constructed and self-contained motor truck were there demonstrated. The high speed and comparatively cumbersome construction of motors at that time necessitated a double reduction in gear between armature and axle, each reduction being about 9 to 1. Thus an armature speed of about 1,500 revolutions per minute gave a car speed of about 15 miles an hour. The later makes of double-reduction motors, of which a great many have been employed both in the United States and in Europe, have done excellent work; but more recent and keener competition in electric traction has resulted in more advanced designs being developed. The electric motor having demonstrated its ability to do the required work, the next problem was so to improve it as to reduce the working expenses as low as possible. This was partially effected by improving the design of the double-reduction motor, and to a much greater extent by the introduction of single-reduction gearing. The success of single reduction stimulated still further improvement in design; and motors mounted direct upon the driven axles, and devoid of all gearing, were developed. These, however, have not yet come into practical use for street cars, on account of their increased weight and also of their rapid deterioration owing to the absence of any spring support, in consequence of which the motors receive all the shocks due to the comparatively rough tramway lines. The increased weight and rapid deterioration, and consequent increase in original cost and maintenance, have prevented their competing on even terms with improved single-reduction motors.

Single-Reduction Motors.—The maturing of the design of single-reduction motors marks a distinct epoch in the construction of tramway motors. The practical experience of many years' use has proved them reliable and efficient; and they have fairly fulfilled the following essential requirements of a motor for tramways: (1) The motor must be as light in weight as possible, having due regard to strength and simplicity in its mechanical and electrical construction. (2) It must be completely closed in, and protected from dirt, moisture, etc. (3) Its capacity must be ample, and it should be able to run continuously for at least two hours at its rated capacity, without heating beyond 90deg. to 135deg. F. It should be capable of developing at least 50 per cent. more than its rated capacity, without injurious sparking or other damage, and the starting torque must be great. (4) All the external and internal parts of the motor must be thoroughly accessible, and easily taken apart. That motor is the best which enables the line to be worked at the lowest cost for fixed charges as well as for running expenses. The relation between weight of motor and expense of working is forcibly shown by the maintenance of way on various tramways at present working. A motor entirely protected from dirt, moisture, etc., needs far less repairs, and so diminishes the cost of working. If a motor does not keep within a certain limit of heating and sparking, renewals of parts will obviously become numerous and costly. Difficulty of access to the wearing parts means higher charges for maintenance and labour.

Gearing.—More than one reduction in gearing between armature and axle means too high speed of the armature, and consequently too great wear in the teeth. Any decrease in number of parts and bearings diminishes the cost of maintenance. Large teeth must be used, and the gearing must run in grease. Experience has proved the greater economy of steel over cast-iron gearing for tramway motors. A recent careful investigation of 66 tramways in 49 cities, using over 7,000 motors, has demonstrated that the average life of cast-iron gearing is somewhat over 30,000 miles, while that of steel gearing is nearly twice as great. Apart from the advantages of longer life and higher efficiency, there is much less danger of breakage in steel than in cast-iron gearing, and of consequent springing or breaking of shafts and frames. The teeth are cut out of a solid rim by finely made cutters of the best known shape, as determined by exhaustive experiments. Motor pinions should be made from the best hammered steel forgings, and the teeth should be formed by accurate cutters and specially designed machinery with the same care as is used in the manufacture of the gearing; and they should all undergo the same rigid inspection and tests as the gearing.

Power.—The average horse-power exerted by a tramway motor at the car wheel probably does not exceed 20 per cent. of the maximum power it is expected to exert in starting the car under the various conditions encountered. In order to get the best efficiency out of such a motor, it is necessary that its point of highest possible efficiency should coincide with the development of the power at which the greatest amount of work is to be done.

Suspension of Motors.—There are three principal ways in which the motors can be suspended from the trucks. They are known as "nose," and "side-bar," and "centre" suspension. In the first method one end of the motor rests on the axle through its bearings, while the other is hung from the truck by a cross-bar and springs. An advantage claimed for this method is that the gearing wears more evenly. In "side-bar" suspension the weight is nearly all taken off the axles. A side frame resting entirely on springs, carries the motor by two lugs, one on either side, which are so placed that the motor is suspended from its centre of gravity. This plan has not proved as successful as was anticipated, and the first, or "nose" suspension, is still much in use.

Rating of Motors.—This is rather a difficult question, because there are so many variable factors. At present nearly every manufacturer has a different method of rating, and a motor which would be called 15 h.p. by one is called 30 h.p. by another. A tramway motor works intermittently, and therefore can exert for brief periods a much larger power than it could continuously. Motors may be rated either by the torque which when making a given number of revolutions per minute they exert upon a wheel of a given diameter, that is to say, by their tractive effort; or else by the horse-power which they can develop. In both cases, however, care must be taken to state the length of time during which the motors are to exert their rated power, and also the rise of temperature permitted in that time. The General Electric Company, which is the largest manufacturing establishment in the United States, rates its motors by the torque which they can exert for one hour at the circumference either of a 30in. or of a 33in. wheel, at the speed for which they have been constructed, with a limiting rise in temperature of 135deg. F. after a run of one hour. Such a rating fairly represents the maximum conditions of ordinary working, and leaves sufficient margin to meet emergencies without injury to the motor. Instead of expressing the power of the motor by the torque, the tractive effort which the motor can give out at the normal speed may be stated. Motors may also be rated by the horse-power which they can safely give out temporarily, while they are so designed that they can run continuously at half that rated power without their temperature rising by more than 90deg. to 135deg. F. Inasmuch as all the insulation used in the construction of tramway motors is practically fireproof, they can stand a far greater amount of heating than ordinary stationary motors.

Power Station.—The success or failure of an electric line depends to no small extent upon the situation and design of the power station. The conditions which govern its erection are in many ways entirely different from those which have to be considered in the construction of an electric lighting station. The load is constantly varying, and the variations are large and unexpected. Breakdowns are more serious than in electric lighting; and such precautions must be taken as will render a suspension of service practically impossible under any circumstances. In many instances the station must be in continuous operation for several consecutive days. In large American power stations certain of the engines have frequently been running for eight and ten days continuously.

TABLE 9.—Sizes of Engines Recommended for Use in Power Stations.

Maximum power required. I.H.P.	Number of engines.	Power of each engine. I.H.P.
200	2	200
400	3	200
600	3	300
1,000	3	500
1,500	4	500
2,000	4	750
5,000	6	1,000
10,000	6	2,000

In early days the engines employed were far too small and weak. At the present time dynamos for tramway work are so constructed that accidents to them are quite as rare as to the driving engines themselves. Countershafts have been abandoned as wasteful in power and useless. Large reserves of power were also provided on the earlier electric lines; this practice has been abandoned, and Table 9 shows the reserve power which should be allowed; it will be seen that a sufficient number of engines are provided to furnish the maximum horse-power required for working the line, with a surplus of one engine in reserve. With this reserve the machinery can be kept in perfect adjustment and repair, one engine being at all times stationary. In case of a breakdown, this extra engine is ready to take the place of the one disabled.

(To be continued.)

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MORE ABOUT TRACTION.

In our last issue we opened up a good many points for discussion in regard to the use of accumulators for traction work, some of which may with interest be considered at greater length. We have contended that those desirous of introducing electric traction have aimed too high; they want perfection at once, and the capability of successfully competing against steam and other motors, mechanical or animal. There is much to be said from this point of view, but we believe it to be wholly wrong. The general use of electricity for traction purposes must come gradually. It is not going to supersede all other forms of traction in a lump. First, for the luxurious and wealthy, then with improvements percolating downwards. The absurdity of requiring too much has kept back an industry. You might as well require a new-fangled powder to propel a huge shell to the moon, after Jules Verne's fashion, as to expect the efficiency and flexibility from electricity that some require. Consider for a moment what effort is asked from thousands of horses. The carriage is ordered at a certain time, and with a pair of horses, a driver, and a footman, takes a lady or ladies shopping or visiting, and makes a run of half a dozen miles, all told, over carriageway pavements. The horses then rest till the morrow. In fact, they also rest half the time they are out, either at the shop or house doors, and so have a chance to recuperate their exhausted energies. Further, if a man is going to drive a long distance, he does it in stages, putting up the horse for an hour or so, and giving it a feed. Assume any figures you please for the weight of the combined motor and vehicle, say, a ton of horseflesh and a ton of deadweight of all kinds. Design an elegant carriage to carry a ton of accumulators and a ton of other weight of all kinds, and you have something analogous so far as weight is concerned. The question comes, is it necessary for these accumulators to propel the vehicle over the whole distance it has to travel without a rest similar to the rest horses would require? Surely, with electric central stations all over the place, with terminals at every large house, and as we expect they will be at every inn and stable-yard, the affixing of flexible conductors to charging terminals and battery terminals would only be analogous to putting a nosebag upon a horse. We have heard a good deal about electric cabs, and charging terminals will be found in various places, but to really develop that branch of motor work, the terminals should, as we have indicated, be as easily found as is the nosebag. There ought to be very little difficulty in arranging for automatic charging. A penny-in-the-slot would give, say, one-third of a unit—with the charge threepence per unit. Perhaps a little difficulty might be found in arranging for charging with varying resistances, but this is not insuperable. In the future an inn proprietor will as naturally provide charging terminals as he now does mangers, and men driving long distances will put up for an hour for charging accumulators like they do now to feed the horses. Taking all these things into consideration, would it not be well to modify somewhat

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the requirements from electricians; and if a battery could be found to satisfy the conditions pointed out in our last issue, to multiply charging terminals and commence business under the ordinary conditions which now hold? England is peculiarly unfortunate in the matter of design. When steam commenced to replace coaches, the designers of carriages for steam work could do no better than slavishly copy the coach designs, and now, when mechanical traction is on trial to replace animal traction, everybody seems wedded to the old order of design for carriage or cab. Many of the latter, to say the least, are not particularly comfortable, and some designer might well make a new departure, giving greater comfort and convenience.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

EFFECT OF ARC LIGHT ON THE EYES.

SIR,—The paragraph "Too Much Light" on page 132 of your last issue reminds me of a very similar experience some years ago, the recital of which may serve as a warning to your younger readers. It was about the first time I had had to deal with arc lamps. One day I was experimenting with two or three naked lamps, and repeatedly stood close up to the arcs to observe their burning and formation—with uncovered eyes! So far as I remember, I did not suffer any special inconvenience until I had retired to "rest" for the night, when I woke up in very great agony and partially blind. My first step was to jump out of bed and plunge my head in a basin of water, but this, repeated several times, only very slightly alleviated the pain. The latter was attended with much watering of the eyes, and at least a day elapsed before I could return to the works. I do not quite understand how in the cases you quote the men should have suffered so severely after only working for about three minutes, and, as I gather from another report, from a distance of 10 yards or so.—Yours, etc., W. PERREN MAYCOCK.

Croydon, July 30, 1897.

[Mr. Maycock's experience is a common one with arc lamp testers till they learn to use the dark glass shields regularly. We presume that the effect occurring after so short a time as three minutes, was due to the more intense rays of the large arc used.—ED. *E. E.*]

ELECTRICAL WATER-LEVEL RECORDERS, AND THEIR USE IN CONNECTION WITH WATER-WORKS.*

BY W. COLES FINCH.

The electrical water-level recorder does not appear to be generally used, and it has occurred to the author, who has now had charge of one of these instruments at the city of Rochester Strood waterworks for over three years, that a short description of the instrument, and of the valuable records obtained by its use, and of its assistance in detecting and locating waste, etc., might prove useful and interesting to members of this association. The recorder from which the diagrams herein referred to were taken is the invention of Messrs. Barr and McWhirter, of Glasgow, and is made by the Glenfield Company, Kilmarnock. This recorder is designed to indicate and record the fluctuations of water-level in a reservoir at a distance from the pumping station, and consists of a transmitting instrument placed over the reservoir and acted upon by a float, and a receiving instrument with dial clock and drum placed in the engine-room or engineer's office. The two instruments may be connected by a single line wire, carried either on poles or laid underground as may be found most convenient.

* Abstract of a paper read before the British Association of Waterworks Engineers.

The transmitter instrument (Fig. 1) is constructed as follows: On the horizontal shaft are two pulleys, on which are wound phosphor-bronze cords, one carrying a copper float, which rises and falls with the water-level, the other carrying a balance-weight to counterbalance the weight of the float. Motion is thus communicated by means of toothed-wheel gearing of brass to the tumbling arm, which arm makes one revolution for each inch or more, as the case may be, of rise or fall of the float. In falling over after it has passed its upper centre of gravity, this arm acts upon one or other of the two side levers, thus making an electrical contact and so indicating either a rise or fall on the receiver at the pumping station. The tumbling arm is weighted with a tube filled with mercury, which brings it down very sharply the moment it has passed its centre. The contacts, which are in duplicate, are of platinum, and have a rubbing or sliding motion, to ensure their being kept clean. The moving parts are on dead centres, to secure the minimum amount of friction.

The receiving instrument (Fig. 2) receives the current sent from the transmitter at the reservoir, and by means of a relay and local battery is made to act upon the one or the other (according to rise or fall) of the two pairs of magnetic coils, attracting one of the pendulous arms, each of which carries a keeper. When the arm is pulled over by the magnetic coil, the pinion on main shaft is made to revolve to the extent of one tooth, and only one, a locking bar preventing any further movement. When the current is released, the pendulous arm swings back by gravity to its normal position. A wheel geared to main shaft carries an index pointer on its shaft and indicates the level of water on the dial. Vertical motion is given to the pen marking on diagram by a light wire cord. The drum carrying the diagram makes one revolution in 24 hours, or in one week, as may be desired. The drum, with diagram, is driven by a strong eight-day or 30-hour pendulum clock.

Diagram No. 1 shows the water-level at any stated time in a reservoir 10ft. deep. Each fall or rise is equivalent to 1in. of water. Upon studying the same it will be seen that the first use of this instrument is as a guide to the engineer at the pumping station, whereby he can see at a glance the result of the pumping and can arrange his work accordingly. It is also a check on the pumping records and time sheets. The diagram shows that pumping commenced at 9 a.m. and stopped at 12 noon; started again at 3.10 p.m. and stopped at 5 p.m. It will also show if there has been any pumping to waste through pumping having continued after the reservoir was full. In this case the pen would mark a continuous horizontal line at 10ft.

Diagram No. 2 is a waste diagram showing the quantity of water lost during the hours from 12 midnight to 4 a.m., and this is regarded as all waste. Then, on reference to Diagram No. 1, it will be seen that at 12 p.m. the reservoir contained 5ft. 3in. and at 4 a.m. only 4ft. 6in. It will be seen that the normal waste is about 11,000 gallons per night, but on the night of October 25 it rose to 34,000 gallons, and this was immediately noticed and traced to a broken main. The night waste for the month of January, 1894, is plotted on the same diagram, and shows the effect of a severe frost. The waste was uniform at about 15,000 gallons for the first three nights of the month; then it rose to 28,000 gallons on the 7th, and after careful inspection and repair of leaks, etc., it resumed its normal state at the end of the month.

The electrical recorder has been found to be of great service in assisting to locate as well as detect waste, and in the town of Strood the consumption of water was reduced 40 per cent. by its use. In the case of the Strood waterworks, where the low-service reservoir is close to the engine-house, and the high-service reservoir at a distance, the author designed and fitted a mechanical arrangement of float, shafting, and gearing to record on the same diagram as the electrical apparatus of the high-service reservoir the levels of water in the low-service reservoir (see Diagram No. 3), which shows the electrical records in steps, and the mechanical records in a continuous line. This system could also be adopted to record the fluctuations of water in wells, which is of great value.

The system adopted by the author with much success in

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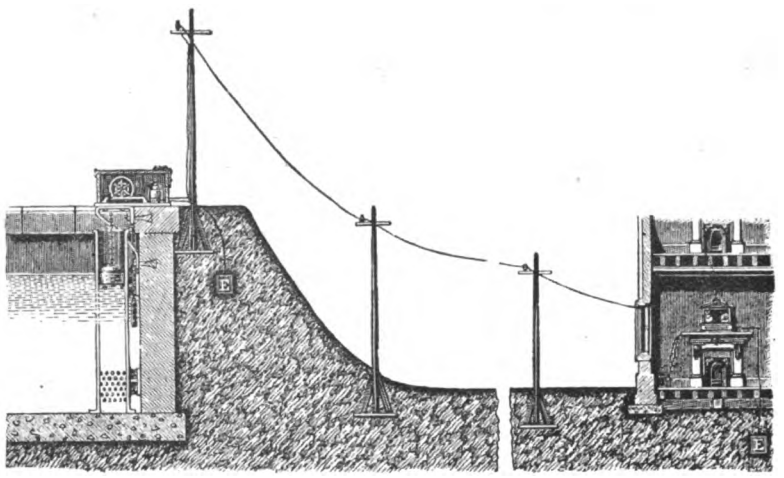
locating waste is as follows: The area supplied is divided into sub-districts, and one district is shut off each night and the effect on the reservoir noted, when the most wasteful districts are subjected to a systematic house-to-house inspection, and the engineer can place all his inspectors in the districts which are shown to be wasteful, and save the labour of examining districts which are in a satisfactory condition. Where there are two districts and reservoirs, one sub-district in each may be shut off the same night. Underground leakage may be traced in the same manner, and a remarkable instance of this kind came under the author's notice recently. There was an excessive waste of water, and district after district was shut off for a night, and failed to show any abnormal waste; and ultimately, when the whole town was shut off and the loss still continued, it became apparent that the leak was at or near the reservoir, and it was ultimately found to be in the wash-out valve of the reservoir, and within 30 yards of the recording instrument. These waste diagrams well repay the little labour expended in compiling them, and the result of the work of the inspectors is immediately noticed, and it is most interesting to watch the gradual improvement consequent on their labours. In 1895 the Rochester Corporation considered the question of adopting the waste-meter system, but after collecting information from other towns as to the result of the system, they finally decided not to adopt it, as they considered the result of the careful following up of the electrical recorder diagrams were quite as satisfactory, the consumption having been reduced from 36 gallons per head per day in 1891 to 17·58 gallons in 1895. I think members will agree that this is most satisfactory work.

The author then describes an instrument made to his requirements, and recently fixed at the Luton works of the Brompton, Chatham, Gillingham, and Rochester Water Company, which is designed to record the water-level in a reservoir 21ft. deep and 2½ million gallons capacity at a distance of about one-third of a mile from the pumping station, and also to record on the same diagram the water-levels in the well, which vary to the extent of 84ft., the reservoir levels being marked in black, and the well levels in red ink. It will be easily seen that this arrangement is most useful, the condition of both well and reservoir being seen at a glance at any moment of the day or night, and this is the more valuable in cases where the demand runs very close to the yield of the springs; it is also very valuable in testing the yield of springs, and ascertaining the quantity of water that can be drawn from the wells. With the assistance of this instrument, and by making a few trials, it can easily be found at what speed to run to extract the largest amount of water from the well. This is of great value, and is more economical than pumping down quickly and waiting for underground storage to refill, and in most cases more water will be obtained. This diagram is also a permanent record of the variations of depth of water in well caused by dry seasons in succession, heavy pumping, or wet seasons, as the case may be; it is also a faithful record of the rate at which the well and headings refill under different conditions, which is also of interest; again, when extensions have been made in headings or underground storage, by making a few trials before commencing, and again after the completion, an accurate record can be obtained of the value, delivery, storage, etc., resulting from the



Sketch showing General Arrangement of Transmitter and Receiver.

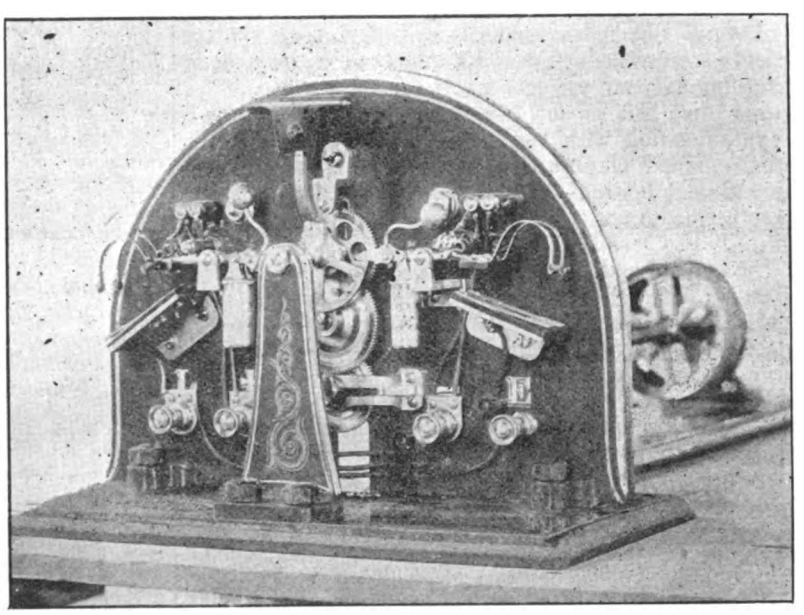


FIG. 1.—Transmitter.

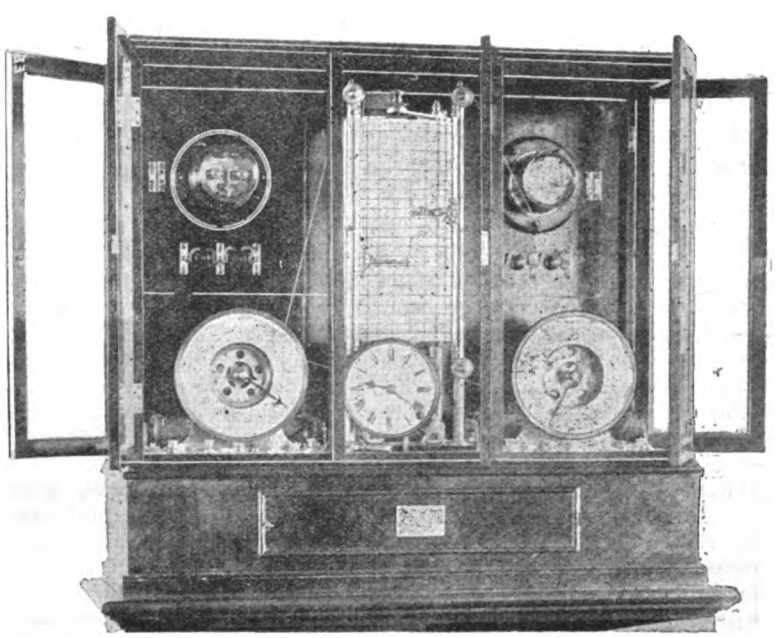


FIG. 2.—Receiver

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extension. From these diagrams the engineer can calculate and obtain a most valuable amount of information, and he will find the electrical recorder the pulse of the supply.

The author's conclusions are that the electrical recorder, in addition to the purpose for which it was primarily intended, can be used for the purposes of detecting and locating of waste, and so render unnecessary the more costly system of waste-detecting meters, at least for small waterworks; for indicating and recording the variations of level in wells; and for testing the yield of wells and springs at various times. An instrument of the kind described requires the very smallest amount of attention, and the value of the information gained will well repay the cost of the installation.

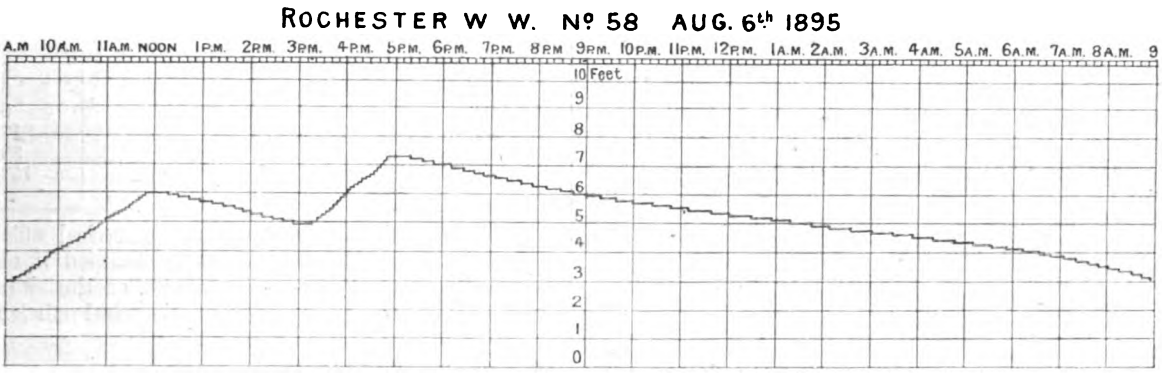

DIAGRAM No. 1.

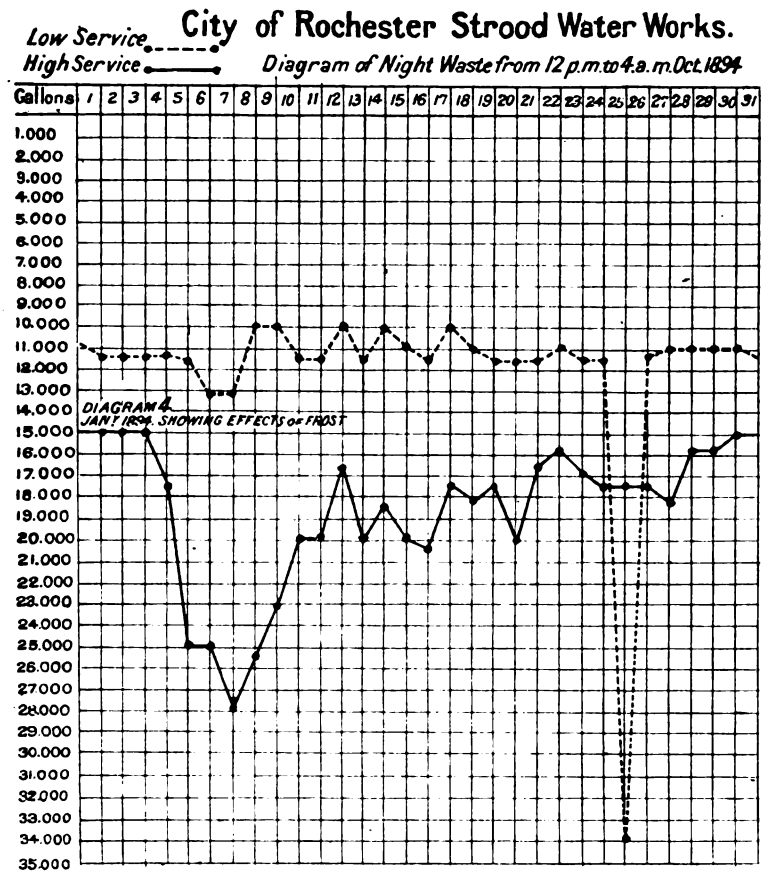

DIAGRAM No. 2.

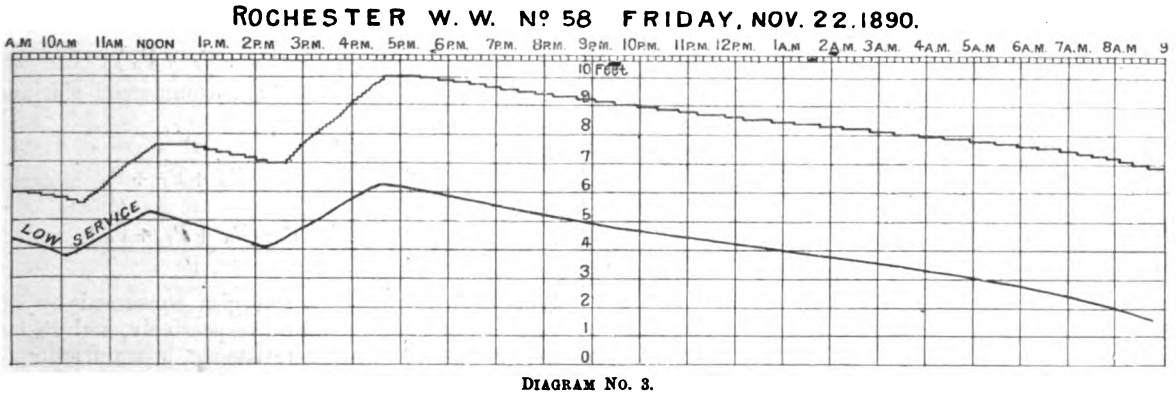

DIAGRAM No. 3.

EFFICIENCY OF DYNAMO-ELECTRIC MACHINERY.*

BY ALFRED E. WIENER, E.E., M.E., M.AMER.I.E.E.

I. Electrical Efficiency.—The electrical efficiency, or the economic coefficient, of a dynamo is the ratio of its useful to the total electrical energy in its armature, and the latter is the sum of the output and of the energy losses due to

* From the *American Electrician*.

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the armature and field resistances; hence the electrical efficiency is expressed by the formula

$$\eta_e = \frac{E \times C}{E' \times C'} = \frac{P'}{P} = \frac{P}{P + P_a + P_f} \quad . \quad (1)$$

where η_e = electrical efficiency of machine; E = useful E.M.F., in volts; C = useful current, in amperes; E′ = total E.M.F., in volts; C′ = total current, in amperes; P = useful electrical energy, in watts; P′ = total electrical energy, in watts; P_a = energy absorbed by armature winding, in watts; P_f = energy used for field excitation, in watts.

In the case of a generator, P is the output available at the brushes, and P′ the total electrical energy developed in the armature; in the case of a motor, P is the energy actually effective in electromagnetic induction; while P′ is the total energy delivered to the brushes—that is, the "intake" of the motor. The electrical efficiency does not include waste by hysteresis, eddy currents, or friction.

Inserting into (1) the values for P, P_a, and P_f—viz., P = useful E.M.F. × useful current, P_a = square of total armature current × armature resistance, and P_f = square of full exciting current × magnet resistance—we have the following formulæ for the electrical efficiency of series, shunt, and compound-wound dynamos respectively:

Series dynamo:

$$\eta_e = \frac{E \times C}{E \times C + C^2 \times (r_a + r_{se})} \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Shunt dynamo:

$$\eta_e = \frac{E \times C}{E \times C + C'^2 \times r_a + C^2_{sh} \times r_{sh}} \quad . \quad . \quad . \quad (3)$$

Compound dynamos:

$$\eta_e = \frac{E \times C}{E \times C + C'^2 \times (r_a + r_{se}) + C^2_{sh} \times r_{sh}} \quad . \quad (4)$$

in which E × C = useful electrical energy, in watts; C′ = total current flowing in armature conductors, in amperes; r_a = resistance of armature, hot, in ohms; r_{se} = resistance of series field winding, hot, in ohms; r_{sh} = resistance of shunt circuit, in ohms; C_{sh} = intensity of shunt exciting current, in amperes.

In the series-wound dynamo the whole current from the armature is carried through the field-magnet coils, the latter being wound with comparatively few turns of heavy copper wire, cable, or ribbon, and connected in series with the main circuit; hence the exciting current is in this case identical with the total armature current and also with the useful current. In the shunt-wound dynamo the field-magnet coils are wound with many turns of fine wire, and are connected to the brushes of the machine, constituting a by-pass circuit of high resistance through which only a small portion of the armature current passes; here, consequently, the field-exciting current, C_{sh}, forms only a part of the total armature current, C′, and the useful current, C, is the difference between the total and the exciting currents. The field coils of a compound-wound dynamo, finally, are partly wound with fine wire and partly with heavy conductors, the fine winding being traversed by a shunt current and the heavy winding by the main current. The total armature current therefore passes through armature as well as series field conductors, and a small portion of it excites the shunt winding, the useful current again being the total current minus the shunt current.

By replacing in (2), (3), and (4) the useful E.M.F., E, by the product of current output and external resistance (by virtue of Ohm's law), and by expressing the total current, C′, in terms of the current output, C (the currents flowing in a divided circuit being inversely proportional to the resistances of the respective branches), formulæ for η_e may be obtained which give the electrical efficiencies as functions of the resistances of the machine only. While it is thus found that in the series and compound dynamos the electrical efficiency is determined by the relative amounts of the internal and external resistances of the machine, the formula of the shunt dynamo, by a simple approximation, shows that the maximum electrical efficiency for that class of dynamos depends solely upon the ratio of shunt resistance to armature resistance, and is, therefore, in every single case given by the numerical value of that ratio. In the following Table I. these values are compiled for electrical efficiencies from η_e = ·8 to η_e = ·995, or from 80 to 99·5 per cent.

TABLE I.—Ratio of Shunt to Armature Resistance for Different Efficiencies.

Percentage of electrical efficiency, 100 η_e	Ratio of shunt to armature resistance, $r_{sh} : r_a$	Percentage of electrical efficiency, 100 η_e	Ratio of shunt to armature resistance, $r_{sh} : r_a$
80%	64	95·5%	1,802
85	128	96	2,304
87·5	196	96·5	3,041
90	324	97	4,182
91	409	97·5	6,084
92	529	98	9,604
93	706	98·5	17,248
94	982	99	39,204
95	1,444	99·5	158,404

From this table the approximate electrical efficiency of any shunt dynamo can be directly obtained if the armature and magnet resistance are known, or the shunt resistance required to obtain a certain electrical efficiency may by its means be readily computed for the case when the armature resistance is given.

The electrical efficiency of modern dynamos is very high, ranging from η_e = ·75, or 75 per cent., for the smallest machines to as high as η_e = ·99, or 99 per cent., for very large generators.

II. Commercial Efficiency.—By the commercial or net efficiency of a dynamo-electric machine is meant the ratio of its output to its intake. The intake of a generator is the mechanical energy required to drive it, and is the sum of the total energy generated in the armature and of the energy losses due to hysteresis, eddy currents, and friction; the intake of a motor is the electrical energy delivered to its terminals. The output of a generator is the electrical energy available at its terminals; the output of a motor is the mechanical energy at its shaft, and consists in the useful energy of the armature diminished by hysteresis, eddy current, and friction losses.

The intake of a generator, or the output of a motor, in foot-pounds per second, for the case of belt-driving, is the product of the belt speed, in feet per second, by the effective driving force of the belt, in pounds; or, converted into watts:

$$P'' = \frac{746}{550} \times \frac{v}{60} \times (F - f) = 1{\cdot}3564 \times v' \times (F - f),$$

where v = belt velocity, in feet per minute; v' = belt velocity in feet per second; F = tension on tight side of belt, in pounds; f = tension on slack side of belt, in pounds. The commercial efficiency of a generator, therefore, is:

$$\eta_c = \frac{P}{P''} = \frac{E \times C}{1{\cdot}3564 \times v' \times (F - f)} \quad . \quad . \quad (5)$$

and that of a motor

$$\eta_c = \frac{P''}{P} = \frac{1{\cdot}3564 \times v' \times (F - f)}{E' \times C'} \quad . \quad . \quad (6)$$

The energy supplied to a generator can also be expressed by

$$P'' = P + P_a + P_f + P_o,$$

and, similarly, the output of a motor by

$$P'' = P' - (P_a + P_f + P_o);$$

hence, another formula for the commercial efficiency of a generator is

$$\eta_c = \frac{P}{P'} = \frac{P}{P + P_a + P_f + P_o} \quad . \quad . \quad . \quad (7)$$

and for a motor

$$\eta_c = \frac{P''}{P'} = \frac{P - (P_a + P_f + P_o)}{P} \quad . \quad . \quad . \quad (8)$$

P_a and P_f denoting the energies consumed by armature winding and field excitation respectively, and P_o being the energy loss due to air resistance, brush friction, bearing friction, brush contact resistance, hysteresis, and eddy currents—that is, the power required to run the machine unloaded at normal speed.

The commercial efficiency, η_c, of a dynamo is always smaller than its electrical efficiency, η_e, since the former, besides the electrical energy dissipation, includes all

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mechanical and magnetic energy losses; the commercial efficiency, therefore, depends upon the amount of the electrical efficiency, upon the shape of the armature, upon the design, workmanship, and alignment of the bearings, upon the pressure of the brushes, upon the quality of the iron employed in its armature and field magnets, and upon the degree of lamination of the armature core; while the electrical efficiency only varies with the resistances of the machine.

The commercial efficiency of well-designed machines ranges from $\eta_c = \cdot6$, or 60 per cent., for small dynamos, to $\eta_c = \cdot95$, or 95 per cent., for large ones.

Since in a direct-driven generator the commercial efficiency is the ratio of the mechanical power available at the engine shaft to the electrical energy at the machine terminals, for comparisons between direct and belt driven dynamos the loss in belting should also be included the commercial efficiency of the belt-driven generator. The following Table II. contains averages of these losses for various arrangements of belts:

TABLE II.—Losses in Dynamo Belting.

Arrangement of belts.	Loss in belting in per cent. of power transmitted.
Horizontal belt	5 to 10 per cent.
Vertical ,,	7 ,, 12 ,,
Countershaft with horizontal belt	10 ,, 15 ,,
,, ,, vertical ,,	12 ,, 20 ,,
Main and counter shaft with belts	20 ,, 30 ,,

III. Efficiency of Conversion.—The efficiency of conversion, or the gross efficiency in a generator, is the ratio between the total electrical energy generated in the armature and the gross mechanical power delivered to the shaft, and in a motor is the ratio of the mechanical output to the useful electrical energy, or, in symbols, for a generator:

$$\eta_g = \frac{P'}{P''} = \frac{P'}{P + P_a + P_f + P_o} = \frac{E' \times C'}{1{\cdot}3564 \times v' \times (F - f)} \quad (9)$$

and for a motor

$$\eta_g = \frac{P''}{P} = \frac{P' - (P_a + P_f + P_o)}{P} = \frac{1{\cdot}3564 \times v' \times (F - f)}{E \times C} \quad (10)$$

The efficiency of conversion is the quotient of the commercial and the electrical efficiency, and therefore varies between $\eta_g = \frac{\eta_c}{\eta_e} = \frac{\cdot6}{\cdot75} = \cdot8$, or 80 per cent., for small dynamos, and $\eta_g = \frac{\cdot95}{\cdot99} = \cdot96$, or 96 per cent., for large machines.

In the accompanying Table III. the average commercial, electrical, and gross efficiencies for dynamos of various sizes are compiled.

TABLE III.—Efficiencies of Dynamos.

Capacity of dynamo, kilowatts.	Commercial efficiency, η_c	Electrical efficiency, η_e	Gross efficiency, η_g
1	·60	·75	·80
2	·67	·82	·82
5	·72	·85	·84
10	·75	·87	·86
15	·78	·89	·88
20	·80	·90	·89
25	·82	·91	·90
30	·84	·92	·91
40	·86	·93	·92
50	·87	94	·93
75	·88	·945	·935
100	·89	·95	·94
150	·90	·955	·9425
200	·91	·96	·945
300	·92	·97	·9475
400	·93	·98	·95
500	·935	·9825	·9525
750	·94	·985	·955
1,000	·945	·9875	·9775
2,000	·95	·99	·96

IV. Weight Efficiency and Cost of Dynamos.—As the commercial efficiency increases with the size of the machine, so the weight efficiency—that is, the output per unit weight of the machine—in general is greater for a large than for a small dynamo, and the cost of the machine per unit of the output therefore gradually increases as the output increases.

If all the different-sized machines of a firm were made of the same type, all having the same linear proportions, and if all had the same, or a gradually increasing, circumferential velocity, and were all figured for the same temperature increase in their windings, then the weight efficiency would gradually increase according to a certain definite law, and the cost per kilowatt would decrease by a similar law. In practice, however, such definite laws do not exist for the following reasons: (1) Up to a certain output a bipolar type is usually employed, while for the larger capacities the multipolar types are more economical, and between the largest bipolar and the smallest multipolar size there will be a sudden jump in both the weight efficiency and the specific cost. (2) The machines of the different capacities are not all built in linear proportion to each other, but, in order to economise material, tools, and patterns, the outputs of two or three consecutive sizes are often varied by simply increasing the length of the armature and the pole-pieces; in this case a small machine with a long armature may be of a greater weight efficiency and of a smaller specific price than the next larger size with a short armature. (3) The conductor velocity is not the same in all sizes; as a general rule it is higher in the larger machines, but often the increase from size to size is very irregular, causing deviation in the gradual increase of the weight efficiency. (4) Certain sizes of machines being more popular than others, a greater number of these can be manufactured simultaneously, and therefore these sizes can be turned out cheaper than others, and the specific cost of such sizes will be smaller than that of the next larger ones. (5) Large generators frequently are fitted with special parts, such as devices for the simultaneous adjustment of the brushes, arrangements for operating switches, brackets for supporting the heavy main and cross connecting cables, platforms, stairways, etc., the additional weight and cost of these extra parts often lowering the weight efficiency and increasing the specific cost beyond those of smaller sizes not possessing such complications. These various reasons, then, show why prices differ so widely and the ratio of weight to output is so varied, and we see from all these considerations that the data derived from various makers' price-lists must necessarily differ more or less.

In the following Table IV. the writer has compiled the weights, list prices, weight efficiencies (watts per pound), and specific prices (pounds per kilowatt) for all sizes of dynamos, as averaged from the catalogues of numerous representative American manufacturers of high-grade electrical machinery:

TABLE IV.—Average Weight and Cost of Dynamo.

Capacity in kilowatts.	Average weight (total net.) lb.	Weight per kilowatt, lb.	Output per lb, watts.	Average price complete.	Price per kilowatt.
				£	£ s. d.
·5	80	160	6·25	16	32 0 0
1	150	150	6·67	25	25 0 0
2	275	137	7·3	38	18 18 0
4	500	125	8	50	12 10 0
6	700	117	8·55	56	19 8 0
10	1,100	110	9·1	83	8 6 0
15	1,600	107	9·35	118	7 18 0
25	2,600	104	9 6	182	7 6 0
50	5,000	100	10	344	6 17 0
75	7,300	97·3	10·3	500	6 13 0
100	9 500	95	10·5	646	6 9 0
150	14,000	93·3	10·7	938	6 5 0
200	18,500	92·5	10·8	1,210	6 1 0
300	27,000	90	11·1	1,750	5 16 0
400	35,000	87·5	11·4	2,250	5 12 0
500	42,500	85	11·8	2,700	5 8 0
600	50,000	83·3	12	3.125	5 4 0
700	58,000	82·9	12·1	3,500	5 0 0
800	65,000	81·3	12·3	3,825	4 15 0
1,000	80,000	80	12·5	4,580	4 12 0
1,500	120,000	80	12·5	6,125	4 7 0
2,000	160,000	80	12·5	8.320	4 3 0

As it is usual to make very small machines for high speeds only, while medium-sized and large machines are built for high, medium, and low speeds, the averages given above for the larger machines refer to medium speed, and must be proportionately reduced for high and increased for low speeds.

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HIGH-SPEED SELF-LUBRICATING STEAM-ENGINES.*

BY ALFRED MORCOM, BIRMINGHAM.

(Concluded from page 143.)

Vibration.—For large central stations situated in densely populated neighbourhoods the design of the steam engine employed has been determined largely by the single question of vibration. The amount of vibration which will cause a nuisance is small; and several London electric stations have incurred serious losses on account of vibrations which at the engines themselves seemed inconsiderable. Having had to approach the subject of vibration in high-speed engines for land and marine purposes simultaneously, the writer was at first led astray by assuming an equality in the conditions, which really did not exist. The vibrations in the engines themselves may be classed as follows: first, those due to vertical changes in the position of the centre of gravity of the moving parts; second, those due to couples produced by the changing momentum in the several lines of moving parts; and third, those due to the obliquity of the connecting-rod producing retardation and acceleration of the moving parts in each line, which occur twice in each revolution.

The "Crescent" engine, with cranks opposite, is practically balanced against the first class of vibrations; but it has a big couple, and also vibrations of the third class. Engines with three cranks at equal angles are practically balanced as regards the first and third classes, but have large couples. Now, it was shown by Mr. Yarrow at the Institute of Naval Architects (*Transactions* 1892, vol. 33, page 213) that by balancing the effects of the couples the heavy vibrations could practically be got rid of in torpedo boats and similarly-built vessels with high-speed engines. This was successfully done with a few small weights in the four-cylinder engines of the "Spitfire" and "Swordfish," as previously mentioned.

The conclusion, therefore, was hastily drawn that engines for land purposes could be similarly dealt with; and an engine was built which was absolutely balanced as far as the first and second class of vibrations were concerned, but experience showed that buildings took up the higher-speed vibrations forming the third class; and it was finally found necessary to fit a return connecting-rod to one line of cylinders, in order to obliterate these vibrations. This expedient gave both in theory and on trial a perfect non-vibrating engine in the station. Three-cylinder engines, however, with equal-angle cranks, in which the third class of vibrations were practically obliterated, were working in central stations without difficulty from vibration; and further investigation led to the conclusion that buildings respond to the quicker vibrations, but are practically indifferent to the heavy but slower vibrating couples which give such trouble in ships. The three-cylinder engine with equal-angle cranks has consequently been adopted as the standard above 200 h.p. for central stations in densely populated districts. Similar engines are also used where a uniform turning effort is especially required: though this object can of course be attained to any desired extent in other kinds of engines also, by providing a sufficiently heavy flywheel.

Advantages of Forced Lubrication.—For all kinds of engines the plan of forced lubrication gives the same advantages—namely, automatic lubrication, noiselessness, economy, and freedom from wear. This is due to the working surfaces being kept apart by the film of oil forced between them. Although, generally, the pressure per square inch on the bearing itself is far in excess of the oil pressure used, yet the relaxation of pressure on the return stroke in a double-acting engine permits the oil at these times to be driven between the metal surfaces; and during the fraction of a second occupied by the acting stroke the film of oil cannot be squeezed out. This might indeed be readily taken for granted, and is clearly proved by the absence of wear in the large number of engines already built. It is at least obvious that the oil is in the best position to take advantage of the momentary relaxation of pressure between the surfaces, if it is itself under a pressure sufficient to push it in between the brass and the journal, so as to flood the bearing completely. If the oil is supplied by gravity alone, under the head usually given in double-acting engines, there is not sufficient time for permitting it to penetrate to any distance. In a single-acting engine under constant thrust no such film is possible. In both the latter cases the journal will, of course, be greased; but if friction and consequent wear of the journal are to be absolutely prevented, such a film of oil as the forced lubrication provides between the journal and brass is essential. The better the body of the oil the less chance will there be of effective lubrication without adequate oil pressure. To show how the oil film should affect the economy, reference may be made to a paper by Prof. Robert H. Thurston published in *Engineering* (1889, January 18, page 69), in which the friction in an engine with balanced slide-valve is sub-divided as follows: Main bearings 40·0 per cent., piston and rod 32·9, crank-pin 6·8, cross-head and wrist-pin 5·4, valve and rod 2·5, and eccentric strap 5·3 per cent. The friction of piston and rod here probably includes that of the guides, which are lubricated under pressure in the engines now described, and in addition to this it will be seen that the journal friction, which can be reduced by oil under pressure, amounts to nearly 65 per cent. of the whole. When it is borne in mind that in an ordinary engine, working at one-quarter of its full power, about 50 per cent. of the power developed is wasted in friction, it is clear that the effect on the economy by the reduction of journal friction should prove considerable at low loads; and with these double-acting self-lubricating engines, as compared with single-acting engines, it is certain that this is so. It was first pointed out by Mr. Alexander Siemens, in a paper read before the North of England Institute of Mining Engineers (November 24, 1894, page 212), in which he compared the results of the first Belliss 300-h.p. self-lubricating engine with a Willans engine of similar power, the two working alongside each other at his Charlton Works; his results showed that the gain due to the diminished friction increased considerably as the loads were reduced.

In dealing with high-speed engines, it is impossible to avoid referring to the admirable work which has been done by Messrs. Willans and Robinson in determining the conditions for economical working under various circumstances. Their trials, however, were made with single-acting engines; and although the results in general will apply to any engine, the reduction of friction in the double-acting self-lubricating engine should qualify them to some extent in detail. If the lubrication is accomplishing the purpose for which it is intended, the efficiency of the engine provided with forced lubrication ought to stand out high; and that this is so for all loads has been proved by results from some hundreds of engines. By the courtesy of Prof. Kennedy the author is enabled to give in Table 4 the results of a trial made by him of one of these engines supplied to the Sunderland Corporation Electric Supply Station, which will serve as an example. Here the engine efficiency at maximum load, it will be noted, works out at 96·3 per cent. The following comment upon the figures in the Sunderland tests was added by Prof. Kennedy: "The most singular point about them is the extraordinary high-brake efficiency of the engine, which is altogether much higher than anything I have previously found. I do not know the special cause of this. I have been extremely suspicious of the figures, and have had everything checked repeatedly. The different figures taken at different periods are quite consistent with each other, and there is nothing in the records to suggest error, except the figures themselves. I can only place these on record, without saying more about them." There is no doubt that the efficiency is remarkably high, but the conditions, as already pointed out, all tend in this direction, and similar results have been proved over and over again with the self-lubricating engines tested at the author's works. In order, however, to establish the results obtained by Prof. Kennedy, a further trial was conducted with a similar engine made for the Cheltenham electric light station from the same drawing as that at Sunderland, and it will be seen that the results given in Table 4 entirely bear out those of the other trials. The high efficiency that can thus be obtained makes itself felt in the economical working of the engine; and as it is due to an absence of friction, a far greater saving will probably arise from the diminished necessity for adjustment and repair on account of wear. In the writer's opinion there is too much difficulty in obtaining the necessary accuracy in indicating a high-speed engine to render efficiency alone a useful standard of comparison. The consumption of steam for work done is what the customer looks at; and results given per indicated horse-power, which take no account of the heavy losses through friction, are useless in comparing engines of different kinds. It will be seen that from the combined efficiency and consumption in the subsequent tests of the Sunderland engine coupled to a continuous-current dynamo, that the previous brake tests are fully borne out. These subsequent tests were made immediately after the others, in the presence of Prof. Kennedy and Mr. Snell, the electrical engineer to the Sunderland Corporation.

Governing.—Amongst the many admirable papers emanating from Messrs. Willans and Robinson on the subject of high-speed engines is a recent paper read to this institution by Captain Sankey (*Proceedings*, 1895, p. 154), in which governing by expansion valve is compared with ordinary governing by throttle valve. This important contribution to the subject is chiefly remarkable for the tendency of the results presented to displace the expansion-valve governor from the high position it has hitherto held as an economical appendage for reducing power. The disadvantages due to the higher initial pressure, with consequent leakage, the frictional loss due to compression, and the increased losses due to liquefaction are clearly pointed out; and the resulting efficiencies of the two modes of governing, especially when determined by work done, and not by indicated horse-power, are shown to be not greatly in favour of the expansion-valve governor. Expansion gear of this sort is also far more liable to wear, and a small amount of wear or of wrong adjustment after repair might lead to a steam distribution yielding at low loads considerably worse economy than

* Paper read before the Institution of Mechanical Engineers.

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TABLE 4.—Trials of Belliss 200-H.P. High-Speed Self-Lubricating Engines, Condensing. Cylinders 12¼in. and 20in. Diameter, with 9in. Stroke.

Station	Sunderland electric supply engine, tested by Prof. Kennedy.					Cheltenham electric light engine, tested subsequently.				
Load	Maximum.	Normal full.	Three quarters	Half.	One quarter.	Maximum.	Normal full.	Three quarters	Half.	One quarter.
Mean effective pressure per square inch reduced to low-pressure cylinder ... lb.	42·3	37 6	28·6	20·0	9·7	—	36 1	—	20 6	10·4
Mean revolutions per minute ... revs	364·6	365·0	364·5	363·9	363·8	—	365·5	—	361·0	361·5
Mean indicated horse-power ... I.H.P	217·5	193·6	147·1	102·7	49·8	—	185·7	—	104 8	53·1
Mean brake-horse power ... B.H.P.	209·5	186·0	140·6	97·0	44·5	—	176 8	—	97 4	44·2
Mechanical efficiency $\frac{B.H.P.}{I.H.P.}$ ... per cent	96 3	96·1	95·2	94·4	89·3	—	95 2	—	93·0	83·2
Water per hour, total ... lb.	3,772	3,383	2,628	1,920	888·5	—	3,301	—	1,939	987·9
,, ,, ,, per B.H.P. ... lb.	18·0	18·2	18 7	19·8	20·0	—	18·6	—	19·9	22·3
	Coupled to continuous-current dynamo.					Coupled to alternator.				
Mean effective pressure per square inch reduced to low-pressure cylinder ... lb.	36·0	24·2	19·2	10·5	2·2	—	28·4	23·0	—	—
Mean revolutions per minute ... revs.	367·6	365·3	362·6	365·2	364·8	—	350·2	351 0	—	—
Mean indicated horse-power ... I.H P.	186·7	129 4	98·2	54·1	11·6	—	144·8	114·4	—	—
Mean electric horse-power ... E.H.P.	168·6	115·1	83·8	40·9	—	—	126·8	98·5	—	—
Combined efficiency $\frac{E.H.P.}{I.H.P.}$ ... per cent.	90·3	88·9	85·3	75·6	—	—	87·5	86·1	—	—

TABLE 6.—Comparative Trials of Belliss 250-h.p. High-Speed Self-Lubricating Engine, Condensing, when Governing by Expanding and by Throttling. Cylinders 12in. and 20in. Diameter, with 10in. stroke. Boiler Pressure 150lb. per Square Inch Above Atmosphere.

Governing by expansion governor or by throttling.	Expanding. Expansion governor in action.				Throttling. Expansion governor out of action.			
Load	Full.	Five-eighths.	One-third.	One-quarter.	Full.	Five-eighths.	One-third.	One-quarter.
Mean effective pressure per square inch reduced to low-pressure cylinder ... lbs.	41·0	27 0	16·4	12·4	40 1	25·9	15·7	10 9
Mean revolutions per minute ... revs.	370	373	380	380	370	370	380	382
Mean indicated horse-power ... I.H.P.	240 9	161·0	99·0	75·3	235 4	152·2	95·0	66·2
Mean electric horse power ... E.H P	213·0	132·8	77·8	53·0	213·0	132·2	77·8	53·0
Combined efficiency $\frac{E.H.P.}{I.H.P.}$ ... per cent.	88 3	82·4	78·5	70·3	90·4	86 8	81·9	80·0
Water per hour, total ... lbs.	4,579	3,041	2,209	1,818	4,473	2 871	1 992	1,505
,, ,, per E.H P. ... lbs.	21·5	22·9	28·5	34·3	21·0	21·7	25·6	28·4

that obtained in the official trial at the works. As in the case of economical results, the comparative efficiency of the two methods of governing will also depend in detail somewhat on the kind of engine, and for this reason the trials that have been made by the author for determining the value of the two kinds of governor with the self-lubricating engine may be of interest. The results given by Captain Sankey are also based entirely on the indicated horse-power; but as the output of the engine is largely modified by frictional and other losses due to the action of the governor itself, the indicated horse-power results are of little practical value. The circumstance that the "Crescent" engine is arranged with both the valves driven by a single eccentric naturally led in the direction of expansion governing, owing to the ability of this governor to act simultaneously on both high and low pressure valves. Trials made in 1891 with a number of sets of dynamo machinery of about 80 h.p., constructed by the writer's firm for the Cunard steamships "Campania" and "Lucania," gave excellent results as far as governing went; but at low powers the results in respect of economy and efficiency were by no means as good as anticipated; and although in consequence of its effective action the use of the governor was continued, the poor economical results led to special trials being made further on for determining this point more exactly. So far as the governing itself is concerned, since the above machinery was built, the throttle governor with ordinary flywheel has been made by the reduction of friction to give exceedingly steady results, with a permanent variation of only 2 to 3 per cent., and a momentary run up to about 10 to 12 per cent., when all the load was suddenly thrown off. With the ordinary flywheel it is not possible to get much finer governing without introducing a tendency to hunt. The effect of a large flywheel permits the fitting of a much more sensitive governor; and with a flywheel of suitable dimensions governing by throttle can be made as fine and steady as may be required. Alternators of ordinary design have, of course, in themselves quite enough flywheel effect for enabling the usual engine flywheel to be dispensed with; and with these there is no difficulty in keeping the run up below 5 per cent., with permanent variation of 2 per cent. The reputation of the expansion-valve governor has been much increased by the value set upon it in the United States, where it is almost universally used; but this fact is largely qualified by a consideration of the high flywheel effects employed in conjunction with the governor in order to obtain the maximum results. The following Table 5 gives a few typical examples for enabling a comparison of these flywheel effects to be made for various services. For the Waterloo and City Railway, where it is desired to light the trains steadily direct from the motor currents, a flywheel of about 5½ tons has been fitted on each of the 300-h.p. sets in order to obtain the

Table 5.—Energy Stored in Flywheel and Revolving Parts of Dynamo per Electric Horse-Power at Full Load, for various services.

	Foot-tons.
Ordinary high-speed engines for electric lighting with continuous-current dynamos ...	0·2 to 0·3
Ditto, with heavy alternator ...	1·5 ,, 3·5
Electric traction, Continental example ...	2·0
,, ,, Montreal street railway ...	4·0
,, ,, Brooklyn electric tramway ...	4·7

required results—namely, permanent variation not exceeding 1½ per cent. and momentary not exceeding 2½ per cent. when all the load is suddenly removed. As far as governing is concerned, therefore, it may be allowed that the advantage, if any, is on the side of the throttle-valve governor, because it is equally powerful in governing, far less liable to derangement and wear, and much easier to adjust.

In respect of economy, the matter will naturally be looked at from two points of view—firstly, for electric lighting and electric power supply where the maximum economy is required at about full load; and secondly, for electric traction, where the normal load will probably be a much smaller fraction of the full load than in electric lighting. For electric lighting and power supply there is no question in the author's mind as to the superior efficiency of the throttle-valve governor. For electric traction, his experiments seem to show that with the double-acting self-lubricating engine there is little, if any, benefit to be derived from the expansion-valve governor; and this benefit will probably be neutralised by the mechanical difficulties which the extra wear on the expansion governor will subsequently entail. To determine this point, a number of experiments have been made with a self-lubricating engine of

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250 h.p., fitted with an expansion governor actuating an eccentric common to both valves. The results show that whilst the expansion-valve governor has a slight advantage when indicated horse-power is considered, the advantage is all on the side of the throttle valve when the output or electric horse-power is considered; and this, of course, is the only matter of importance in practice.

It is also found that the characteristic curve of water consumption for the Belliss engine is more horizontal than those for single-acting engines. This is due, as already pointed out, to the action of the forced lubrication in reducing the amount of friction, and consequently the amount of steam used per brake horse-power. In order to elucidate this point more fully, the results obtained at Sunderland were compared with the consumption per brake horse-power for a Westinghouse engine of about the same power, fitted with an expansion-valve governor, for which the data are taken from the *Proceedings* of the Institution of Civil Engineers, vol. cxiv., p. 68. It was found that, while with the expansion governor in the Westinghouse engine the result at half load is better than at full load, it is not better than the result obtained at half load with the throttle governor in the Belliss engine, which has, moreover, a decided advantage at full and low loads.

THE FATAL ACCIDENT AT THE BOURNEMOUTH ELECTRIC SUPPLY STATION.

The following is Major Cardew's report to the Board of Trade on the above accident:

I have the honour to report that, in accordance with your instructions, I have enquired into the facts connected with the death of J. Morris, engine fitter's labourer at the Bournemouth electric supply station on the 6th inst. I attach an extract from a local newspaper giving a report of the proceedings at the coroner's inquest. The case appears to be quite simple, and in my opinion the death of the man was certainly directly due to electric shock. On the 6th inst. Morris was assisting Edward Sackman, a fitter by trade, putting in gas fittings. For this purpose it was necessary to drill holes in certain iron columns to which the gas brackets were to be fixed. These columns are of channel section, and stand slightly in front of the wall of the building to which the various switches and apparatus for regulating the electric power are fixed. The men had fixed one fitting and had nearly finished drilling a second column, when Sackman left work somewhat hurriedly just before the dinner hour, as he was troubled with toothache. He states that before leaving he warned Morris to be careful not to accidentally touch any of the high-pressure apparatus. After dinner Morris started to drill another of these columns which were adjacent to certain "synchronising switches." These switches are so constructed as to expose the metal portions which are liable to be, and evidently at the time were, charged to high pressure. They are, however, fixed at such a height that persons standing on the floor would not be liable to make contact with them, the lowest portion of the metal exposed being at a height of 6ft. 6in. from the ground. The switches are operated by means of cords, and under ordinary conditions would be considered safe. Morris, however, had to work at some height from the floor level, and for this purpose brought a short ladder and fixed it against the wall. As he stood on this ladder his head was level with the switches, which were only 10in. distant from the column. Morris started to drill from the back of the column, and he must have tried to get his head in such a position as to see his work, and thus have brought his right temple into contact with the upper portion of the switch while holding on to the metal of the column with his left hand. The current which must have passed through his brain would under these circumstances, as the electric pressure was over 2,000 volts, have been sufficient to cause instant death.

In this unfortunate case the fault appears to me to be attributable chiefly to the carelessness of the man who lost his life. He had been for many years in the service of the electric supply company, and had been often employed in work connected with the high-pressure supply, and, without doubt, was aware of the danger of touching any portion of a high-pressure system. I must, however, point out that he was a man of imperfect education; that at the time he was engaged upon mechanical work totally unconnected with the electric supply; and that his attention being occupied with his work, he may very possibly have been entirely oblivious at the time of the fact that he was surrounded with danger of a peculiarly latent and incomprehensible nature. The engineer-in-charge at the time should, I consider, have carefully supervised the operations of this man whilst he was engaged on mechanical work in close proximity to high-pressure apparatus. The case, in fact, is very analogous to the fatal accident in January of last year to a workman in a transforming chamber at Cheltenham, and my remarks on that case to some extent apply to this also. It is also to be noted that the switch with which the man's head came into contact could have been easily discharged without in any way affecting the supply from the station, and as only one machine was running at the time, I consider that it was an oversight to have left this switch charged. I would further remark that had a conspicuous "danger" warning been exhibited at these switches, it is almost inconceivable that Morris would have sacrificed his life.

BURNLEY ELECTRICITY ACCOUNTS.

The following are the accounts for the municipal electricity works at Burnley for the year ending March 31, 1897. The engineer, Mr. W. R. Wright, wishes us to explain that during the year the Council instructed him to fix a set of telephonic fire-alarms and firemen's calls; to do this he had to form another account, which appears as general stores in the accounts. Also, the last year the accumulators gave out, hence a slow-speed rope-driven set of some 150 h.p had to be run from Christmas the whole 24 hours per day. This has caused the coal bill to rise considerably. The output during the heaviest winter nights, from 11 p.m. to 6 a.m., scarcely ever exceeded 45 units, and these only having three public arc lamps. The repairs are somewhat heavy, due largely to one item alone; some £65 was caused by the bursting of a motor-generator. Of course these items are a mere "fleabite" to a large station, but to a small station they are of the most vital importance, and do more harm in frightening the committee than in the loss of revenue. The committee have just recommended the Council to borrow £25,000 for extensions, which includes changing the system from 210 to 460 volts across the outer, and some £10,000 for additional mains, besides increasing the station.

The lamps actually connected to the mains and supplying lights during the last 12 months were respectively: April, 10,009; May, 10,093; June, 10,198; July, 10,378; August, 10,378; September, 11,227; October, 12,525; November, 12,525; December, 13,391; January, 13,560; February, 13,630; March, 13,722. The total plant capacity now is 334 kilowatts. The figures in the accounts are according to the manuscripts received, and appear to be slightly out if added up.

EXPENDITURE.

				£	s.	d.
Generation of Electricity.						
Coal and carriage	£284	7	0			
Oil, waste, water, and engine-room stores	85	15	0			
General stores	167	3	4			
Wages at generating station	377	16	4			
Repairs and Maintenance.						
Works and plant	28	15	4			
Engines, boilers, and machinery	159	17	10			
				1,103	15	2
Distribution, repairs, etc.				21	2	7
Miscellaneous.						
Attending and repairing lamps	13	7	8			
Rates and taxes	176	3	6			
				189	11	2
Management Expenses.						
Salary, engineer's department	208	6	8			
Printing stationery, and advertising	23	8	10			
General establishment charges	34	19	3			
Proportion of town hall expenses	20	0	0			
Collectors' wages and salaries	40	0	0			
Wages	22	9	6			
				349	4	3
				1,663	13	2
Interest and Sinking Fund.						
Interests on loans	707	11	0			
,, on consumers' deposits	0	15	9			
,, on sinking fund	662	7	6			
				1,370	14	3
Amount transferred to reserve fund				600	0	0
Net profit carried to borough fund				112	12	4
				£3,746	19	9

INCOME.

	£	s.	d.
Sale of current—			
520 units at 6d.	13	0	0
167,098½ ,, 5d.	3,481	4	5
5,534 ,, 3d.	69	3	6
	3,563	7	11
Less discount	167	15	4
	3,395	12	7
Rental of meters	120	14	1
Charges for work done	230	13	1
	£3,746	19	9

THE KINGSTON ENQUIRY.

At the Kingston Town Hall last week, Lieut.-Colonel A. C. Smith, R.E., one of the inspectors of the Local Government Board, held an enquiry relative to the application of the Corporation of Kingston to borrow a further sum of £20,000 for purposes of electric

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lighting. We are indebted to the local papers for the following report.

Very little public interest was manifested in the proceedings, no ratepayers outside the Corporation being present. The Mayor (Councillor Homersham), Alderman J. Marsh, Councillors J. J. Collings, F. Gridley, J. N. Horsfield, W. Youldon, and G. E. Street, the town clerk (Mr. H. A. Winser), the borough surveyor (Major Macaulay), the borough electrical engineer (Mr. J. E. Edgcome), and Mr. A. H. Preece (consulting engineer for the original scheme), were present during the proceedings.

The **Town Clerk** said there were two distinct matters involved in the present enquiry. One was the application for sanction to excesses of expenditure on the loans already granted, which excesses amounted altogether to £5,405. 15s. 1d., and the other was the application for a further loan of £14,242. 10s. for extensions, to which they now wished to add £228. The items making up the excesses were as follows:

Buildings	£48	3	1
Extension of plant	578	18	9
Extension of mains	2,692	15	9
Testing instruments and meters	142	14	6
House connections	740	11	0
Transformers, etc.	811	1	3
Station wiring	74	14	8
Tools and workshops	38	15	8
Printing, etc.	219	14	3
Commission	104	12	0
	5,452	0	11
Less balance on spares	46	5	10
	£5,405	15	1

They hoped the Local Government Board would allow the sum of £207 paid to the architect of the existing buildings, and a further item of £21 for alterations, to be added to the capital account and provided for out of the loan.

Mr. A. H. Preece said that the mains were laid over a larger area than was originally contemplated, which accounted for most of the excesses. At the last enquiry a sum was provided to cover these items, but as they were unable at that time to state clearly where they intended to put the mains, the amount was struck out. It was quite impossible at that time to define the exact route, because they were bound to be guided by the number of consumers cropping up.

The **Town Clerk** said the total amount deducted by the Local Government Board was £2,228. The sum of £207, which was disallowed, was the professional fee paid to the borough surveyor, in his capacity of architect of the buildings. The inspector at the last enquiry refused to sanction that item, because the architect was the borough surveyor, and he held that the work came within his duties. It was pointed out to the inspector at the time that the printed definition of the surveyor's duties expressly excluded architectural work, but for reasons that were not explained the Local Government Board struck out the item.

Mr. J. E. Edgcome, who is acting as consulting engineer for the proposed extensions, then explained to the inspector the plans and details of the work, the items being as follows:

Steam alternators	£2,000	0	0
Two boilers	1,420	0	0
Superheaters	240	0	0
Mechanical stokers	300	0	0
Brickwork for boilers	250	0	0
Steam-pipes, valves, exhaust pipes, etc.	495	10	0
Boiler cover, chequered plates, etc.	195	0	0
Rearrangement of switchboard	640	0	0
Transformers	700	0	0
Consumers' connections	1,217	0	0
Low-tension mains	700	0	0
Extensions (four sections)	4,055	0	0
Other smaller works	220	0	0
	£12,442	10	0

This outlay would carry them up to the end of 1898. The extensions would provide for 6,000 additional lamps of 8 c.p. burning simultaneously. The present total capacity was 7,000 lamps, so that if the present application was granted it would practically double the capacity of the plant, and enable future extensions to be made at very much less proportionate cost. The original length of main laid was five miles of high-tension and one mile of low-tension. The second loan provided for 1¾ miles of high-tension and 1¾ miles of low-tension mains, and the present application covered three-quarters of a mile of high-tension and six miles of low-tension mains, making a total of 7½ miles of high-tension and 8¾ miles of low-tension mains. During the present year there had been a considerable increase in revenue and in the number of lamps installed. A total of 567 lamps had been connected during this year, which brought them perilously near the limit of their capacity. They had an application from the Royal County Theatre for 1,000 lamps of 8 c.p., and as the whole of those lamps would frequently be burning together, it was imperative that the extension of the plant should be proceeded with at once to meet the increased demand in the autumn. In reply to the inspector, he said the deficit on the first year (omitting capital charges) was £587, in the next year the loss was £252, while last year there was a profit of £301.

The **Town Clerk** said the total loan indebtedness of the Corporation was £117,293. 4s. 7d., of which electric lighting was reponsible for £22,183. 12s. 7d. It was estimated that, if the present rate of increase in the consumption of electricity was maintained, the demand upon the rates for the repayment of the capital would be reduced nearly to vanishing point by the end of 1898. It was contemplated to light 150 of the public lamps by electricity, and the extension of the low-tension mains would partly provide for this.

Major Macaulay explained the proposed extension of the buildings, which would cost £2 000, but said he had not included his commission in that estimate.

Councillor Collings pointed out to the inspector that the policy of the committee in asking for these extensions was justified by the constantly increasing revenue. They had lighted some street lamps with incandescent electricity, and the experiment was so successful as to justify them in considerably extending that form of street-lighting, and when they were ready with a scheme they would have to apply for a supplementary loan. The repayment of capital was a great burden to a municipal enterprise like electric lighting, especially during the earliest and the worst years, and he hoped the Local Government Board would lighten their burden as much as possible by extending the period for repayment over as many years as possible. He also pressed for an early reply to the present application, and said that although they applied for £20,000, they would not take it all up at once, but as they required it.

Replying to questions by **Councillor Street, Mr. Edgcome** said the present number of lamps installed was 7 292. He admitted that the replies received to post-cards sent out enquiring as to the prospect of people taking the light in the districts where new mains were to be laid were not encouraging, but said that his experience was that when the current was made available people often made up their minds to take it.

Councillor Street said there was no great craving for the light in Kingston. It had cost a very great deal of money, and they were not getting much return for the money. In a very short time it would be necessary to spend a large sum of money on the sewerage, which was of infinitely greater importance than electric lighting, and he deprecated the constant additions to the rates for unnecessary things.

Councillor Collins pointed out that the rates were not increasing. For the year ended March, 1895, the total Corporation rates were 5s. 5d., and for 1896 5s. 7½d., but to March, 1897, only 5s 3d.

The **Inspector** said he thought that the electric lighting would soon be a paying business, whereby the Corporation would be able to reduce the rates. The enquiry then closed, and the inspector went to visit the works.

COMPANIES' MEETINGS AND REPORTS.

EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY, LIMITED.

The fourteenth ordinary general meeting of the Edison and Swan United Electric Light Company, Limited, was held on the 30th ult. at the Cannon-street Hotel, Mr. J. S. Forbes, the chairman of the Company, presiding.

The **Chairman**, in moving the adoption of the report, remarked that they gave little information in it, because one of the difficulties of a business where competition grew from day to day was the great advantage to a private trader to know what the public company with whom he was competing was doing. The profit and loss left a balance of £34,850, and, after meeting the debentures, interest, etc., there was £29,584 available for distribution. They recommended a dividend for the past half-year at the rate of 6 per cent. per annum, making, with the interim dividend, 5½ per cent. for the past year, as compared with 5 per cent. previously; and concurrently with that additional payment they carried forward a larger balance—namely, £8,493—as against £5,352 in the preceding year. They thought it wise not to divide close up, because they had just entered upon a larger business. They had during the year amalgamated with the Manchester Company. Under that amalgamation they had paid a considerable sum of money in shares, and had taken obligations upon themselves in relation to the work of that company which were not sufficiently developed to enable them to form a very safe opinion as to what the outcome would be, although they had every reason to believe that the bargain would turn out a good one. Paragraph 2 of the report told them that the arrangement had been carried out, and that the Manchester Company had handed over their effects to them—some of which were good and some not very good—including the interest they had in the Altrincham Electric Supply, Limited. That was an electric supply company in respect of which £23,000 or £24,000 had been invested, but which had been in operation too short a time to produce any very certain result as to the profitable character of it. They believed it would be a profitable investment, and a year hence they would know more about it. It was obvious, however, that the broader their base the more they could stand the depreciated selling price of the lamp, because so large a proportion of the expenses of the business was in fixed charges, apart from the mere material or wages, that the cost of each lamp decreased as the number increased. The figures were the same for certain things, whether they sold 1 000,000 or 2,000,000 lamps. What they wanted to have was not only the best lamp on the market, but the lamp which, in respect of both price and merit, might be in respect of price equal, and in merit somewhat better than that of other people. He was happy to think that this was felt to be the case, because a good deal of the competition they had to meet

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after the expiration of the patent came from people who were attracted by the comparatively lower prices at which they could buy German or other lamps in competition. Their business during the past year had been largely extended, and considerable additions had been made to the shops and plant. On the transactions of the year they had made £7,324 more profit, the amount carried to the profit and loss account last year having been £27,526, as compared with £34,850 this year.

The **Earl of Lichfield** seconded the motion, which was carried unanimously.

CENTRAL LONDON RAILWAY COMPANY.

The fourth ordinary general meeting of this Company was held on Wednesday at 16, Great George-street, Westminster, Mr. Henry Tennant presiding.

The **Chairman**, in moving the adoption of the report, said he would not detain them long, because, except with regard to the Davies-street Station, there was nothing of an unusual character to bring before the meeting. The expenses during the half-year had been £338,894, and, adding this to the amount previously expended, the total outlay to June 30 last was £1,146,220. The principal item of expenditure had been the payment to the Electric Traction Company of £289,327, mainly on account of works executed by them. An item of £23,073 had been paid for the additional land which the directors decided to obtain in order to provide for a larger station at the Post Office than was at first contemplated. At the last half-yearly meeting there was some discussion on a proposal of the directors with respect to obtaining powers for a station site on the north side of Oxford-street. That was a proposal made in consequence of their not having been able to arrange with the owners of the property on which the Davies-street Station was intended to stand. He was, however, glad now to be able to state that the terms had been agreed between all the parties concerned, and the Davies-street Station and street improvements would be carried out as originally intended. When this arrangement was made it became unnecessary to proceed with the Bill, and he was glad to say that the arrangement was arrived at ere the usual and somewhat expensive proceedings before committes either of the House of Commons or the House of Lords were entered upon. He certainly had no wish to spend money in parliamentary contests when they could properly be avoided. The requisite notices to the property owners had been issued in respect to the various properties required at Davies-street, and as soon as possession had been obtained the necessary works would be started. From the report of the engineer it would be seen that the work of constructing the tunnels had made satisfactory progress. They had a great work at the Bank Station, and the engineers reported that the subways there were being pressed on as fast as possible. It was satisfactory to know that this important and, as an engineer would say, very delicate kind of work had been carried on so far without accident. On other parts of the work some fatalities had occurred, which the directors and all concerned deeply regretted. He might here say that two of his colleagues, Lord Colville and Sir F. Knollys, were not present, owing to their attending the functions of royalty, in, he hoped, a more airy climate than that of London.

He then moved the adoption of the report, which was seconded by **Lord Rathmore**, and carried.

This concluded the business of the meeting.

DUDLEY AND STOURBRIDGE STEAM TRAMWAYS COMPANY.

An extraordinary general meeting of this Company was held on Thursday, the 29th ult., at the Grand Hotel, Birmingham, Mr. G. Bagott presiding, to consider the agreement for the sale of the Company's undertaking to the British Electric Traction Company, Limited, dated April 30, 1897.

The **Chairman** said he had much pleasure in meeting them that morning on what was most important business. They were there for the purpose of hearing read an agreement respecting the sale of their Company to the British Electric Traction Company. He need hardly say more, but would call upon Mr. Rowlands to read the agreement, and then they would be pleased to hear any remarks or any questions which might be put.

Mr. Rowlands read the agreement by which the vendors undertook to sell the property of the Company to the British Electric Traction for £44,208. 15s., being equivalent to £3. 15s. per share on the 11,789 shares issued by the vendor company, the purchase to take place as from January 1 last, and the purchasers to take over the whole undertaking and assets of the vendors from that date, less the dividend of 2½ per cent. already paid the shareholders for the year ending 1896. The purchasers agreed to pay to the vendors for the year ending December, 1897, or at the actual date of completion of purchase, an amount equal to 3 per cent. per annum on the issued capital of the vendors, and also to bear and pay the premium for insurance against accidents, and all other risks (including the sum of £100 already paid by the vendors), but not exceeding £400. The agreement was conditional upon the same being adopted by the shareholders of the vendors, and upon the purchase being completed on or or before December 31, 1897.

Mr. Gareke said he was present as the managing director of the British Electric Traction Company, and also as a shareholder, and probably one of the largest, in the Stourbridge Company. To show their *bond fides* in the matter, they had taken a large block of shares in the Company, and, as a matter of fact, the present market price was much below the price they were bound to pay if the scheme went through. They might probably have asked themselves why it was that the agreement was made conditional and not absolute. The reason was a very simple one. The Dudley and Stourbridge Company had only five or six years tenure of life, and at the end of that time the local authorities might buy up the concern. With so short a life it was not practical to spend the large capital which would have to be expended for the purpose of an electric tramway, nor was it any use of them thinking to spend £70,000 or £80,000 without first making some arrangement with the local authorities by which they would get an extension of running powers. It was a pity that local authorities did not more fully realise the enormous advantages which the Company hoped to bring to the districts in providing a better service, which could not fail to develop the districts through which the trams would run. He felt that instead of local authorities putting obstacles in the way of capitalists who were willing to find money to work electric tramways, and seeking to impose upon the pioneers of electric traction conditions which they could not comply with, with remuneration to themselves, they ought to place facilities in the way of inducing them to come in their district. To show the shareholders that they meant business, he might say that they had for some time been negotiating for the electrical equipment of other lines between Birmingham and Wolverhampton, and some of them were on the point of completion. At that very moment they were carrying out a scheme whereby they would take over the Electric Construction Company's arrangements with the South Staffordshire Tramways Company for the equipment of the whole of the lines of that company, and they were taking over at once the existing electric lines between Darlaston, Walsall, and Bloxwich. That was a matter of interest to the shareholders of the Dudley and Stourbridge Company, because their line and the lines of the South Staffordshire Company converged at Dudley. If their policy was successful and not too many obstacles in their way, they hoped some day to be able to provide a continuous service of electric power right over the South Staffordshire district. He thought everyone who lived in the district would appreciate that, and there could be no doubt but that it would be of enormous advantage to the several localities concerned. As they were probably aware, the negotiations between the two companies had extended over a considerable period, but not from any spirit of enmity or animosity, or a desire on their part to make a close bargain. He must say the directors of the Dudley and Stourbridge Company had met them in a fair spirit, and the agreement they had concluded would, if completed, be as satisfactory as any they were likely to make. He might also tell them that the price agreed on was much in excess of the price that they were first prepared to pay. Originally they did not intend to give more than £3. 7s. 6d., or at the most £3. 10s., per share, but they found that the directors were men of business who understood what they were doing, and therefore they were able to secure the sum mentioned that morning. As far as he was concerned, he felt quite justified in recommending his directors to conclude the bargain on those terms, and he also congratulated them upon the sale. If the existing shareholders desired to continue their interest in the new company when it had been electrically equipped, his directors would make every effort to give them an opportunity of taking shares.

The meeting terminated with a vote of thanks to the chairman.

WATERLOO AND CITY RAILWAY COMPANY.

The seventh half-yearly general meeting of this Company was held yesterday at Waterloo Station, Mr. W. S. Portal presiding.

In moving the adoption of the report, the **Chairman** stated that the sum expended during the past year was £80,079. 6s., making a total of £360,605 up to June 30, 1897. The fifth and final call on the share capital of the Company would be made on or about October 1 next. They hoped to be able to hand the railway over to the London and South-Western Railway Company for working by the end of the year. As for the progress which had been made, he referred them to the engineer's report. They had met with various delays with regard to pipes, etc., but these they hoped soon to overcome.

Colonel Campbell seconded the report, which was carried unanimously.

BRITISH ALUMINIUM COMPANY, LIMITED.

An extraordinary general meeting of this Company was held on the 29th ult. at Westminster Palace Hotel.

Mr. R. W. Wallace, Q.C., presided, and remarked that several shareholders had expressed a desire to know what the legal position of the Company was with regard to its monopoly for the supply and manufacture of aluminium under their patents, and although the meeting had been called merely to make alterations in the articles of association, in certain small particulars, he thought it would be advisable to give the information asked for on that occasion. As many of them were probably aware, the Board had proceeded against various firms and persons who had imported aluminium from America and Germany, and he was happy to be able to say that all those who disputed the Company's monopoly had now submitted to the injunctions granted by the Court, with the exception of one or two, and they were about to do so. The principal firm against which they brought an action was Sir W. G. Armstrong, Mitchell, and Co., of Newcastle-on-Tyne, and two or three weeks ago they obtained an injunction against them. The Government had also paid them royalties on aluminium imported from America. Foreign manufacturers were now

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convinced that this Company's monopoly was a good one, and the shareholders would in future derive the full benefit of it. The electrical process was the only one which could be adopted for the manufacture of aluminium, and this Company were the only manufacturers of aluminium in this country. The Aluminium Supply Company, which had worked up a very good business as agents for the American Company, was found to be so valuable an organisation that the Board had decided, not only to allow it to continue, but they had taken a half-share in it. The Board had had under consideration the development of the large water powers which this Company possessed. He did not think it desirable to state at present where these water powers were, although he might go so far as to mention that some of them were in Scotland and others in Wales. It was quite possible that in the course of the year a separate branch of the Company would be formed to deal with them. After alluding to the proposed alteration in the articles of association, the principal of which was to leave it to the Board to charge 10 per cent. interest on the calls in arrears, instead of making the payment compulsory as at present, he moved a resolution in accordance with the object for which the meeting was convened.

Dr. A. A. Common seconded the resolution, and it was agreed to.

The **Chairman** subsequently stated that the Board had declared a further interim dividend of 7 per cent. on certain of the preference shares. He also said that the demand for aluminium was increasing every day.

ANGLO-AMERICAN TELEGRAPH COMPANY, LIMITED.

The half-yearly meeting was held at Winchester House on 30th ult., Sir Gerald Fitzgerald, deputy chairman, presiding.

The report stated that one quarterly interim dividend of 12s. 6d. per cent. on the ordinary stock, and of £1. 5s. per cent. on the preferred stock, was paid on May 1, 1897, absorbing £43,750 and a second quarterly dividend of 13s. per cent. on the ordinary stock, and £1. 8s. per cent. on the preferred stock, amounting to £49,000, would be paid on July 31, 1897, leaving a balance of £8,507 carried forward to the next account.

In moving the adoption of the report and accounts, the **Chairman** said he had to place before them accounts which showed improvement in the traffic receipts of £5,935 as compared with the corresponding period of last year, and it was an indication that both in this country and in America there was a steady extension of trade, which they hoped would not be interfered with by the tariff legislation now passing through Congress. He was happy to say there was no indication of this up to the present time, as the traffic receipts for July exceeded those of the corresponding month of last year by something like £1,000. There was a decrease of £3,727 in the expenses, and £3,000 of this was due to the absence of repairs to any of their cables. They would be glad to see that their ship, the "Minia," had earned a sum of £8,455, as against £2,400 during the same period of last year. This enabled them to carry forward an unusually large balance. He would point out that the present was an interim dividend, and they would deal finally with the balance at the end of the financial year. This balance arose entirely from the money earned by the "Minia" in repairing cables for another company, and was an extraordinary profit. The repair of the Western Union cable in mid-Atlantic was done in the shortest time on record. As regarded the state of their own cables, they had already mended a fault in their 1880 cable, near Newfoundland, and the ship was at present at Valentia repairing a second fault. They would have to be prepared to renew two of their cables, which were somewhat old, and their ship, too, would within a reasonable period have to be replaced. He urged that the renewal fund ought to be enlarged.

Mr. C. Burt seconded the motion, and the report was adopted.

ELMORE'S AMERICAN AND CANADIAN COPPER COMPANY, LIMITED.

The report of the managing director of Elmore's American and Canadian Patent Copper Depositing Company, Limited, sent out with the balance-sheet for the year ending March 31, states that the working expenses amount to £144, compared with £110 and £165 for the two preceding years. The accounts shows that the assets amount to £86,690, or £519 in excess of the liabilities, after meeting the current expenditure; and in addition the Company has a cash reserve of £797, being deposits paid on certain shares which have been forfeited through failure of the allottees to pay the calls thereon. Since the date of the balance-sheet this reserve has been increased by £250 and the calls in arrears reduced to £500, which will be still further reduced very shortly. The reserve is far more than sufficient to meet any possible loss on plant, the greater part of which consists of about seven tons of Elmore copper cylinders, easily convertible into cash. The rest is made up of £2,777 in cash, £7,632 of remunerative investments, and £408 of good debts. In the report issued in December last great importance was attached to the new method of rapidly operating the Elmore process. The value of this improvement is becoming more and more apparent by the results attained in the works of the two English companies at Leeds. Whilst it is fully applicable to the manufacture of finished goods, yet it is specially applicable to the refinement of copper, and, therefore, will find its largest field of application in America. This Company has been offered the rights for the United States of America and Canada on substantially the same terms as those accepted by the English companies, but there is a practical difficulty in the way of this Company utilising the new process independently of the English companies, inasmuch as it would be pretty certain to lead to copper refined in America by the new process being exported to England, which is the chief export market for it, and this, of course, would clash with the English company's rights. To avoid this it is proposed that this Company should come into the amalgamation which it is intended to carry out between the two English companies—namely, Elmore's Patent Copper Depositing Company, Limited, and Elmore's Wire Manufacturing Company, Limited. The advantages of the arrangement are very obvious. The management will be concentrated; the capital of the Company will be invested in a strong company properly financed earning, as the Board hope to show, a dividend from the very commencement, and having the benefit not only of the profits from the British trade, but also the benefit of royalties and sales in America, where, according to recent returns, some 300,000 tons of copper were refined last year. Although the report and accounts are issued at the present time for the purpose of information, yet it is not proposed to hold a general meeting until later in the year, when details of the above scheme can be published.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Switzerland.—Tenders are invited at Lausanne for a concession for erection and lease of electric works. Applications to be made to the Municipality before September 25.

Madrid.—We hear that the Government will shortly advertise for 12,000 telegraph posts. Sgr. Montabo was the successful tenderer for the lately advertised 20,000 zinc cylinders.

Paris.—The last term of receiving tenders for 12,000kg. (about 25,000lb.) of oil for lighting purposes closes on Aug. 10, at 11 a.m., at the office of the Under Secretary of State of the Post and Telegraph Department, rue de Grenelle 103.

Sydney (New South Wales).—Tenders are required by October 18, at noon, at the General Post Office, for supplies to the Telegraph, Telephone, and Post Office Departments, including iron, copper, and insulated wire, insulators, nails, screws, nuts, bolts, electric batteries with all accessories and chemicals, diaphragms, arc lamps, incandescent lights, 11,000ft. carbon for arc lamps, and various other appliances.

Derby.—The Corporation are prepared to receive tenders for the supply of one alternating-current dynamo and engine and for the supply to the present engine of one continuous-current dynamo. Specifications, etc., form of tender may be had on deposit of £1. 1s. (which will be returned on receipt of a bona fide tender) from Mr. J. E. Stewart, engineer, Electric Lighting Station, Derby, on and after 7th inst. Tenders, endorsed "Electric Lighting, Tender for Dynamo, etc.," to be sent to Mr. H. F. Gadsby, town clerk, by 12 noon on 30th inst.

Ludlow.—The Corporation offers a prize of £20 for the best and most economical scheme of electric lighting for the borough. The scheme must deal exhaustively with the whole matter, and give definite information of the cost of steam and water power for the purpose of comparison with the total cost of the undertaking and working expenses. Schemes to be delivered at the offices of Mr. John Herbert Williams, town clerk, Ludlow, marked "Scheme for Electric Lighting," before 4 p.m. on September 1. Should the Corporation employ the engineer whose scheme is awarded the prize to carry the work out, then the £20 will merge in the commission to which he would then be entitled to.

Egypt.—The Secretary of State for Foreign Affairs has received a despatch from her Majesty's Agent and Consul-General at Cairo, drawing attention to a notice published in the *Official Journal* of the Egyptian Government of 23rd ult., in which it is stated that tenders are invited by the Egyptian Government for Welsh coal for the use of the Administration of Railways and the Port of Alexandria. Tenders should be sent under cover by registered post, and should reach the President of the Administrative Council by October 15 next. Such further particulars as have been received may be seen at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 6 p.m.

St. Pancras.—Tenders are required by the Vestry of St. Pancras for the supply of Welsh and other steam coal for use at the Regent's Park and the King's-road electricity stations for nine months. Delivery to be made as required. Average about 100 tons per week. Copies of the specification, conditions of contract, and form of tender to be obtained upon application at the Electricity Department Offices, 57, Pratt-street, Camden Town, N.W., on payment of a deposit of £1. 1s., which will be returned on receipt of specification, accompanied by a bona fide tender. Tenders to be sent to Mr. C. H. F. Barrett, vestry clerk, Vestry Hall, Pancras-road, endorsed "Tender for Coal," by 12 noon on August 9.

Carlisle.—Tenders are invited by the Corporation for the following work in connection with their electric lighting station in Carlisle: (Contract No. 1) boilers (Lancashire) and mechanical stokers; (2) engines, dynamos, condensers, pumps, etc., steam, exhaust, feed, and drain pipes; (3) storage battery; (4, section A) switchboard for dynamos and feeders (section B) boosters and switchboard for batteries and boosters; (5) arc lamps and their erection; (6) feeders, mains, and arc lamp leads. In contract No. 2 it is a condition that the dynamo makers must have already constructed dynamos of at least 100 units capacity. Copies of any of the specifications, with forms of tender and general conditions, can be obtained on payment of £1. 1s. each (to be returned on

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receipt by the Corporation of a bona fide tender), at the office of Mr. Henry C. Marks, city surveyor, Fisher-street, Carlisle; or Dr. A. B. W. Kennedy, 17, Victoria-street, Westminster, London, S.W. Tenders, on the prescribed forms, enclosed separately in sealed envelopes, and marked "Electric Lighting, Tender for Contract No. —," must be delivered at the office of the City Surveyor, Carlisle, by August 19.

Sedgefield (Durham).—The Visiting Committee of the Durham County Asylum, Sedgefield, having decided to instal the electric light in the Winterton building at the Sedgefield Asylum, invite tenders with specifications for the work. Each firm will be at liberty to suggest its own method, power and arrangement, and number of lights. The building for the housing of the machinery will be erected by the Visiting Committee on plans to be arranged with the firm whose proposal for the installation is accepted, and will be on such a scale that additional machinery can be placed therein so as to provide for the lighting of the main building when that project is decided on. As a guide to firms it may be stated that from 500 to 550 16-c.p. lights will probably be required for Winterton, and a larger number for the main building. Plans of the buildings can be seen at the office of Mr. Crozier, county engineer, Shire Hall, Durham, and the buildings may be inspected and further information obtained upon application to Dr. Smith, the resident medical superintendent at the asylum. Tenders, addressed to Mr. A. O. Smith, clerk to the Visiting Committee, Durham, will be received at his office, 19, Elvet-bridge, Durham, up to noon on August 7.

Madras—Tenders are invited for the utilisation of water flowing from the Periyár Lake for purposes other than irrigation and not incompatible with the use of the water for drinking. The irrigating season extends over nine to ten months, during which time the discharge is likely to be from 1,100 to about 500 cubic feet a second, according to the demands for irrigation and the available quantity in the lake. Subject to the risk of interruption by accident or drought, supply can be given throughout the irrigation season. No supply can be guaranteed at other times, but, so long as water is available, the Government will be prepared to issue it in such daily quantities as may seem to it advisable with reference to the time which is likely to elapse before the supply is replenished by the setting in of the rains. The fall from the tunnel to the foot of the hills is approximately 900ft., and the distance measured along the course of the stream about 6,800ft. One cubic foot per second falling 900ft. is estimated to produce over 60 effective horse-power. Intending lessees should state the quantity of water required in cubic feet per second and the annual rent offered for each cubic foot per second. No rent will be charged for the first year from the date of the concession; for the second year the charge will be one-fifth, and an additional charge of one-fifth will be made every year until the full rent is reached. The whole or part of the concession may be surrendered on a year's notice being given. Lessees will construct at their own expense, on plans to be approved by Government, all the weirs and other works required to divert the water from the river below the tunnel. For further information, application may be made to the Chief Engineer for Irrigation, Madras, by whom tenders will be received up to October 31, 1897.

Port Elizabeth (Cape Colony).—The Town Council of Port Elizabeth (Cape Colony) invite tenders for lighting the streets and municipal buildings of Port Elizabeth by electricity, in consideration of the grant of a concession for the exclusive right of supplying electric current through the streets and roads of the town, to private houses, stores, etc., for terms of 5, 15, 20, 25, or 30 years respectively. There are approximately about 54 miles of streets in the town, as follows: main thoroughfare, 5 miles 1,196 yards; principal streets, 16 miles 1,433 yards; minor streets, 32 miles. The streets of the town are at present lighted by 380 gas lamps of reputed 16-c.p. The municipal buildings consist of town hall, municipal offices, morning market, feather market, wool market, and museum. The main streets are to be lighted by arc lamps, and the side streets and municipal buildings by incandescent lamps. Tenderers must state at what sum per annum they are prepared to adequately light the streets and municipal buildings for the various periods mentioned above, if they are granted a concession for any one of the periods referred to. The concession will provide, inter alia, that the particular system and plant to be adopted by the concessionaires shall be subject to the approval of Council; the charge for supplying current to private houses shall not exceed 1s. 9d. per London Board of Trade unit; and that the Council will have the option of taking over the whole undertaking, etc., at a valuation to be made in case of difference by two arbitrators or their umpire at the end of the period of the concession at the then value of the plant and mains. Tenders, endorsed "Port Elizabeth Electric Lighting," should be delivered to the agents of the Municipality, Messrs. Davis and Soper, 54, St. Mary-axe, London, E.C. (from whom further information may be obtained), on or before September 21.

City of London.—At a meeting of the Court of Common Council, Mr. Brooke Hitching said he understood that the Commission of Sewers had received a proposal from an electric lighting company offering to compete for the electric lighting in the City. He asked whether it was true that the company in question had asked the committee to assist it in getting the Board of Trade order. Mr. Smallman said a company called the South London Electric Supply Company had given statutory notice of its intention to apply to the Board of Trade for an order, but not until the end of 1898. Nothing would be done before then.

BUSINESS NOTES.

Bridgwater.—The Town Council have decided to become suppliers of electric light.

Wrexham.—The Bill confirming the Wrexham electric lighting order has received the Royal assent.

Chesterton.—The additional estimates supplied to the Parish Council increase the amount for electric lighting to £6,800.

Change of Address.—Claud Hamilton, Limited, electric light engineers, Glasgow, have removed from 137, Waterloo-street to 247, St. Vincent-street.

Bedford.—Lieut.-Colonel A. C. Smith, R.E., has held an enquiry into the application of the Town Council for sanction to borrow £20,000 for purposes of electric lighting.

The Thames Valley Launch Company, of Weybridge, Surrey, have constructed 14 boats within the last 11 months, one of these for H.M. Government, and one for the Corporation of Southport.

Derby.—The Electric Lighting Committee of the Town Council have now under consideration Mr. Manville's report, and have concluded a contract with the British Insulated Wire Company, Limited.

Carnarvon.—The Town Council have decided to take similar steps as those reported from Rochester in order to safeguard their interests against an application from a private electric lighting company.

Deal.—At their next meeting the Council will consider what action should be taken with regard to the notices received from two companies that they were about to apply for powers to supply the electric light at Deal.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended August 1 amounted to £1,555, as compared with £1,357 in the corresponding week of the previous year, being an increase of £198.

Berkhamsted.—The question of the electric light for Berkhamsted has again come up after a long interval. The Council does not object to a reasonable extension of the period for carrying into effect the order which had been obtained.

Bo'ness.—The Harbour Commissioners have instructed their engineers to prepare specifications and take tenders from several first-class electrical engineering firms for an installation suited to the requirements of the harbour and dock.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended July 30 were £2,752. 19s. 5d., compared with £2,376. 11s. 6d. for the corresponding period of last year, being an increase of £376. 7s. 11d.

Electric Advertising.—An immense electric sky-sign will soon be erected over the "Empire." It will be visible from a long distance. It will spell out the word every few seconds, and will be a most conspicuous object. It will cost over £300.

Dundee.—It was reported at a meeting of the Town Council that the receipts for gas and electricity for the past three months had been: gas, £6,528. 16s. 11d., an increase of £27. 2s. 4d.; and electricity, £811. 4s. 8d., an increase of £124. 16s. 3d.

City and South London Electric Railway.—The number of passengers carried by the electric railway on Monday shows an increase of about 1,500 on the corresponding period of last year. This increase was attributable to the Surrey *v.* Notts match.

Colne—The Town Council have discussed a recommendation from the Gas Committee for the adoption of the electric light, and resolved that powers should be sought during the next session of Parliament to supply electricity within the lighting district of the borough.

Battersea.—The Vestry, as presumptive electric light manufacturers for Battersea, looked glum when they received notice from Mr. Tavener, of the Falcon Hotel, that he is about to erect a building on his ground to contain dynamos for the generation of his own electric light.

W. T. Henley's Telegraph Works Company, Limited.—An interim dividend on the ordinary shares for the half-year ending June 30 has been declared at the rate of 6 per cent. per annum, and on the preference shares for the same period at the rate of 7 per cent. per annum, both payable on September 1.

Redruth.—An application from the Postmaster-General for permission to erect telegraph posts from Trewirgie House along the public road towards Carn Brea as far as the jurisdiction of the Council extends was granted. It was mentioned that the proposal is to erect a telephone trunk wire from Liverpool to Penzance.

The Marconi System.—Signor Marconi, who arrived in London last Saturday, states that he has completed negotiations with a syndicate to form a company to exploit his latest invention. He is to receive £10,000 in cash and half of the £100,000 stock of the company. It is rarely that science pays so well and so quickly.

City and South London Railway.—The returns for the week ended August 1 were £851, compared with £1,036 for the corresponding period of last year, being a decrease of £187. The total receipts for the half-year 1897 amounted to £4,517, compared with £4,524 for the corresponding period last year, being a decrease of £7.

Banks.—The Town Council's special committees recommend that the future gas testings be made with the No. 7 Sugg's steatite batswing burner, and that the offer of Messrs. Wood and Brodie to prepare plans and estimates and to assist the Council in obtaining a provisional order for an electric installation in the district be accepted.

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Montrose.—The managers of Montrose Royal Lunatic Asylum, Infirmary, and Dispensary have accepted the report of their committee recommending that the electric lighting of the new house for private patients be obtained from the machinery at the main building of the institution, the wires being conveyed in a conduit to the new house, at the cost of £1,100.

Torquay.—The Town Council require the services of thoroughly competent persons to fill the following appointments in connection with the generating station and electric lighting installation of the borough: (1) engineer-in-charge; (2) engine driver; (3) stoker; (4) cleaner and arc lamp trimmer; (5) jointer for house connections. For further particulars see advertisement.

Edinburgh.—The bursting of a water-main caused a stoppage of the electric light in Edinburgh on Monday last. A conduit was flooded, and a permanent earth on some of the feeders thus established. The fault was speedily localised, and in three hours the supply was again in working order. This speaks well for the staff, as several leading officials were away on holiday.

Peterborough.—The Town Clerk reported at the last Council meeting that he had received a notice from the Peterborough Electric Lighting Powers Company of their intention to apply for powers to supply electric light in Peterborough. From the debate which ensued, it appears that, although there exists a previous resolution adjourning the electric lighting question for 12 months, the same might be rescinded.

Hastings.—At the quarterly meeting of the Hastings Town Council a scheme for the improvement of the Old Town be carried out, and that £80,000, the estimated cost of the work, be applied for, was discussed. Reports on the arrangement with the electric light company for temporarily continuing the lighting of the Front line were received. It is proposed to ultimately purchase the plant of the company for the town.

Oswestry.—The National Telephone Company have for some time had under consideration the bringing of Oswestry into connection with their system. Having secured the necessary number of subscribers in the town, they have begun operations. Poles are being laid along the Holyhead road, the office will probably be on the Bailey Head, and it is hoped that in about a month a communication will be made with the trunk line.

Eccles.—Mr. F. Oldfield moved the adoption of the minutes of the Electric Lighting Committee, which stated that an inspector of the Local Government Board had held an enquiry into the application of the Council to borrow £11,400 for electric lighting, and the town clerk had also applied for the Board's sanction to borrow a sum sufficient to defray the expenditure already incurred in estimating electric schemes for the borough.

Rotherham.—The Town Council are asking Prof. Kennedy whether he will act as consulting engineer to the Corporation for a small installation of electric light. A notice from the Electric Supply Corporation, of Mansion House-buildings, of their intention to apply for a provisional order to supply electricity within the borough of Rotherham, will be opposed. Steps will be taken forthwith to obtain a provisional order on behalf of the Corporation.

Beanland, Perkin, and Co.—We understand that Messrs. Beanland, Perkin, and Co. have secured the exclusive right for Great Britain and the Continent for the improved "Ajax enclosed arc lamp," and are now prepared to supply the same. The makers claim that this is the only lamp in which the patent light-diffusing Holophane inner globes or bulbs can be successfully used, and that a gain of 50 per cent. in the effective light is secured, with better distribution.

Belfast.—The honour of being the first firm to print an Irish newspaper with electricity as the motive power is claimed by the enterprising firm of Messrs. W. and G. Baird, Limited, of Belfast. The motors are those of Messrs. Holmes and Co., and similar to the one working the *Graphic* exhibit at the Crystal Palace. The ceremony of switching on the first current was performed by Mr. R. H. H. Baird, J.P., in the presence of a number of friends. A note in the front of the paper will show that others claim the above honour.

Personal.—We understand that Mr. R. A. Dawbarn has been appointed superintending engineer of the Brush Electrical Engineering Company in succession to Mr. W. Geipel, whose retirement we recently announced. Mr. Dawbarn has had a wide experience of electric lighting and power schemes, and has been awarded premiums for competitive municipal projects on several occasions. We wish him success in his new responsibilities, and that his efforts may increase and establish the connections of the Brush Company.

Isle of Man.—A committee of the Manx Tynwald Court has concluded a two days' public enquiry into a proposal to construct a marine promenade, 50ft. wide, with electric tramway from Queen's Pier, Ramsey, round the front of the bay to the southern extremity at Port Lewaigue, the tramway to be part of the line running to Ramsey from Douglas, *vid* Laxey. It is expected that the sea-wall will be completed by November, and every effort will be made to complete the line between Douglas and Ramsey in time for next summer.

Halifax.—The following tenders have been accepted in connection with the Halifax Corporation's proposed electric tramways: (1) rails, Leeds Steel Company; (2) poles, J. Spencer and Co., Wednesbury; (3) mains, Callender Cable Company, London; (4) bonds, insulators, and trolley wire, Electric Construction Company, Wolverhampton; (5) generators and car equipment, Electric Construction Company: (6) accumulators, Chloride Storage Company, Limited, Clifton Junction.

Acton.—At a special meeting of the District Council, a letter was read from the managing director of Edmundson's Electric Corporation stating that that body is desirous of establishing electric supply works in those districts where the local authority is not prepared to undertake the work, and asking if the Acton Council would agree to transfer its provisional order to a local company which could be formed, and for which capital could be found through the agency of the corporation. The matter was referred to the Works Committee.

City of London Electric Lighting Company, Limited.—The returns of the City of London Electric Lighting Company, Limited, for the quarter ending June 30 show a gross revenue of £27,656, £3,155 of which is derived from the sale of current for public lighting, £23,000 from private lighting, and £1,500 from what is described as other sources. This shows an increase of £7,253 over the corresponding quarter last year, almost the whole of which is due to private accounts. The equivalent of 8-c.p. lamps connected June 24, 1896, was 215,559, as against 270,898 on June 30, 1897. Increase during last quarter, 9,962.

Brush Electrical Engineering Company.—Mr. Justice Stirling, in the Chancery Division on Saturday last, sanctioned an unopposed petition for the reduction of the capital of the Brush Electrical Engineering Company from £750,000 to £660,000. The Company had issued 90,000 preference shares of £2 each and 90,000 ordinary shares of £3 each, all being paid up or credited as paid up in full. The ground of the present reduction was that capital had been lost to the extent of £90,000 or was unrepresented by available assets, and it was proposed to effect the reduction by making the nominal value of the ordinary shares £2 instead of £3.

Dublin.—Dr. Carte, chairman of the Dublin United Tramway Company, addressing the ordinary general meeting of the shareholders last week, said the receipts of that company amounted to £17,733, and from the Dublin Districts Tramways Company £2,648, out of which the directors recommended a dividend of 4 per cent. on the ordinary shares, carrying forward £418. He mentioned that arrangements were being made to replace horse haulage over their whole system by electricity. The diminished speed on the Dalkey electrical line had resulted in a decrease of traffic, but an effort was being made in Parliament to rectify this disability. The directors' recommendation was adopted.

Aldeburgh.—The Corporation have held a special meeting, when a report was presented from the Paving and Lighting Committee recommending that steps be taken to invite tenders by public advertisement for lighting the town for the ensuing season. The Council and the gas company are at loggerheads. Communications have been made by the Council, but no replies have been received from the company, who have expressed no willingness to enter into a contract for lighting the town, and, consequently, the streets at night are in darkness. The committee's recommendation found favour with the meeting, who resolved to invite tenders for lighting the town for one, two, three, or four years.

Dudley.—At the last monthly meeting of the Tipton District Council it was reported that notices were received from the Midland Electric Corporation for Power Distribution, Limited, and the South Staffordshire Blast Furnace Power Syndicate of their intention to apply to the Board of Trade for provisional orders, to be confirmed in the next session of Parliament, to empower them to supply electricity for public and private purposes in the district of Tipton. It was recommended that a sub-committee be appointed to confer with neighbouring authorities upon the subject, and also to consult with the Council's solicitor as to the powers of the Council in the matter, and as to giving notice to oppose the application if deemed advisable.

Darlington.—The Corporation are investigating the question of electric lighting, and if the comment of the *Darlington and Stockton Times* from which we abstract below, is true, it behoves the good fathers to walk warily. The *D. and S. T.* says that the committee has for years conducted with pre eminent success an important and revenue-making branch of the Corporation's commercial concerns, and has so economically managed affairs that not only the price of gas has been lowered to consumers, but a heavy amount resulting from the profits of gas manufacture has yearly been distributed as dividend among the ratepayer proprietors in the form of reduced district rates. Its past success may prejudice it against the introduction of any other lighting agent. Quite so.

Broadstairs.—The Broadstairs and St. Peter's District Council discussed at the last meeting the subject of electric lighting, and it appeared as if the Council, as a body, were opposed to electric lighting in this district. It was stated that their object in opposing the application which was before them was to prevent the creation of any more monopolies, as such matters should be in the hands of the ratepayers, and when the time arrived for lighting by electricity in the district such powers should be in the hands of the ratepayers, and not, as in the case of gas and water, in the hands of private companies. The Vice-Chairman admitted that the Council was opposed to all this electric lighting, as they had always said when an application was before them that they were going to lay down their own plans, but if they waited for this they would have to wait until Doomsday. He was convinced it would bring the gas company entirely to book, for they charged what they liked, and the gas bill was enormous.

Parish of St. Mary, Islington.—A meeting of the Vestry will be held to-day, when a report from the Electric Lighting Committee will be received, stating that, pursuant to the Vestry's reference of June 18, 1897, it has had under consideration the question of extension of mains, and is of opinion that extensions should first be made in the roads, of which particulars are given

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in the appendix, more particularly as the probable demand for electricity will be greater in those roads (especially in those numbered 1, 2, and 3) in proportion to the capital expenditure required than in any other part of the parish, as they can be directly connected with the existing mains in the Caledonian and Upper Holloway roads (which have been recently laid, and are, therefore, not yet loaded) instead of necessitating additional feeders being laid the whole of the distance from the works; that it is also of opinion that it would be advisable to carry out the work by the existing staff, on the completion of the Caledonian-road mains, instead of engaging additional men who could only be employed temporarily; submitting the appendix for the information of the Vestry; and recommending that the work be executed as suggested.

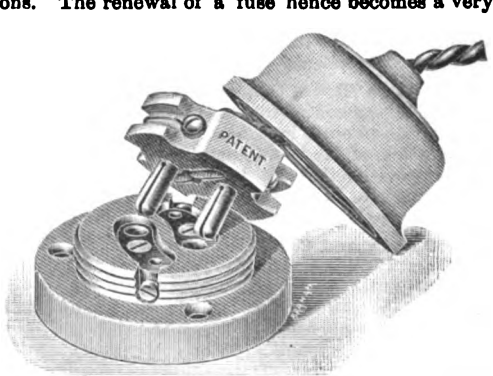
Smithfield Markets Electric Supply Company, Limited.—This Company was registered on July 16, with a capital of £100,000 in £5 shares. Object: primarily, to adopt and carry into effect an agreement bearing date July 12, 1897, and expressed to be made between R. Jewell of the one part and H. M. Manley as trustee for and on behalf of this Company of the other; generally to carry on the business of an electric light company in all its branches; and in particular to construct, lay down, establish, fix and carry out all necessary cables, wires lines, accumulators, lamps, and works, and to generate, accumulate, distribute, and supply electricity, and to light cities, towns, streets, docks, markets, theatres, buildings, and places both public and private. The signatories are: A. H. S. Browne, Gleneagle-road, Streatham, S.W.; T. Brown, 9, Oberstein-road, Clapham Junction; H. M. Manley, 16, Stafford-terrace, Kensington; P. J. Hayes, Crieve House, Ealing, W.; J. Smith, 41, Lennard-road, Penge, S.E.; D. Robinson, 14, Jessica-road, Wandsworth Common; A. Manning, Beechfield, Watford. The number of directors is to be not more than five nor less than two. The subscribers are to appoint the first. Qualification, £250. Remuneration, £900 per annum, divisible.

Bristol.—On Friday last a most regrettable accident occurred at the electric lighting station, Bristol, by which one of the employés, a man named Coleman, met with his death. The main cables from the alternators to the switchboard are india-rubber insulated, and up to the present time have been run in wood casing and capping, the side fillets of which are ⅞in. wide; all the casings run in a trench under the floor level. The work in hand was the removal of this wood casing and capping and the replacing by Doulton ware casing, the work being carried on only on cables which were not alive at the time. To allow of a particular alternator being used and to prevent the cables of that machine being disturbed over the week-end and holiday, the man, Coleman, replaced a piece of wood capping over the cables from this machine, but unfortunately it appears that he selected a piece of capping wider than the respective casing, and although he had previously been cautioned only to screw capping on through the side fillets, he made use of an old hole in the capping, some 1½in. from the edge of the same, and put the screw through the insulation of the cable. Subsequently, after the load had been put on to these cables, deceased came in contact with this screw-head, the shock from which caused his death. Artificial respiration was immediately resorted to, and kept up for about one hour, but without avail, a medical man summoned shortly after the accident being of opinion that death had been instantaneous.

Alley and Maclellan, Glasgow.—We have received from the above firm a very well got-up catalogue of their high-speed engines. The firm have adopted the Westinghouse type, and, from what we can gather from their testimonials, are paying great attention to the process of manufacture. The Westinghouse types of engines, both single and compound, are well known to most engineers, but those who do not know the principles on which these engines work cannot do better than read the description prefacing this catalogue. The firm have standardised their engines up to the 250-b.h.p. size, and claim to have now some 12,000 h.p. running. In designing these engines, the special points the makers claim to have kept in view are: to render the engine by its extreme simplicity and the peculiarities of its design as to the adjustments, keying-up, packing, oiling, etc., independent of the careless attendance of an unskilled engineer; to reduce the requirement of repairs to a minimum by making the good performance of the engine independent of wear; to make the repairs when required at the lowest possible expense of time and money by strict interchangeability of parts; to secure high speed, which modern practice and experience has shown to be desirable in a degree for all purposes of power, and absolutely essential in many cases, as in electric lighting, blowing, etc.; to retain with the above advantages a proper grade of fuel economy; to place a strictly first-class high-speed automatic engine on the market at a moderate price by systematic manufacture on a large scale.

Bermondsey.—The committee charged with the consideration of a proposal to introduce electric lighting into the parish have presented a long report extending over 13½ pages, which recommended the continuous-current system, at a pressure in all of about 450 volts, as the system best adapted to Bermondsey. The current could be distributed very efficiently and economically throughout the whole of the parish through a three-wire network, enabling the Vestry to give their consumers a supply at a pressure of about 225 volts. The site recommended was a portion of the Vestry depôt. It was suggested that Jamaica-road, Dockhead, and Bermondsey New-road, should be lighted by 18 arc lamps of 1,200 c.p., with two further lamps outside the town hall in Spa-road. These could burn till midnight, and then each be replaced by two lamps of 32 c.p. until the lighting is extinguished at dawn. With respect to the plant, a shaft 100ft. high, and a boiler-house and engine-house, and the necessary offices will be required at an estimated cost of £3,000, a generating plant costing £6,550, battery of accumulators £550, feeder mains and distributing network with meters and house connection boards £3,535, cost of public lighting £600 (20 arc lamps as stated), contingencies, etc., raising the total estimate to £15,635. The revenue is estimated at £2,902, comprising £2,625 for 5,250 lamps of 8 c.p. at 6d. per unit, 20 public lamps at 2d. per unit £194 (burning till midnight), and 40 public incandescent lamps burning after midnight £83. The maintenance is estimated at £1,669 per annum, and the cost of public lighting for the area indicated £400 per annum. The estimated surplus, after meeting all charges, is £588. As the station is extended, so, it was stated, will the gross profits increase out of proportion to the increase of capital, and the net surplus represent a much greater percentage. The statement is submitted that the public electric lighting will certainly cost more than the present gas system, but for such extra expenditure the streets will be lighted until midnight with at least 16 times as much light as at present, and from midnight until sunrise as well as at present, whilst the additional and excellent lighting of the streets will be the best advertisement possible for the undertaking. The installation would inevitably result in a commercial profit to the ratepayers. With respect to the proposal to establish a dust incinerator, the report (which as to details was prepared by Messrs. Kincaid, Waller, and Manville) states that the refuse could not be disposed of more economically than at present. Under these circumstances it was hardly likely the Vestry would be prepared to abandon the present system of barging the house refuse. The committee, in conclusion, recommended the Vestry to apply to the Board of Trade for a provisional order authorising the Vestry to supply electricity for public and private purposes within the parish, and that a special meeting be held on September 21 next to pass the necessary resolution as required by the Electric Lighting Act, 1882.

A. P. Lundberg.—We have received from the above firm a sample of a new type of detachable ceiling rose designed for high voltages which possesses several novel features. The detachable part is made to contain a double-pole fuse, the fuse wire lying round the grooves in the edge of the porcelain disc. This gives a good length of fuse (⅝in.) in such a position that in "blowing" no harm whatever can be done, as the fuses are enclosed by the outer cover when in place. All the brass parts are properly protected, so that short-circuit or leakage of current is prevented. The detachable portion is of novel construction, contact being made by two springy brass pins in a similar way to that adopted in wall connections. The renewal of a fuse hence becomes a very simple



operation, as it can be conveniently done right away from the fixed part of the ceiling rose (anyone who is in the habit of renewing fuses in ceiling roses when at the top of a ladder will appreciate this). The ceiling rose will be found useful when the wiring of a building is in progress, as the base part only need be fixed in position and connected, the cover and detachable portion being added afterwards. When redecoration of a room becomes necessary, the cover, detachable portion, flexible, etc., can be detached and removed right out of the way of workmen. The whole apparatus is of small size (only 2½in. diameter), and provision is made for taking strain off terminals.

Electric Traction at Liverpool.—The Traction Committee at Liverpool have, as announced previously by us, consulted several experts on the above subject, and we are glad to note that business is likely to result. Where so important a problem has to be solved, as to the system of traction to be applied in Liverpool, involving an early outlay exceeding one million sterling, it is satisfactory to find an unanimity of opinion that electricity has, without question, shown itself to be the best form of motive power yet devised for tramway purposes, and that as regards cost and efficiency it has proved itself economical and reliable. The overhead wire and trolley system is advised by the committee and the experts as being the cheapest and most satisfactory mode of transmitting the electricity to the cars. Mr. Pearson, of New York, has favoured the committee with estimates in some detail of the relative cost of reconstructing and equipping the tramways at present existing in Liverpool, and he places the cost for the overhead trolley system at £911,000, and for the conduit system at £1,285,000. The efficiency of either arrangement is equal, and it is quite practicable and attended with no disadvantage to lay one portion of the line on the one system and the remainder with the other. There is also in the reports a general concurrence of opinion that the advantages of quicker locomotion attainable by the use of mechanical traction would be reduced to a minimum if the present system of conveying outside passengers were to be continued. The time occupied by each

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passenger in getting to and from his seat would be so much time lost, as it would not be prudent to allow this movement whilst the car was in motion. Under these circumstances the committee are of opinion that before embarking upon any large expenditure, or coming to a final conclusion as to the mode of applying electricity, or the character of the rolling-stock to be employed, it is desirable that an experiment should forthwith be made with one part of the Liverpool system. By this means the public would have an opportunity of forming an opinion as to the advantages or otherwise of the system. The effect of overhead wires could also be better appreciated, and, at the same time, a means be afforded for instructing a staff for the management of mechanically-propelled cars. For this purpose the committee asks authority from the Council to enter into arrangements for laying and equipping a system of electric traction from St. George's Church to the Dingle and Prince's Park (*viâ* Park-lane) with the overhead trolley. The committee select this route as it will not interfere with the working of any of the other lines in the city, which must for the present be continued by horse traction, as the committee are advised that no fair experiment of mechanical power can be conducted on lines which are at the same time partly used by horse traction. The probable cost of equipping this section, and the necessary relaying of the rails, would not exceed £50,000, of which £25,000 would be expended on the track. This would be available for any system of locomotion that may hereafter be adopted. As the laying and equipping of tramways and the organisation of a new service with mechanical power are matters of a very special engineering and practical character, the committee are of opinion that it would be desirable to engage the services of an engineer specially for the purpose, and they consider Mr. Pearson would, from his knowledge and status, be well qualified to undertake such a duty. They ask, therefore, to be allowed to negotiate with him for this purpose.

Science Research Scholarships.—Her Majesty's Commissioners for the Exhibition of 1851 have made the following appointments to Science Research Scholarships for the year 1897, on the recommendation of the authorities of the respective universities and colleges. The scholarships are of the value of £150 a year, and are ordinarily tenable for two years (subject to a satisfactory report at the end of the first year) in any university at home or abroad, or in some other institution approved of by the Commissioners. The scholars are to devote themselves exclusively to study and research in some branch of science, the extension of which is important to the industries of the country. A limited number of the scholarships are renewed for a third year where it appears that the renewal is likely to result directly in work of scientific importance. The following are the scholars nominated by the different institutions preceding their names: University of Edinburgh, Longfield Smith, B.Sc.; University of Glasgow, James Muir, B.Sc.; University of St. Andrews, Harry M'Donald Kyle, M.A., B.Sc.; University College, Dundee, Sydney A. Kay, B.Sc.; Mason College, Birmingham, Gilbert Arden Shakespeare, B.A., B.Sc.; University College, Bristol, Charles Henry Graham Sprankling, B.Sc.; Yorkshire College, Leeds, Harold Albert Wilson, B Sc.; University College, Liverpool, William Augustus Caspari, B.Sc.; University College, London, Percy Williams, B.Sc.; Owens College, Manchester, John Henry Grindley, B.Sc.; Durham College of Science, Newcastle-on-Tyne, Robert Railton Hallaway, B.Sc.; University College, Nottingham, Richard S. Willows (conditional appointment); Firth College, Sheffield, Ernest Clark; University College of South Wales, Cardiff, Maria Dawson, B.Sc.; Queen's College, Belfast, William Alexander Osborne, M.B.; M'Gill University, Montreal, James Lester Willis Gill, B. App.Sc.; Queen's University, Kingston, Ontario, Frederick John Pope, M A.; University of Sydney, Tom Percival Strickland, B.E.; University of Melbourne, Walter Rosenhain, B.C.E. The following scholarships granted in 1896 have been continued for a second year on receipt of a satisfactory report of work done during the first year, the places of study being given after the names of the holders: University of Glasgow, William Craig Henderson, M.A., B.Sc., Cavendish Laboratory, Cambridge; University of Aberdeen, Alexander Ogg, M.A., B.Sc., University of Göttingen; Mason College, Birmingham, Thomas Slater Price, B.Sc., University of Leizig; University College, Bristol, Emily Comber Fortey, B.Sc., University College, Bristol, and Owens College; Yorkshire College, Leeds, Harry Medforth Dawson, B.Sc., University of Berlin; University College, London, Joseph Ernest Petavel, University College, London, and Davy-Faraday Laboratory; Owens College, Manchester, John Leathart Heinke, B.Sc., Owens College, and University of Tübingen; Durham College of Science, Newcastle-upon-Tyne, John Armstrong Smythe, B.Sc., University of Göttingen; University College, Nottingham, George Blackford Bryan, B.Sc., Cavendish Laboratory, Cambridge; University College of Wales, Aberystwith, Spencer William Richardson, B.Sc., Cavendish Laboratory, Cambridge; Queen's College, Galway, John Henry, M A., B.E., Cavendish Laboratory, Cambridge; University of Toronto, Arthur Melville Scott, B.A., University of Göttingen; Dalhousie University, Halifax, Nova Scotia, Douglas M'Intosh, B.Sc., Cornell University; University of New Zealand, John Angus Erskine, M.A., University of Berlin. The following scholarships granted in 1895 have been exceptionally renewed for a third year: University of Glasgow, Walter Stewart, M.A. B.Sc., Universities of Glasgow and Berlin; M'Gill University, Montreal, Robert Owen King, B Sc., M'Gill University and Harvard University; University of New Zealand, Ernest Rutherford, M.A., Cavendish Laboratory, Cambridge. The Scholarships Committee consisted of Sir Henry Roscoe (chairman), Lord Rayleigh, Lord Kelvin, Lord Playfair, the late Mr. Mundella, Dr. William Garnett, and Sir J. Norman Lockyer. We are indebted to the *Times* for the above.

Rochdale.—The *Rochdale Observer* has the following editorial note on the combination of refuse destructor with electric lighting plant: "One of the most remarkable of recent developments in municipal enterprise is the use of household refuse as fuel in the generation of electricity. Public attention has been directed to the matter during the past few weeks by the big scheme inaugurated at Shoreditch, where the Vestry are using the contents of the ashbins for the production of electricity, not only for lighting and heating the municipal offices, but for general motive power and for street and private illumination as well. Time will prove whether Shoreditch is not expecting too much from its dust and ashes, but however this be, it is certain that nearly all other towns are getting far too little. It is still thought by most people that to get rid of the refuse is the best that can be done. Tips being tabooed, destructors are coming into general use, and the question at once arises whether, instead of burning refuse to waste, the heat cannot be advantageously used in the making of steam for various purposes. Rochdale was one of the first towns to attempt the solution of the problem. Mr. F. W. Brookman, the manager of the sanitary works, has studied this question for years, and four or five years ago he persuaded the Health Committee to abandon gas for the electric light in the illumination of the works, assuring them that the steam for generating the electricity could be raised by burning ashbin refuse. The experiment was completely successful, and the Health Committee were so satisfied with it that they have suggested over and over again that the surplus power at the sanitary works might be used in producing electricity for lighting the town hall and other municipal buildings. The hints thrown out have not been acted upon, and now the Gas Committee are engaged on a scheme for a public supply of electricity to all within a certain radius who may demand it. The report of the consulting engineer has not yet been received, but it will be ready within a few weeks, and a good many people will be interested to know whether he recommends the utilisation of the power now wasted at the sanitary works. At the present time no coal is used as fuel at the sanitary works. A portion of the refuse when burned generates all the steam required in the manufacture of manure, as well as providing the heat necessary to drive off the moisture from the excreta in the drying machines; and, as we have shown, electricity is also produced. The whole of the premises, including the new buildings, are lighted by it, and in the committee-room electric radiators are used for heating purposes. At Shoreditch a certain amount of coal is used with the refuse to make it good fuel, but this not found at all necessary in Rochdale, and the only coke consumed is used for the special purpose of minimising the offensiveness of the odour from the excreta furnace. The refuse is tipped in front of the boilers, and is shovelled in unscreened. There is absolutely no waste, for the clinker which remains in the furnace after combustion is removed and crushed, and then forms an ingredient of mortar, for which there is a brisk demand on the part of local builders. At present two mortar mills are kept at work. As the members of the Health Committee have repeatedly stated in the Town Council, there is a great deal of surplus power which might be used in the production of electricity. No one proposes, as we understand it, that Rochdale should attempt which Shoreditch is undertaking—to rely upon refuse (with a little coal added) as the only fuel to be used—but some means will probably be found for utilising the power at the sanitary works in connection with the scheme to be adopted by the Gas Committee. There is another consideration. It is highly probable that electric traction will be adopted for the tramways in the course of a few years. For a time, at any rate, more power would be needed for that purpose than for illumination. This is doubtless being borne in mind by those members of the Gas Committee specially charged with the preparation of the electric lighting scheme. We may add that with the exception of Southampton, which started about the same time, Rochdale was the first town in England to use household refuse as a substitute for ordinary fuel in the production of electricity."

PROVISIONAL PATENTS, 1897.

JULY 26.

17531. **Improvements in the regulating devices of horizontal shunt arc lamps.** Jasper Wetter, 37, Essex-street, Strand, London. (Elektrizitats-Actiengesellschaft vormals Schuckert und Co, Germany.) (Complete specification.)

17523. **An improvement in or relating to coin-freed electrical meters.** Frederick John Beaumont, 166, Fleet-street, London.

17527. **Improvement in electrical gas-lighting devices.** Hermann Ahrendt, 6, Lord-street, Liverpool.

17528. **Improvements in spring jacks for telephone switchboards.** John Edward Kingsbury, 24, Southampton-buildings, Chancery-lane, London. (The Western Electric Company, United States)

17540. **Improvements relating to electric light fittings.** Henry Lea, 18, Southampton-buildings, Chancery-lane, London.

17545. **An improved electric circuit closing device.** Carl Adolph Hollstein, 18, Southampton-buildings, Chancery-lane, London.

JULY 27.

17575. **Electric fountains for decorative and the like purposes.** William Brew, 4, Alexandra-place, Selhurst, Surrey.

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17579. Improvements in secondary batteries. Alfred William Southey, 16, Elm-street, Gray's-inn-road, London.

17583. Electric condenser. Charles Schenck Bradley, 111, Hatton-garden, London. (Complete specification.)

17585. Improvements in and connected with lighting by means of electricity. Oliver Prescott Macfarlane, 45, Southampton-buildings Chancery-lane, London. (Richard Joseph Crowley, France.)

17596. Improvements in trolleys or sliding contacts for electric cars. William Lloyd Wise, 46, Lincoln's-inn-fields, London. (Alvaro Silas Krotz, William Preston Allen, and Oliver Smith Kelly, United States.) (Complete specification.)

17597. Improvements in electric railways. William Lloyd Wise, 46, Lincoln's-inn-fields, London. (Alvaro Silas Krotz, William Preston Allen, and Oliver Smith Kelly, United States.) (Complete specification.)

17601. Improvements in apparatus for transmitting electric impulses. Herbert Godsall, 4, Temple-gardens, London.

17606. Improvements in means for rectifying alternating electric current. The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. (Elihu Thomson, United States.) (Complete specification.)

17630. Improvements in the working of tramways and railways by overhead electrical conductors. William Edward Kenway, 7, Staple-inn, London.

JULY 28.

17676. Improvements in electricity meters. Walter Emmott, Penny Bank-chambers, Halifax.

17683. Improved means and apparatus for electrolytically decomposing salts of the alkaline and earthy metals for the manufacture of caustic bleaching powder, chlorine and other products contained in them. Frederic Hungerford Bowman and Frederic Edmund Bowman, 17, St. Ann's-square, Manchester.

17691. Improvements in electrical conduits. Henry Lewis Doulton and Charles Edward Morris, Lambeth Pottery, Lambeth, London. (Complete specification.)

17694. Improvements in and connected with electric lamps for cycles and other vehicles and a device for attaching and adjusting same. James Moores and Henry Oliver Farrell, 15, Hanging-ditch, Manchester.

17695. Improvements in and connected with armature cores of permanent magnet dynamo-electric machines. James Moores and Henry Oliver Farrell, 15, Hanging-ditch, Manchester.

17733. Improvements in or relating to electric lighting. Theophilus Davies Farrall, 322, High Holborn, London.

JULY 29.

17764. Improvements in and relating to electric light signalling on railways. John Orr and James Archibald Donachie, 96, Buchanan-street, Glasgow.

17792. Improvements in rail bonds for electric tramways. Alfred Whalley, Ashville, Helsby, near Warrington.

17812. Improvements in electric railway systems. John McLeod Murphy, 111, Hatton-garden, London. (Complete specification.)

17820. Improvements in the manufacture of electric cables and in apparatus therefor. Willoughby Statham Smith, 24, Southampton-buildings, Chancery-lane, London.

17824. Improvements in electric alarms for cars. Alexander Nathan, 40, Chancery-lane, London. (Complete specification.)

17826. Improvements in electric lanterns. Oscar Charles Prasse, 40, Chancery-lane, London. (Complete specification.)

17837. Improvements in apparatus for the electro-deposition of metals. James Holloway, 24, Southampton-buildings, Chancery-lane, London.

JULY 30.

17924. An improvement in field magnets for electric generators and motors. Charles Tuson, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

JULY 31.

17970. A method of propelling boats or barges by means of electricity. John Richardson Wigham, 33, Capel-street, Dublin.

17998. Improved means for exhausting incandescent electric lamps, vacuum tubes, and the like. Robert Burn, 24, Southampton-buildings, Chancery-lane, London.

18029. An improved process for the manufacture of electrode plates for storage batteries. Carl Marschner, 45, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1896.

7222. Apparatus for manufacturing tubes by electrolytic deposit. Elmore. (Elmore.)

12939. Transmitting electrical impulses and signals and apparatus therefor. Marconi.

14872. System of automatic telephone exchange. Berditschewsky-Apostoloff.

12696. Electrical accumulators. Roux.

14996. Automatic or thermostatic fire-alarm telegraph systems. Heys. (Frost.)

15223. Electric battery. Kirkpatrick-Pickard.

15495. Portable incandescent electric lamps. Morison.

15768. Electromagnetic brake for vehicles. Lake. (Union Elektricitäts-Gesellschaft.)

15837. Electric apparatus for striking a bell, bells, or the like, or producing other effects by means of and at a distance from a clock. Dale.

17608. Means or apparatus for effecting the electro-deposition of zinc or other metals upon tubes or other circular or analogous objects. The Cowper-Coles Galvanising Syndicate, Limited, and Cowper-Coles.

17666. Automatic maximum speed governors for electrically-propelled vehicles. Parshall.

18312. Induction telegraphy. Evershed.

19021. Incandescent electric lamp. Renous and Bronislawski.

19308. Utilising the residual products obtained in the working of certain kinds of voltaic batteries. Walker, Wilkins, Lones, and Lones.

19650. Electric insulators. Blankinsop and Brown.

20217. Electrical switches. Tucker.

21380. Apparatus for supplying electricity to electrically-propelled railway and tramway vehicles. Wise. (Diatto.)

29827. Electric photographic time and position recorder specially useful for races. Gaut.

1897.

1827. Electric motorcars. Heys. (Heilmann.)

12910. Telephone receiver supports. Duque and Cosgrove.

13099. Silvered glass reflectors for incandescent electric lamps and the method of manufacturing such reflectors. Edwards. (Munzel.)

13523. Starting switch with automatic cut-out for electric motors. Cutler.

13524. Starting switch with automatic cut-out for electric motors. Mower. (Cutler.)

13975. Electrical bond or connection for railway and like rails. The British Thomson-Houston Company, Limited. (Potter.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	9¼-9¾
Brush Company, Ordinary	2	1⅝-1¾
—— Non. Cum., 6 per cent. Pref.	2	1⅝-1¾
—— 4½ per cent. Debenture Stock	100	105-109
—— 4½ per cent. 2nd Debenture Stock	100	93-97
Callender's Cable Company, Debentures	100	108-113
—— Ordinary	5	6½-7½
Central London Railway, Ordinary	10	9¾-10¼
——	6	5¾-6¼
Charing Cross and Strand	5	12¼-13¼
Chelsea Electricity Company	5	9¾-10¼
—— 4½ per cent. Debentures	100	110-113
City of London, Ordinary	10	23½-24½
—— 6 per cent. Cumulative Pref.	10	16½-17½
—— 5 per cent. Debenture Stock	100	130-135
City and South London Railway, Consolidated Ordinary	100	64-66
—— 4 per cent. Debenture Stock	100	139-141
—— 5 per cent. Pref. Shares	10	15½-16
County of London and Brush Provincial Co., Ordinary	10	12¾-13¼
—— 6 per cent. Cum. Pref.	10	15-15⅝
—— 4½ per cent. 2nd Debenture Stock	10	15-15⅝
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1⅝-1¾
—— 5 per cent. Debentures	—	89 94
Edison and Swan United Ordinary	5	2½-2¾
—— 5 per cent. Debentures	5	4¼-4¾
Electric Construction, Limited	2	1¾-2 xd
—— 7 per cent. Cumulative Pref.	2	2⅜-2½ xd
Elmore's Copper Depositing	1	¾-1
Elmore's Wire Company	2	⅜-½
W. T. Henley's Telegraph Works, Ordinary	10	18¾-19¼
—— 7 per cent. Preference	10	18¾-19¼
—— 4½ per cent. Debentures	100	108-113
House-to-House Company, Ordinary	5	8½-9
—— 7 per cent. Preference	5	10¼-10¾
India Rubber and Gutta Percha Works	10	20¾-21½
—— 4½ per cent. Debentures	100	105-108
Kensington and Knightsbridge Ordinary	5	13-13½
—— 6 per cent. Pref.	5	8-8½
London Electric Supply	5	1⅝-2
Metropolitan Electric Supply	10	16¾-17½
—— 4½ per cent. First Mortgage Debenture Stock	100	118-122
National Telephone, Ordinary	5	6½-6¾
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	15-17
—— 5 per cent. Non. Cum. Third Pref.	5	6-6½
—— 3½ per cent. Deb. Stock	100	105-110
Notting Hill Company	10	15-16
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8¼-8½
—— £4½ shares	4½	7¼-7½
Oriental Telephone and Electric Company	1	⅜-½
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	102-104
St. James's and Pall Mall, Ordinary	5	16½-17½ xd
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	36-39
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	8	10¾-11¼
Westminster Electric Supply, Ordinary	5	14½-15½ xd
Yorkshire House-to-House	5	8-8¼

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NOTES.

Brussels.—A German-Belgian syndicate has been formed for the object of laying a submarine cable to South-East Africa and the Transvaal.

Institution of Electrical Engineers.—From the new list of members of the above Institution we gather that at the end of June the total membership was as follows: honorary member, 1; foreign members, 176; members, 618; associates, 1,721; and students, 237. This gives a total membership of 2,753.

The Institution of Mechanical Engineers.—We much regret that in our last issue we published a part of Mr. P. Dawson's paper on "Mechanical Features of Electric Traction." This paper was not read at the Birmingham meeting of the institution, and hence our publication was premature and will not be continued.

Accumulator Cars.—We understand that Mr. Desmond FitzGerald has discovered a law that the maximum useful effect is produced when the weight of accumulators in the cars is equal to the aggregate weight of all the other bodies to be conveyed—*i.e.*, to that of the vehicle, motors, passengers, and luggage. According to this law—a demonstration of which will be given in our next issue—the weight of accumulators in an autocar should practically be neither greater nor less than half the average total weight of the vehicle.

A Faulty Electric Bell.—We understand that the Chicago National University, which is in the habit of conferring degrees on gentlemen of approved status for the modest sum of 5dol., has its offices at 151, Throop-street. A large sign is placed across the front, bearing the words "Chicago Business University," while another sign near the top reads "Electrical College." It was found, however, that repeated rings at the door-bell failed to elicit any response. Such want of attention in a business university is unpardonable, and the most charitable excuse is that the electrical students had been experimenting with the bells.

Village-Lighting.—We gather from *Cosmos* that the little village of Monceau-sur-Oise can set an example to many large towns in matters of lighting. This village has a population of only 250 inhabitants, and yet all the streets and houses take the electric supply. A charge—12s. per annum per lamp—is made independent of the number of hours the lamp is used. Hence of an evening every lamp is in use, and, from our contemporary's glowing description, we gather that the village is a blaze of light. The source of power is a waterfall having a head of about 7ft., and capable of developing about 150 h.p. The supply was organised by a local engineer.

The Institution Journal.—We have received part 130 (twenty-sixth volume) of the *Journal* of the Institution of Electrical Engineers, edited by Mr. F. H. Webb. This number contains the discussion on Mr. Raworth's paper; "The Generation of Electrical Energy for Tramways"; paper by Mr. A. P. Trotter on "Disturbances of Submarine Cable Working by Electric Tramways," with discussion; and also Mr. W. M. Mordey's much-discussed paper on "Dynamoes." It has just struck us that the title of this last paper is not the only one in the list open to question. A comma in the title of Mr. Trotter's paper would remove any misapprehension as to the capacity of a tramway to work a submarine cable.

Trolley Parties.—The Liverpool people are counting up the joys of the electric cars beforehand, so that they may start the new venture with a good load curve. So the *Liverpool Courier* expatiates on the enjoyment of the American institution, "the trolley party." From the beautiful description of this function, we gather that the "four-horse char-a-banc" will have a poor chance of lasting many more years in Liverpool. We are told that another peculiarity of the American street cars is that ladies are not allowed to stand in them. When a lady enters a crowded car a seat is promptly vacated for her convenience. No doubt this is sometimes done even in England, but rarely in the same way, with the result that while here it is recognised as courtesy and thankfully acknowledged, there it is taken as a right for which no thanks are necessary.

Electric Brakes.—The electric tramways in Dresden are equipped with about 200 of the Siemens and Halske electric brakes, and it is said that they have given excellent results during the past 12 months. These brakes act upon the car axle, which is not driven by the electric motor. They are fixed both upon the motorcar and upon each of the trailers, and act simultaneously. It is claimed that these brakes act in about one-third of the time of the hand-brakes. Trials with both show that the electric brake stopped a car going at the rate of 15 miles per hour within 14 yards, while a car with a hand-brake going at 12 miles per hour travelled 35 yards after the brake was applied. The same electric brakes are used for the line Behrenstrasse-Treptow, at Berlin. In this case the brake acts upon the motor direct, and there is no brake upon the trailing carriages. When going at the usual speed these cars are stopped within eight yards.

Searchlights for Military Purposes.—A gentleman, writing to the *Telegraph* under the initials "P. V.," considers that the recent attack on the British camp on the Malakand has once more emphasised the necessity for such isolated military posts being furnished with an electric searchlight. Had there been a searchlight available on this occasion, its use might, perhaps, have averted an attack. It would certainly have minimised our casualties, and enabled the defenders of the position to give a better account of the enemy. He then rightly refers to the need for a readily portable search-lighting plant: It would be of great advantage if a portable searchlight were devised that could be carried by pack animals and accompany a force advancing into an enemy's country, to be used for protecting camps; but while there are no difficulties connected with a searchlight for a permanent stationary position, there are difficulties—perhaps not insuperable—in connection with one that is intended to be moved about over broken ground.

The Light Railways Act.—The improved facilities offered by the Light Railways Act is now being exemplified. The cost of the local enquiries is naturally much less than the previous procedure, with a parliamentary enquiry and a regular complement of counsel and parliamentary agents. Without wishing to disparage the value of these gentlemen's services, or to gloat over their loss of practice, we must express our gratification at the time saved under the Light Railways Act. We understand that the first of the provisional orders under this Act is now before the Railway Department of the Board of Trade for confirmation. At the local enquiry the Commissioners sat from 1 p.m. to 2 p.m., then adjourned till 3 p.m. for lunch. Recommencing their sitting at 3 p.m., they all managed to catch the 3 30 train back to town. When it is known that powers were sought to construct the same line the previous year under the old procedure, and that after weeks of parliamentary enquiry the Bill was rejected, the cause of our jubilation will be understood.

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The Proposed Pacific Cable.—A cablegram from British Columbia states that one of the survey vessels of the British navy will arrive there shortly to help in the survey for the proposed Pacific cable, and will make a survey from there to Hawaii. Honolulu advices state that H.M.S. "Penguin" has completed the survey from Australia to Hawaii. The Admiralty is about to survey Clayoquil Sound and issue a chart of that harbour, in order to decide upon the landing-place of the cable. The Right Hon. Mr. C. H. Reid, the Premier of New South Wales, has stated, in a recent interview, that the delay in settling the details of this cable was due to Canada. As yet that country has made no definite proposal as to what she was ready to do. New South Wales, Queensland, and New Zealand were ready, and Victoria would probably come in; but until Canada had made a definite proposal, Great Britain would not act in the matter. He thinks that unless Canada acts promptly the scheme will drop, and an alternative scheme *viâ* Cape Colony would be adopted.

Technical Education at Brighton.—The Corporation have adopted the report of the meeting of the Technical Instruction Committee held on July 26, at which it was resolved that the Municipal School of Science and Technology be opened for all classes hitherto carried on by the Council at York-place School on September 20 next. Nearly all subjects of the Science and Art Department's syllabus will be taught, in addition to the following subjects: pattern-making, carpentry and joinery, brickwork and masonry, builders' quantities, plumbing, sanitary work, mechanical engineering, electric wiring and fitting, electric lighting and power, typography, French, German, Latin, shorthand, typewriting, book-keeping, commercial arithmetic, and surveying. Mr. J. H. Judd has been appointed to be head of the Mechanical Engineering Department, Dr. Clutterbuck to be head of the Chemistry Department, and Mr. Edmonds to be head of the Natural Sciences Department.

New Publications.—Messrs. Oldenbourg, of Munich, will publish next autumn a work called "Elektromechanische Konstruktionen," by Mr. Gisbert Kapp. The work contains 25 sheets of working drawings, representing continuous, alternating, and multiphase current dynamos, transformers, and motors. The text contains a complete collection of formulas and rules for designing, with typical calculations. The same firm announces the second edition of C. Hochenegg's exhaustive work on "Conductors of Electric Lines." Mr. Hochenegg is the chief engineer of Siemens and Halske, and his practical experience renders his observations of particular value.—Prof. E. Arnold, director of the Electrotechnical Institute at Karlsruhe, is now issuing the first part of a work interesting to students especially. It contains 55 tables and drawings referring to the construction of continuous-current dynamos. All figures are drawn to the same scale, and details referring to output, number of turns, winding, etc., are added, so that the work will be useful to the practical electrical engineer as well as to the student for whom it is intended.

Platinum.—The Russian Ministry of Finance has recently issued a report on the production of platinum in Russia, which is abstracted in the Chambers of Commerce *Journal*. It seems that that country stands first in the world for this production, 40 times the quantity produced by all other countries together being obtained there. In the year 1880 the quantity produced amounted to 6,481lb.; in 1895 it reached 9,708lb. The production went on increasing up to the last year, when it diminished on account of the wet weather in summer. This rare metal is found exclusively in the Southern Ural. The manner of working up the metal is unknown in Russia; this is done in Germany, to which country the platinum is exported in a crude state. Whatever Russia requires of worked-up platinum, it has to buy back from Germany. Of late years the price of this article has run very high; at present it is about £20 per pound of crude platinum in Russia. On mining for the platinum the still rarer metal iridium is also found, but only in very small quantities. Last year the total quantity of iridium obtained did not amount to more than 8½lb., and this was only slightly exceeded in 1894.

The Society of Arts Journal.—The current number of the above *Journal* continues the report of the Technical Education Congress. The subjects are hardly of special interest to our readers, but the following titles of the papers will remind them where to look for the general information. They were as follows: "L'Enseignement des Langues Vivantes," by L. Suttle, M.A.; "Provision of Higher Commercial Education in London," by Sidney Webb, LL.B., L.C.C.; "Present State, Claims, and Prospects of Commercial Education," by Edward E. Whitfield, M.A.; "A Plea for the More Scientific and Systematic Teaching of Book-keeping," by Stanley Latham; "Teaching of Domestic Economy in Girls' Secondary Schools," by Miss Mitchell; "Technical Education in Rural Districts," by the Countess of Warwick; "Technical Education in Secondary Schools," by Miss Fanny L. Calder; "History of Training Schools for Teachers of Domestic Economy in England," by Miss Pycroft; "Treatment of Domestic Science as an Element in Girls' Education," by Miss L. Edna Walter, B.Sc.; "Relation Between General and Technical Education," by Miss E. P. Hughes; "Technical Education in India, its Conditions and Prospects," by J. A. Baines, C.S I.

The Lighting of Trains in Victoria.—The Standing Committee on Railways, after giving consideration to the question as to the advisability of the adoption of an improved system of lighting for railway carriages, has forwarded its report to the Minister of Railways. During the discussion Mr. Melville, M.L.C., suggested that as the electric system of lighting trains is now declared by competent authorities to be the safest, cleanest, and most economical that can be applied to the Victorian railways, it would be unwise, at present, to proceed with the "Pintsch" system, as it is more costly than the electric light, and is, moreover, dangerous in case of overturning of trains. The "Pintsch" system, he said, had the further disadvantage that all the necessary plant has to be manufactured outside the colony. The following resolution was carried: "That an improved light in our railway carriages is essential, but the committee are of opinion that, before recommending any new illuminant, fuller tests and information are necessary, both in regard to the cost and safety of the various systems; and further, that should Pintsch gas be ultimately found the cheapest and best system, the cost of plant and appliances will probably be materially reduced after the expiry of the patent rights in 1899."

The American Trolley Patents.—The Circuit Court of Appeals for the Second Circuit of New York handed down a decision on Wednesday, July 21, in the case of Thomson-Houston Electric Company *v.* Hoosick Railway Company, a case involving the famous Van Depoele trolley patent. In this decision, which was written by Judge Wallace, all of the judges concurring, the Court holds that this Van Depoele trolley patent is invalid by reason of the same invention having been described and disclosed in an earlier patent to Van Depoele. This decision invalidates this patent, which is controlled by the trust made up of the General Electric Company and the Westinghouse Company. This patent has been used by its owners as granting them a monopoly for the use of any trolley,

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because it was claimed to cover broadly the idea of the under-contact trolley on an overhead wire. The Walker Company were the suppliers of the apparatus used at Hoosick, and they practically fought the action. The above decision will hence allow the electrical firms outside of the General Electric and the Thomson-Houston Companies to manufacture their own trolleys, and hence to supply complete electrical railway equipment. It seems that the other Courts of Appeal in the States will have to confirm the above decision before it becomes general. The fact of an inventor by his early patents spoiling his others of a later date is distinctly novel.

Electrical Production of Nitric Acid.—Some conclusions by F. von Lepel on the apparatus for obtaining the best results when oxidising nitrogen by means of electric sparks or the electric arc are abstracted as follows in the current number of the *Chemical Journal*: "The best yield of nitric acid is obtained when the electrodes are placed in the lower expanded extremity of a perpendicular glass tube of two to three litres capacity. The lower cathode is in the form of a flat plate, whilst the upper anode is pointed. A moderately rapid stream of air is kept passing through the apparatus, and a fine liquid spray is forced in from above; this dissolves the nitric acid as it is formed, and the acid solution can be drawn off below. A solution containing 0·56 per cent. of nitric acid was obtained with a cylindrical vessel of 1·75 litres capacity, whilst with a spherical vessel of one litre capacity the amount of acid was only 0·31 per cent. The yield of acid increases more rapidly with an increase in the strength of the current than with an increase in the length of the sparks; if the air is not kept in motion, the nitric peroxide is destroyed almost as quickly as formed. The amount of air present, the nature of the electrodes, and also the nature of the liquid spray, greatly affect the yield of acid. Liquids which can act as oxygen carriers—for example, magnesium sulphate or calcium permanganate—increase the yield of acid; ozonised air and Röntgen rays, however, appear to decrease the yield.

Cheap Lightning Conductors.—Baurath Findeisen, of Stuttgart, in a lengthy and interesting paper read before the Electrotechnic Verein of that city, dwells upon the fact that the damage resulting from lightning in the cities is unimportant compared with that in the country districts. Out of 2,000 cases considered within the last 25 years, he estimates the damage done to town houses at £4. 10s. per case, which sum is repaid by the insurance company. The farmer is often uninsured and unsecured, while his house, exposed to frequent rains, offers a good path to a discharge. His buildings are also filled up to the roof with grain, hay, and other highly inflammable material. The destruction of property and harvest produce in Germany caused by lightning is stated at £400,000 per annum, and the professor considers that this sum could be reduced by half if an inexpensive and yet efficient lightning conductor were offered to the farmer, who as a rule neither can nor will incur the cost of an expensive installation. The farmer has also been set against the inexpensive ones by having been told—often by those who profit by their own advice—that cheap lightning conductors are a danger rather than a protection. It is often pointed out that all metal appliances on the roof such as roof ridges, spouts, gutters, etc., are a protection against lightning, etc. He quotes and illustrates a number of actual cases to prove that the spouting is usually a good conductor. He concludes that a number of galvanised iron wires on the roof, carried around its four sides, conducted down the four corners of the house, and let in the ground, make a cheap and efficient lightning conductor.

Ancient Lightning Conductors.—The conclusions or discovery of Baurath Findeisen on a method of providing cheap lightning conductors cannot be said to be new, as the same thing was recommended by Prof. Oliver Lodge some years ago in his classic paper before the Institution of Electrical Engineers. Even this was a reinvention; when, some 1,827 years ago, the Roman Emperor Titus besieged Jerusalem, Josephus and other sources tell us that at the end of the siege, when weapons had become scarce, the besieged mounted the roof of the Temple, tore therefrom the metal staves which stood upon it and used them as javelins. Now to get at the origin of these staves and their use upon the top of the roof, we must still go a few hundred years back, right to the building of the Temple. Here we find that when the Temple was nearing its completion, there were erected upon its roof many hundred metal (copper) rods, two yards in height, with pointed tips, which latter were made of pure gold, a somewhat expensive but thoroughly efficient system of lightning rods. They stood upon the flat roof. This roof, which enclosed the four sides of an open court, sloped a little towards the inner side of the court, and small channels directed the rain-water into the metal spouting, which conducted the water (and the electricity) into the great cistern which was let into the centre of the courtyard. That the Temple, standing upon an eminence in the land of frequent thunderstorms, was nevertheless never struck by lightning, was looked upon as a miracle by the believing Jews. To us it is only another indication of the not less miraculous amount of knowledge these priests contrived to bring out of Egypt along with the other spoils.

Commercial Intelligence Committee.—The Board of Trade have appointed a committee, consisting originally of the following gentlemen—viz., Sir Courtenay Boyle, K.C.B. (chairman), the Hon. Sir H. Stafford Northcote, C.B, M.P., Sir Henry Bergne, K.C.M.G., Mr. S. E. Spring-Rice, C.B., Mr. A. E. Bateman, C.M.G.—to consider and advise as to the best means of bringing to the knowledge of the home trades the information furnished by consuls and commercial attachés, and by agents-general and other representatives of Colonial Governments and of India, as to the supply and demand and other conditions of the markets in their respective districts; and as to the opportunities which they afford for the introduction and development of British trade. Also to report whether it is, in their opinion, desirable that consuls and agents should be instructed to remit home from time to time samples of goods most in demand in such markets; and, if they shall be of that opinion, to advise what (if any) arrangements should be made for the exhibition of such samples in London or for their circulation with the aid of chambers of commerce to the provincial trade centres, with information as to price and other conditions under which they are supplied. It is also announced that the following gentlemen—viz, Sir James Mackay, K.C.I.E., member of the Council for India; Sir Albert Rollit, M.P., president of the London Chamber of Commerce, late president of the Association of Chambers of Commerce; Mr. C. P. Lucas, Assistant Under-Secretary of State for the Colonies; Mr. W. H. Holland, president of the Manchester Chamber of Commerce—had been appointed additional members of the Commercial Intelligence Committee, of which Mr. G. J. Stanley, of the Board of Trade, will act as secretary. We are indebted to the Chambers of Commerce *Journal* for the above details.

Arc Lamp Carbon.—The new American tariff law has touched many people deeply, and the arc lamp carbon suppliers are amongst the number. Our contemporary, the *Electrical World*, has interviewed several people to find the

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general opinion as to the effect of the new duty. The following opinion is a fair sample of what was thus obtained, and it is not too complimentary to the U.S.A. manufacturers. Mr. J. C. A. Sutor, the well-known importer of carbons, was of the opinion that the change of tariff on carbon pressed hardly on the central-station owners, with many of whom this item was a very important one. "So far," added Mr. Sutor, "it has been found impossible to manufacture carbons in the United States which can compete with those made in Germany. The carbon companies in America have experimented at great length, and at an enormous expense, in the attempt to produce an article equal to that imported. So far the results have not been satisfactory on account of the impurities occurring in the raw materials found in this country. Owing to the high duty placed upon the raw material it has been found cheaper to import the manufactured product rather than to attempt to make the carbons here. In many types of arc lamps the use of imported carbons has been found to be very essential, and, indeed, the success of the enclosed arc lamps which are rapidly coming into general use is due in a very great measure to the quality of the carbon. It is a significant fact that the central-station men will pay two or three times as much for the higher grades of carbon. The public has been accustomed to arc lamps which are free from the objectionable hissing and fluttering, and will be seriously opposed to going back to the old *régime*." Mr. Sutor predicts that the result of the tariff will be that the users of carbon will have to pay correspondingly higher prices, but that it will not check the importation.

Balancing Multiphase Systems.—The difficulty of ensuring equal loads on each circuit of a multiphase system of mains has often been experienced. Is is perhaps not far from the truth to say that the best measure of the commercial value of a multiphase alternator design is the smallness of the inconvenience arising from such want of balance. In America, where alternators are used with a large self-induction, such trouble is much felt. This has led Mr. Peter M. Heldt, Chicago, to invent a system which is intended to entirely overcome the unbalancing, and to place the multiphase system of distribution on the same basis of regulation with the single-phase system. This is described in the *Electrical World* as follows: "From the terminals of a three-phase generator three main conductors are led to the primary terminals of three transformers, or to the primary terminals of a three-phase transformer. The three secondary coils are each divided into three equal parts. These nine parts are connected in three groups of three each, each group comprising one section from each coil. Two of these parts are connected directly in series, while the third one is connected to these two in an inverse manner, for the reason that the phase of the E.M.F. induced in it is in direct opposition to the resultant of the E.M.F.'s induced in the other two parts. By means of this inverse connection the resultant E.M.F. of the two parts and the E.M.F. of the third part are therefore directly added. By taking the inverted part from a different coil for each group, regular three-phase E.M.F.'s will be induced in the secondary system. As each group or phase of the secondary winding bears an equal inductive relation to each of the primary windings, each secondary circuit takes an equal share of its energy from each of the primary circuits. The primary currents and the secondary induced E.M.F.'s are therefore always equal, no matter what may be the distribution of load on the secondaries. In practice, where light and power are supplied from the same mains, small motors are connected to the same transformers with the lights, while large motors would be supplied from separate transformers of the ordinary type. The advantages claimed for this system of distribution over the ordinary systems are the following. It permits perfect regulation of all the phases by simply varying the field strength of the generator; it reduces the cost of generators and line conductors; it simplifies secondary installations. As the only constructional difference between this and the ordinary systems is in the winding of the transformers, existing plants can be changed to the new system at a comparatively small outlay.

Teachers' Classes in London.—The July number of the *London Technical Educational Gazette* contains particulars of the teachers' classes being organised for the coming winter. Those on engineering include a course for teachers on mechanical engineering, to be given at University College, Gower-street, W.C., by Prof. T. Hudson Beare, on Saturday mornings from 10 to 1 during October, November, and December, commencing on Saturday, October 16. Also a free course for teachers of about 10 lectures on the strength of materials will be given at King's College, Strand, W.C., by Prof. Capper, during the Michaelmas term, on Saturday mornings, at 10 o'clock, commencing on Saturday, October 16. Each lecture will last for one hour, and will be followed by such demonstrations and practical laboratory work as may be required. The object of the course is to acquaint teachers with modern methods of teaching the subject named, and to illustrate the use and preparation of laboratory apparatus for demonstration. The number of students for both classes will be limited to 20 In physics a free course for teachers will be given at King's College, Strand, W.C., on Saturdays from 10 to 1, under the direction of Prof. W. G. Adams, D.Sc., F.R.S., assisted by Mr. S. A. F. White, M.A. The course will commence on Saturday, October 16. The class will be specially designed for persons who are actually engaged in teaching in elementary schools, secondary schools, or evening science classes, and whose special object is to become familiar with accurate methods of physical measurement, and with the methods of introducing physical measurements to junior pupils upon sound educational lines. The course will deal with laboratory methods of teaching the elements of heat, with special reference to the elementary measurements connected therewith, but opportunities will also be given to more advanced students to study methods of research in their application to the same subject. A course for teachers on magnets and electric currents will be given at University College, Gower-street, W.C., by Prof. Fleming on Saturday mornings from 10 to 1 o'clock, beginning on Saturday, January 22, 1898, and extending until Easter. The course will be adapted for science teachers and teachers in Board schools who, having some knowledge of the subject, desire to receive instruction in modern methods of science teaching, with the object of improving their methods. The course will consist in the delivery of a model lecture experimentally illustrated, and subsequently the teachers will be taught in the laboratory to make and use the apparatus employed in the lectures. The number of students will be limited to 20. A course of nine lectures and laboratory work in practical physics, illustrating the syllabus recently issued by the Head Masters' Association, will also be given during the winter term at Battersea Polytechnic by Mr. A. E. Briscoe, B.Sc. (Lond.), A.R.C.S., assisted by Mr. S. G. Starling, B.Sc. (Lond.), A.R.C.S. The lectures will be given at 10 30 a.m. on Saturdays, commencing on Saturday, October 23; the lectures will be followed by practical work.

Perpetual Motion.—We have received a communication from a Mr. E Bailey concerning an invention he claims to have made. The statements and claims we give

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below, so that if our rendering of his meaning be wrong, we shall have done him no injustice by our comments. His claim to get enough water gas from the electrical horse-power to drive a 10-h.p. motor is one that wants qualifying. If he does not take into account the element of time and drives the motor for one-tenth of the time the water is being decomposed, the statement infringes the law of the conservation of energy. Mr. Bailey says: "The object of this invention relates to the means of producing two highly explosive gases—oxygen and hydrogen—in component and equally proportioned parts for combustion by electric current decomposing water or a compound of water and acids or alkalies according to the specific gravity of the required solution and flow of current. These gases are produced in hermetically-sealed cells or chambers having two electrodes or more so coupled up either in parallel or series to the electric generator or batteries, the electrodes being immersed in the solution. The gases are then produced in quantity or pressure as required by the flow of current; and previous to being united or exploded, can be mixed with atmospheric air according to the required explosion. The advantage over other gases which are used for motive power is the highly explosive qualities of the mixture, and that it is proportionately produced for combustion, and is not dependent upon atmospheric air. Also the explosion produces no obnoxious or carbonaceous discharges or fumes. It has an explosive pressure of about 700lb. per square inch, or 1 e.h.p. produces sufficient gases to drive a 10-h.p. motor. These gases can be either stored under pressure in hermetically-sealed cells, or the electrical energy stored in storage batteries, or produced from primary batteries, for the purpose of driving motorcars. This is a great advantage over both oil and electric driven cars, it giving off no obnoxious fumes, and only one-half the fuel or storage battery power required in the present motorcars will be needed." Our correspondent then proceeds to discuss the use of this mixture of gases as "ammunition," by which term we gather he means as a substitute for gunpowder in propelling shot and shell. He then details the application of his invention to ship-propulsion. He suggests that a number of charging stations be established at all the principal ports at which the ship can take in a cargo of the gases, to be used on the voyage for driving the main engines. He winds up by saying that "This being entirely a new means of developing energy, and a great saving in space and weight, a future improvement is looked for in the development of motive power for propulsion." The communication is made in good faith, and we hope the author will not be discouraged in his inventive career by a failure of his first attempt. He must remember that the natural law of the conservation of energy is an established fact; and he would also do well to study general science.

Lift Signalling.—The *Electrical World* of New York, in a recent issue, described fully the electrical equipment of the Bowling Green Building in that city. The electric lighting arrangements seem to be exceedingly complete, but the lift-signalling gear seems to us to be particularly novel. This system was installed by Benner and Opdyke. Before describing this elevator-calling system it may be stated that there are eight passenger elevators arranged in a row on the north side of the building. Some of these are for express service, while others stop at every floor. At each landing there is located a double push-button contact device. One button of this device is marked "up" and the other "down." The mechanism is enclosed by a metal front and upper and lower end covers, while the sides are protected by glass, having marked at each end the words "to go up" and "to go down" in transparent letters. Behind these, on the base of the contact device, are placed small incandescent lamps, which are kept lighted, clearly indicating the text on the glass. Each contact, either up or down, consists of a push rod, which, when depressed, brings into contact several connection strips, and either one of these pushes, when operated, is held in a locked position by a small electro-magnet. From each contact device, only one of which is located on each floor, a series of six wires extends to a switchboard on the top of the elevator shaft. One common switchboard is used for the terminals from all the contact devices on the different floors. The board is of marble, with brass contact terminals. From these contact terminals the wires of each respective contact device extend to what is known as the commutator, a device which is mechanically connected to the cable sheave of each respective car. The commutator consists of a central screw shaft rotated by bevel gears connected to the previously mentioned cable sheave. On this screw shaft moves longitudinally a nut which has attached thereto two contact strips. At each side, at a slight angle to the central shaft, are a number of insulated contact buttons, all of those on one side being from the up-contact pushes of all the call boxes, while those on the other side are for the down pushes. When the sheave is revolved in one direction the threaded shaft of the commutator takes a corresponding direction, and the travelling nut, by friction, is thrown over against one series of contact points. When the direction is reversed, the direction of travel is reversed, and the nut is thrown against the opposite contact points. In this way, when going up, the car signals can only be actuated by up pushes, while in going down the signal can only be actuated by down pushes. From the commutator to its corresponding elevator car is run a three-wire cable, part of which is flexible to accommodate itself to the ascent and descent of the car. Two of these wires connect with the buzzer in the car which serves as a signal, while the other is normally closed through a push button, and is used for preventing the push from being unlocked by opening the releasing magnetic circuit of the push button in case the operator should find that his car is too heavily loaded to take on any additional load. The operation of the button in the car holds the call button in contact for the next car. From one contact of each call box a wire is run to an annunciator on the ground floor, which serves to indicate when a call is made to the starter. This annunciator consists of a number of magnet coils, which, when a button is pushed, are energised, holding up the needle of that particular call and only releasing it when the push button itself is released, thus opening the circuit, including the magnet in the call box and the annunciator. The connection of the signal in the car with both of these devices and the battery actuates the push release magnet, which serves as a return signal. This annunciator has no particular value during the busy hours, but serves the purpose of a call at night or at other times when the cars do not make regular trips. The operation of the system is exceedingly simple. Should either an up or down button be pushed, that particular button will serve to connect the signal in the nearest approaching car of the entire group, as soon as it reaches a point within seven-eighths of a floor space from the floor on which the actuated call device is located. The entire system works automatically, and the signal is only heard in that one car or cars which come within this distance of the floor at which it is desired to stop, and has therefore some advantages over signals in which the buzzer or bell is rung in all cars. An indicator is also placed on each floor to show which of the eight lifts the would-be passenger is to expect to answer his call.

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THE MECHANICAL CONSTRUCTION OF ELECTRICAL MACHINERY.

BY F. M. WEYMOUTH.

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THE DYNAMO.

(Continued from page 168.)

Bearings (continued).—Figs. 254 to 260 herewith represent two further types of self-oiling bearings. These are designs by Messrs. The India Rubber, Gutta Percha, and Telegraph Works Company, Limited, Silvertown; and we have to thank that company very much for drawings from which our diagrams are produced. As compared with self-oiling bearings such as we have hitherto touched on, it will be perceived that these contain further points of novelty.

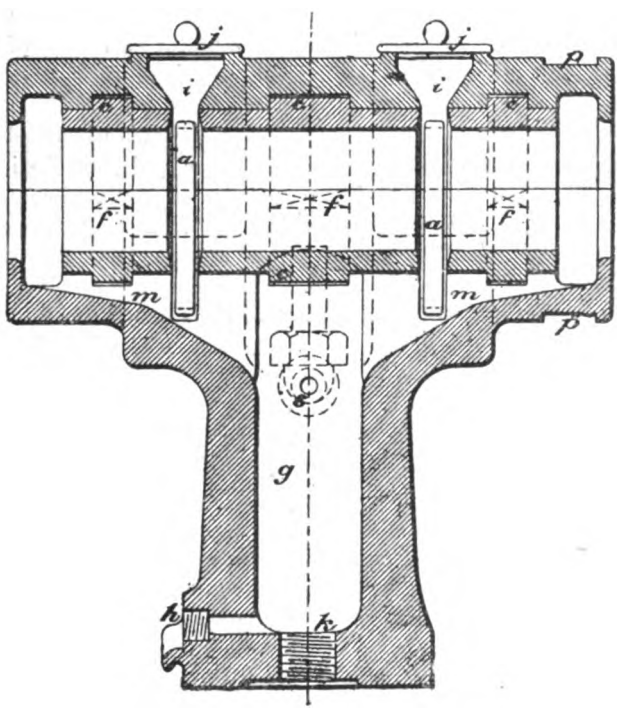

FIG. 254.

Thus the latter of the two shows oil-rings applied to a swivel bearing. We may, however, give more particular attention in the first instance to the design shown Figs. 254 to 257.

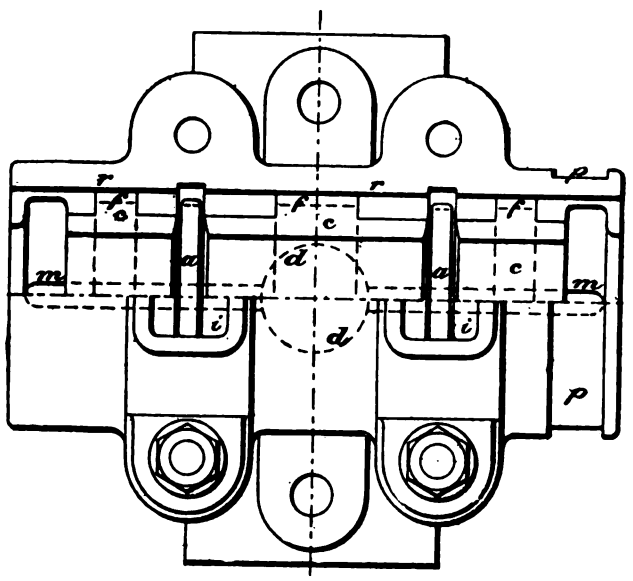

FIG. 255.

In general conception it will be seen that this is a cap bearing, whereof the cap is held down by studs fixed into bosses in the base, and is steadied sideways by raised portions, *r r*. Referring to the plan (Fig. 255), which shows one-half of the cap removed, it will be observed that the vertical joints between the jaws of the cap and *r r* come beyond the internal diameter of the oil-catching hoods; and thus the horizontal joint between the cap and the base is continued through the hoods, which conserves toward the latter being kept oil-tight in respect of this same joint. The brasses are prevented from rotating by snugs, *f f*, on the lower step fitting recesses in the base. They are steadied endways by collars, *c c*, fitting corresponding annular grooves bored in the cap and base as shown; and the snugs, *f f*, project from these collars so as not to interfere with necessary turning. Clearances are left at the bottom of the grooves, as indicated in the diagrams; and the outer periphery of the collars may be left rough, or be just cleaned up with a file.

One of the points, however, of what we may term prime interest, is the fact that there are here six separate brasses; and the oiling rings, lettered *a a* in all views, divide the

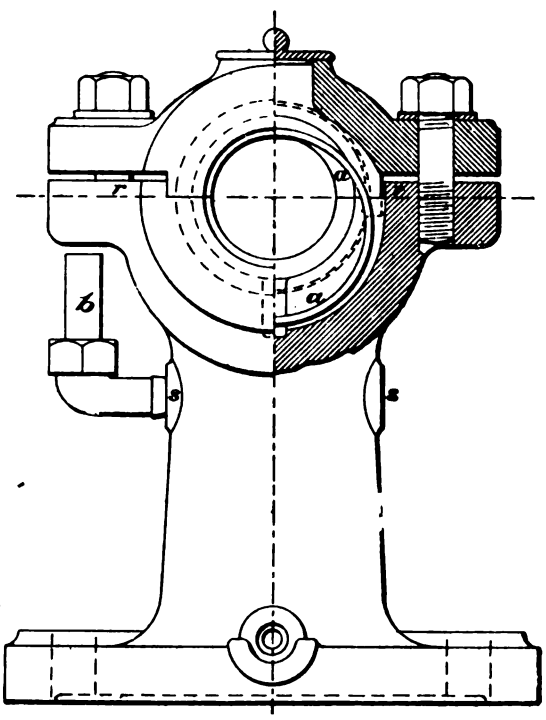

FIG. 256.

lower brasses equally with the upper, instead of the lower brass being in one long length as in former cases we have had under consideration. It will be perceived that on this account there is no necessity for the oiling rings to have an internal diameter large enough to pass over the snugs, *f f*—as would otherwise be the case—or indeed over any portions of the brasses whatever. With the shaft absent, and the cap off, each ring can be dropped into place from above quite independently as regards the brasses. Thus one very distinct advantage is that in raising or lowering the shaft out of or into the bearings, the rings, not

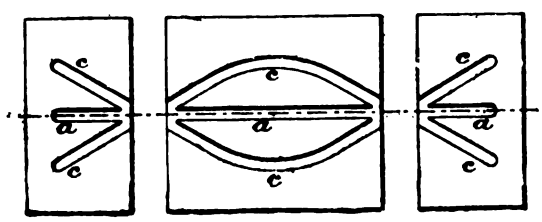

FIG. 257.

being engaged with the lower brasses, can remain on the shaft, and offer no impediment to its movement. The rings can be kept as small in diameter as may be desired, and there is no need to swell the bearing out sideways to obtain room within as would be required were the rings large. It will be observed that the rings are very light, and are rounded on the outer corners.

A seeming drawback, due to the division of the lower brass, might appear to lie in the fact that there is thus no very apparent method for retaining the oil brought up by the rings, and cause it to pass through the bearings. It

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will be noticed, however, in the diagrams, that the ends of the brasses adjacent to the rings are bevelled inwards: this thus allows the oil to collect between the brass ends and the sides of the rings. Oil-ways cut in the upper brasses then facilitate the entrance of the oil and its circulation within the bearing surfaces. Fig. 257 herewith presents a developed inverted plan of the upper brasses, and shows this arrangement. This consists of grooves, *a a*, straight along the top, and side grooves, *c c*, proceeding from the same entrances, and carried downwards at angles of about 30deg. with the central groove. The writer is informed by the makers that by these means a very sufficient lubrication is effected. No grooves are, of course, cut on the lower brasses.

It will be observed that the waste oil from the hoods is drained back by passages, *m m*, into the well, *g*, from whence it can be drawn off by a tap at *h*, when no longer fit for use. The hole, *k*, which is supplied for the purpose of steadying the core of the well, *g*, during casting, is tapped as shown, and permanently plugged. In order to watch the height of the oil in the well, there is a connection from the well by means of a hole at *s* to a gauge glass, *b*, outside. The oil thus rises in this latter and becomes visible. The oil-well, as indicated in the elevation, and by the dotted circle, *d d*, in the plan, is a slightly-coned cylinder in shape. It will be observed that by removing the small covers, *j j*, the rings, *a a*, may be seen, or oil poured in, when the machine is running.

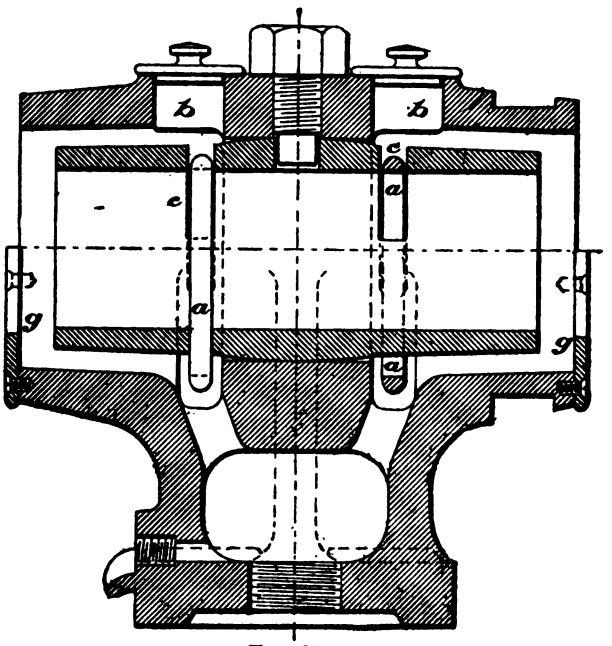

Fig. 258.

In Figs. 258 to 260 is shown the type designed by this same firm, wherewith oiling rings are fitted to a swivel bearing. It will be noted that, like the Wilson Hartnell bearing shown Figs. 245 and 246, this is also of the solid type, not having a cap. The sleeve, in one piece as usual with a swivel bearing of this general pattern, has gaps, *c c*, cut across the top as shown, to admit the rings, *a a*. These latter are represented in Fig. 258, one in full view and the other in section; and both are in section in the half sectional plan in Fig. 259. They must have an internal diameter sufficiently large to enable them to pass over the ends of the sleeve or bush, as obviously, unlike the last case, they cannot here be merely dropped into position from above. It will be observed that the rings are rounded on the outer edge or side, and so, like those previously dwelt on, they offer no appreciably large flat surface towards the sides of the gaps, *c c*, in the sleeve. Oil-holes, *b b*, fitted with covers as shown, permit, by removing these latter, a view of the rings, and also the admission of oil, while the shaft is rotating. A feature, novel as compared with bearings we have hitherto discussed, is the use of retaining plates, *g g*, screwed on at the ends to prevent the escape of oil. As it is necessary for the rings, *a a*, to reach the oil, it will be observed that the upper surface of this latter may very well extend the whole length of the bearing from one plate, *g*, to the other. Experience in any given case will, of course, demonstrate the best or safest maximum height of oil-level. A plentiful circulation of oil through the bearing is

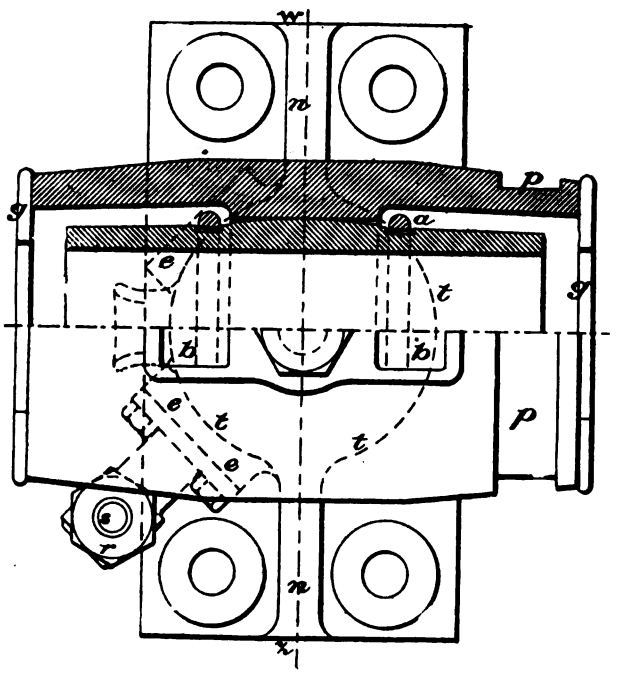

Fig. 259.

requisite for cool and free running, while of course too much would lead to overflow at the ends. For observing the height of the oil two facings or bosses, *e e*, are cast on the bearing, to either of which a gauge may be attached, as shown at *r r*, having a vertical glass tube, *s*, as in the last case.

Fig. 260 gives a section through the main casting on *w z*, but through the sleeve at one of the gaps, *c c*, embracing an oiling ring. It will thus be seen that the lower ends or edges of the gap are rounded over, as shown at *v v*, in full on one side, but dotted on the other: oil may thus collect in the slight recess between this rounding and the surface of the rotating journal. The outer limits of the gap at

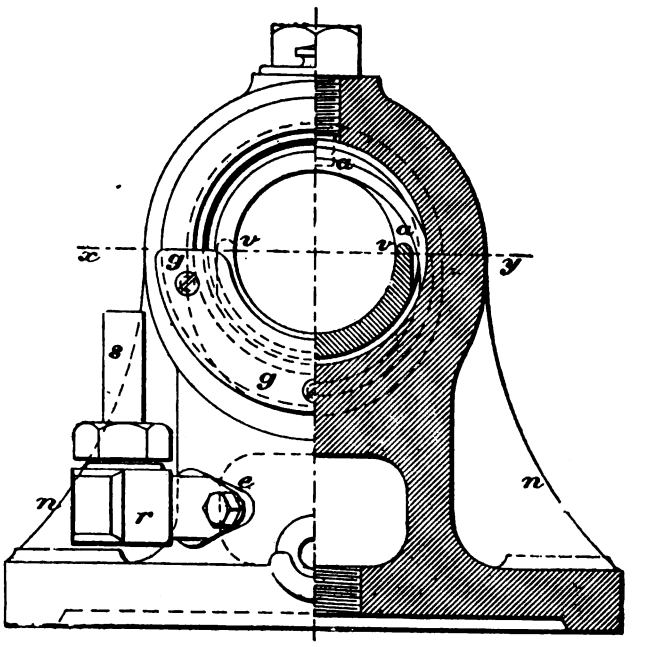

Fig. 260.

each end are finished off with a straight vertical cut by machine or file, as shown, which gives more freedom to the ring. It will be seen also in the same view that, for the sake of the extra depth required by the rings, the central section on *w z* is roughly elliptical, the lower half of the

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outer periphery being struck from a point somewhat below the main centre line, $x y$. The stalk, or base, of this bearing, as indicated by the dotted circle, $t t$, in the plan, is a vertical cylinder approximately in consonance with other bearings designed by this firm. Additional stiffness between the head and the foot of the casting is lent by the ribs, $n n$, on either side. This arrangement, however, as may be noted, conserves toward general snugness, and enables the gauge to be kept close in, instead of projecting in a manner rendering it more liable to receive damage from any ulterior source.

In both of these bearings by the Silvertown Company it will be observed that there are two rings as compared with the one or three in previous designs we have illustrated: the rings also are relied on solely for the lubrication. In both, also, a simple method of dealing with the brush gear is present, inasmuch as it is only required to turn an annular groove out of one end of the casting, as shown at $p p$, which in the former case, Fig. 254, comes on the cap. There are thus no special patterns required, or parts to add to a pattern; and the same pattern without alteration may do for all the bearings in a machine. This special feature, however, is, of course, facilitated in the case of the cap bearing, by the fact that the cap and the base are bolted together by means of bosses cast on each, as shown clearly in the plan, Fig. 255, which leaves both ends of the bearing with an unbroken cylindrical periphery free to receive the groove.

(To be continued.)

THE ALTERNATING-CURRENT INDUCTION MOTOR.*

BY CHARLES PROTEUS STEINMETZ.

Polyphase Induction Motor.

§ 1. *Load Curves.*

In its general behaviour the alternating-current induction motor is analogous to the continuous-current shunt motor. Like the shunt motor, it operates at approximately constant magnetic density. It will run at fairly constant speed, slowing down gradually with increasing load. The main difference, however, is that in the induction motor the current is not passed into the armature by a system of brushes, as in the continuous-current motor, but induced in the armature by the alternating field, and in consequence thereof, the primary circuit of the induction motor fulfils the double function of an exciting circuit corresponding to the field circuit of the continuous-current shunt motor, and an inducing circuit producing the current in the armature by electromagnetic induction.

In its electromagnetic features, however, the induction motor is essentially a transformer. That is, it consists of a magnetic circuit interlinked with two electric circuits, the primary or inducing, and the secondary or induced circuit. The difference between transformer and induction motor is that in the former the secondary is fixed regarding the primary, and the electrical energy induced in the secondary is made use of, while in the latter the secondary is movable regarding the primary and the mechanical force acting between primary and secondary is used.

The secondary or armature of the motor consists of two or more circuits displaced in phase from each other so as to offer a closed secondary to the primary circuits, irrespective of the relative motion. The primary consists of one or several circuits.

In consequence of the relative motion of the primary and secondary, the magnetic circuit of the induction motor must be arranged so that the secondary while revolving does not leave the magnetic field of force. That means the magnetic field of force must be of constant intensity in all directions, or, in other words, the component of magnetic flux in any direction in space be of the same or approximately the same intensity but differing in phase. Such a magnetic field can either be considered as superposition of two magnetic fields of equal intensity in quadrature in time and space, or it can be represented theoretically by a revolving magnetic flux of constant intensity, or simply treated as alternating magnetic flux of the same intensity in every direction.

In the polyphase motor this magnetic field is produced by a number of electric circuits displaced from each other in position in space, and excited by currents having the same displacement in phase as the exciting coils have in space.

In the monocyclic motor, the one of the two superimposed quadrature fields is excited by the primary energy circuit, the other by the magnetising or teaser circuit.

In the single-phase motor, the one of the two superimposed magnetic quadrature fields is excited by the primary electric circuit, the other by the induced secondary or armature currents carried into quadrature position by the rotation of the secondary.

In either case at or near synchronism the magnetic fields are identical.

The transformer feature being predominant, in theoretical investigations of induction motors it is generally preferable to start therefrom.

The characteristics of the transformer are independent of the ratio of transformation, other things being equal. That is, doubling the number of turns for instance, and at the same time reducing their cross-section one-half, leaves the efficiency, regulation, etc., of the transformer unchanged. In the same way in the induction motor it is unessential what the ratio of primary and secondary is, or, in other words, the secondary circuit can be wound for any suitable number of turns, provided the same total copper cross-section is used. In consequence hereof the secondary circuit is mostly wound with one or two bars per slot, to get maximum amount of copper, that is, minimum resistance of secondary.

The general characteristics of the induction moter being independent of the ratio of turns, it is for theoretical considerations simpler to assume the secondary motor circuit reduced to the same number of turns as the primary, or the ratio of transformation 1, by multiplying all secondary currents and dividing all secondary E.M.F.'s with the ratio of turns, multiplying all secondary impedances and dividing all secondary admittances by the square of the ratio of the turns, etc.

Thus in the following under secondary current, E.M.F. impedance, etc., shall always be understood their values reduced to the primary, or corresponding to a ratio of turns 1 to 1, although in practice a ratio 1 to 1 will hardly ever be used, as not fulfilling the condition of uniform magnetic reluctance desirable in the starting of the induction motor.

Let in the polyphase induction motor—

$Y_0 = g + j\,b$ = primary admittance, or admittance of the primary circuit at open secondary circuit;

$Z_0 = r_0 - j\,x_0$ = primary impedance;

$Z_1 = r_1 - j\,x_1$ = secondary impedance induced to the primary by the ratio of turns.*

All these quantities refer to one primary circuit and one corresponding secondary circuit Thus in a three-phase induction motor the total power, etc., is three times that of one circuit, in the quarter-phase motor with three-phase armature the impedance of $1\frac{1}{2}$ of the three secondary circuits is to be considered as corresponding to each of the two primary circuits, etc.

Let e = primary counter E.M.F., or E.M.F. induced in the primary circuit by the flux interlinked with primary and secondary (mutual induction).

s = slip, with the primary frequency as unit—that is, $s = 0$, denoting synchronous rotation, $s = 1$, standstill of the motor.

It is then:

$1 - s$ = speed of the motor secondary as fraction of synchronous speed.

$s\,N$ = frequency of secondary currents, where

N = frequency impressed upon the primary;

hence

$s\,e$ = E.M.F. induced in the secondary.

* *Transactions* of the American Institute of Electrical Engineers.

* The self-inductive reactance refers to that flux which surrounds one of the electric circuits, only without being interlinked with the other circuits.

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The actual impedance of the secondary circuit at the frequency s N is

$$Z_1^s = r_1 - j\,s\,x_1;$$

hence,

Secondary current:

$$I_1 = \frac{s\,e}{Z_1^s} = \frac{s\,e}{r_1 - j\,s\,x_1} = e\left(\frac{s\,r_1}{r_1^2 + s^2 x_1^2} + j\,\frac{s^2 x_1^2}{r_1^2 + s^2 x_1^2}\right) = e\,(a_1 + j\,a_2),$$

where $$a_1 = \frac{s\,r_1}{r_1^2 + s^2 x_1^2} \qquad a^2 = \frac{s^2 x_1^2}{r_1^2 + s^2 x_1^2}.$$

Primary exciting current:

$$I_{00} = e\,Y_0 = e\,[g + j\,b];$$

hence,

Total primary current:

$$I_0 = e\,[(a_1 + g) + j\,(a_2 + b)] = e\,(b_1 + j\,b_2),$$

where $$b_1 = a_1 + g. \quad b_2 = a_2 + b.$$

The E.M.F. consumed in the primary circuit by the impedance Z_0 is $I_0\,Z_0$, the counter E.M.F. is e, hence:

Primary terminal voltage:

$$E_0 = e + I_0\,Z_0 = e\,[1 + (b_1 + j\,b_2)\,(r_0 - j\,s_0)] = e\,(c_1 + j\,c_2),$$

where $$c_1 = 1 + r_0\,b_1 + s_0\,b_2. \quad c_2 = r_0\,b_2 - s_0\,b_1.$$

Eliminating complex quantities, it is:

$$E_0 = e\sqrt{c_1^2 + c_2^2};$$

hence,

Counter E.M.F. of motor:

$$e = \frac{E_0}{\sqrt{c_1^2 + c_2^2}},$$

where E_0 = impressed E.M.F., numerical value.

Substituting this value in the equations of I_0, I_{00}, I_0, etc., gives the complex expressions of currents and E.M.F.'s, and eliminating the imaginary quantities it is:

Secondary current:

$$i_1 = e\sqrt{a_1^2 + a_2^2}.$$

Exciting current:

$$i_{00} = e\sqrt{g^2 + b^2}.$$

Primary current:

$$i_0 = e\sqrt{b_1^2 + b_2^2}.$$

Denoting by: $[M\,N] = [(m_1 + j\,m_2)\,(n_1 + j\,n_2]$ the product: $m_1\,n_1 + m_2\,n_2$, it is:

Torque:

$$T = [I_1\,e] = e^2\,a_1;$$

hence,

Power output:

$$P = (1 - s)\,T = e^2\,a_1\,(1 - s).$$

Primary input:

$$P_0 = [I_0\,E_0] = e^2\,(b_1\,e_1 + b_2\,c_2).$$

Volt-amperes, or apparent input:

$$Q = i_0\,E_0.$$

The torque is by this equation given in watts at synchronism, that is T = power which would be developed if the motor would run with this torque at synchronism. This makes us independent of the number of poles, frequency, speed, etc., and thus allows the direct comparison of motors.

The output, P, includes friction, windage, etc, thus the net mechanical output is P – friction, etc. Since, however, friction, etc., depend upon the mechanical construction of the individual motor and its use, it cannot be included in a general formula. P is thus the mechanical output and T the torque developed at the armature conductors.

The efficiency is, $\frac{P}{P_0}$,

the power factor, $\frac{P_0}{Q}$,

the apparent efficiency, $\frac{P}{Q}$,

the torque efficiency, $\frac{T}{P_0}$,

the apparent torque efficiency, $\frac{T}{Q}$.

The meaning of these quantities is the following:

The "efficiency" or "power efficiency" is the ratio of the true mechanical output of the motor to the output which it would give at the same power input if there were no internal losses in the motor.

The "apparent efficiency" or "apparent power efficiency" is the ratio of the mechanical output of the motor to the output which it would give at the same volt-ampere input if there were neither internal losses nor phase displacement in the motor.

The "torque efficiency" is the ratio of the torque of the motor to the torque which it would give at the same power input if there were no internal losses in the motor.

The "apparent torque efficiency" is the ratio of the torque of the motor to the torque which it would give at the same volt-ampere input if there were neither internal losses nor phase displacement in the motor.

The torque efficiencies are of special interest in starting where the power efficiencies are necessarily zero, but it nevertheless is of importance to find how much torque per watt or per volt-ampere input is given by the motor. These terms are preferable to the terms "torque per watt" or "torque per volt-ampere" generally used in this case, since they are independent of the number of poles, frequency, etc., of the individual motor.

Thus from the quantities, primary admittance, primary impedance and secondary impedance, the induction motor can be calculated.

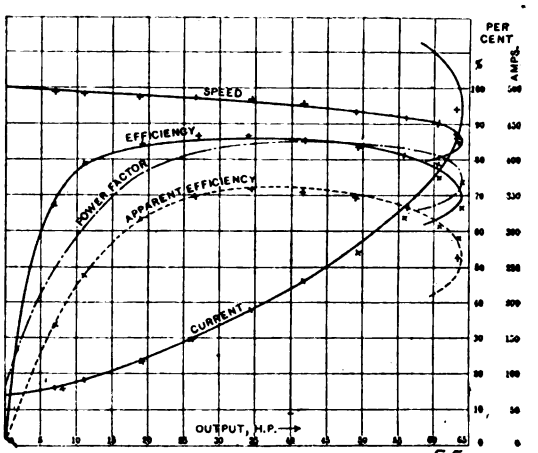

FIG. 1.—1-8-30-900-110, Form "A." 60 Cycles, 8 Poles, 110 Volts. Three Phase. Curves calculated with: $Y = \cdot045 + \cdot384\,j$; $Z_0 = \cdot045 - \cdot124\,j$; $Z_1 = \cdot041 - \cdot124\,j$. Friction: 510 Watts at Synchronism. Observed by Test: ×.

The predetermination of admittance and impedance belongs in the field of induction motor design, and therefore falls outside of the scope of this paper.

As instance, in Figs. 1 and 2 are calculated the load and speed curves of a 60-cycle three-phase eight-polar motor, 110 volts impressed, of the constants.

$Y_0 = \cdot045 + \cdot384\,j$.
$Z_0 = \cdot045 - \cdot124\,j$.
$Z_1 = \cdot041 - \cdot124\,j$ per circuit in delta connection.

510 volts are allowed as friction at synchronism.

The output and torque are three times the values derived directly from calculation since the motor contains three circuits, and the current shown in the diagrams is the current per line, or $\sqrt{3}$ × the current derived from calculation.

In Fig. 1 are shown in drawn lines the speed, efficiency, and current input of the motor with the horse-power output as abscissæ, in dotted lines the apparent efficiency, and in dash dotted lines the power factor.

In Fig. 2 are shown with the speed or the slips in per cent. of synchronism as abscissæ, the torque as ordinates for the three-phase armature resistances:

$r_1 = \cdot041$, or short-circuited armature.
$r_1 = \cdot33$.
$r_1 = \cdot76$.

This motor is the I-8-30-900-110, Form A, of General Electric Company's make, and the results of test of this motor are marked in Figs. 1 and 2 by crosses, showing the

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exceedingly close agreement between the calculated values and the results of test.

Examining the equations in the preceding, we see that the expression of the current, counter E.M.F., etc., contains the impressed E.M.F., E_0, as factor; the torque, power output, and power and volt-ampere input, contain E_0^2 as factor, while the efficiency, power factor, apparent efficiency, and torque efficiencies are independent of E_0.

That is, in an induction motor, the efficiency, power factor, apparent efficiency, torque efficiency, apparent torque efficiency at a given slip or speed, and thus starting torque per volt-ampere or watt input are independent of the impressed E.M.F.

The current and counter E.M.F.'s are proportional to the impressed E.M.F.'s.

The torque, power, and volt-amperes are proportional to the square of the impressed E.M.F.

This obviously applies only as long as the iron is below saturation, which, however, is always the case.

Under torque, output, etc., are understood the values at the armature conductors disregarding friction. Since the friction is the same at different impressed E.M.F.'s, and the total output varies with the square of the impressed E.M.F., the difference or the net mechanical output will be somewhat more than proportional to the square of the impressed E.M.F. On the other hand, at high impressed E.M.F.'s—that is, greater output—the motor gets hotter, and thus its electric resistance rises and thereby reduces the output somewhat when running continuously.

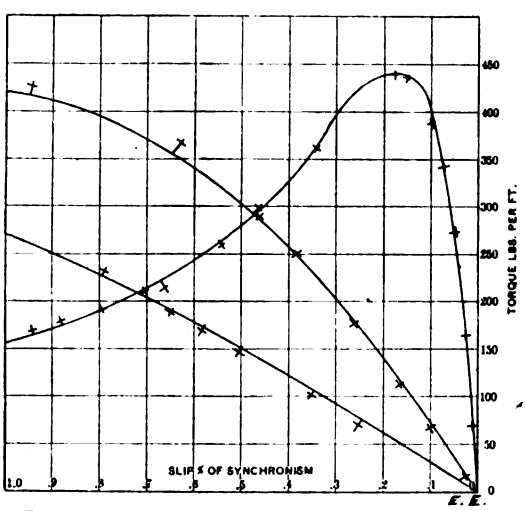

FIG. 2.—I-8-30-900-110, Form "A." 60 Cycles, 8 Poles, 110 Volts. Three Phase. Curves calculated with: $Y = \cdot045 + \cdot384\,j$; $Z_0 = \cdot045 - \cdot124\,j$; $Z_1 = \cdot041 - \cdot124\,j$. Friction: 510 Watts at Synchronism. Observed by Text: ×.

Rating the induction motor at a given percentage, say two-thirds of maximum output or of maximum torque, the characteristic features of the motor are seen to be entirely independent of the impressed E.M.F., and merely dependent upon the admittance, $Y_0 = g + j\,b$, and the impedances, $Z_0 = r_0 - j\,x_0$, $Z_1 = r_1 - j\,x_1$.

A change of one of the impedances has comparatively little effect on the motor characteristic, provided that the other impedance is changed so that the total impedance, $Z_0 + Z_1$, remains the same. Since the primary and the secondary impedance are generally fairly equal, except when intentionally made different, as by inserting high resistance in the secondary to get greater starting torque and greater drop of speed under load, or by inserting reactance in the primary to reduce the starting current and the starting torque, and since from tests of the motor only the sums of the impedances can conveniently be derived, but not the individual impedances, it is mostly sufficient to assume both impedances as equal.

$$Z = Z_0 = Z_1, \text{ or: } Z = \tfrac{1}{2}(Z_0 + Z_1).$$

Hereby the induction motor is reduced to two complex imaginary constants, Y and Z, or four real constants, g, b, r, x, the same terms which characterise the stationary alternating-current transformer on non-inductive load.

Instead of conductance g, susceptance b, resistance r, and reactness x, may be chosen as characteristic constants

the absolute admittance $y = \sqrt{g^2 + b^2}$,

the absolute impedance $z = \sqrt{r^2 + x^2}$,

the power factor of admittance $\beta = \frac{g}{y}$,

and the power factor of impedance $\gamma = \frac{r}{z}$,

If the admittance, y, is reduced n-fold, and the impedance, z, increased n-fold, with the E.M.F. $\sqrt{n}\,E_0$ impressed upon the motor, the speed, torque, power input and output, volt-ampere input and excitation, power factor, efficiencies, etc., of the motor—that is, all its characteristic features—remain the same, as seen from above given equations; and since a change of impressed E.M.F. does not change the characteristics, as seen above, it follows that a change of admittance and of impedance does not change the characteristics of the motor, provided the product, $\delta = 2\,y \times z$, remains the same.

Thus the induction motor is characterised by three constants only:

The product of admittance and impedance, $\delta = 2\,y\,z$, which may be called the characteristic constant of the motor.

The power factor of primary admittance, $\beta = \frac{g}{y}$.

The power factor of impedance, $\gamma = \frac{r}{z}$.

All these three quantities are absolute numbers.

The physical meaning of the latter two, the power factors, is obvious.

The physical meaning of the characteristic constant or the product of admittance and impedance is the following:

If I_{00} = exciting current,

I_{10} = current taken by the motor at standstill,

it is approximately $y = \frac{I_{00}}{E_0}$,

$$z = \frac{E_0}{2\,I_{10}},$$

thus: $$\delta = 2yz = \frac{I_{00}}{I_{10}}.$$

The characteristic constant of the induction motor, $\delta = 2yz$, is the ratio of exciting current to short-circuited current.

(To be continued.)

WIRING RULES.

The Institution of Electrical Engineers has just issued the following general rules for wiring for the supply of electrical energy.

These rules embody the chief precautions and requirements which the Institution considers necessary to secure satisfactory results. They have been drawn up to meet the ordinary cases of dwelling-houses, offices, or business premises in which it is desired to lay the conductors, and fix the fittings and appliances necessary for utilising electrical energy either for lighting, for heating, for motive power, or for other purposes. They are arranged in such a form that they may be used as a specification of requirements and precautions which must be strictly enforced if a user of electrical energy wishes to have his house or premises supplied in such a manner that he may be as free as possible from risk of fire, of extinction, failure of supply, or danger to person, and at the same time have his work carried out with due regard for economy both in first cost and in after cost of maintenance. The rules are framed to meet all ordinary cases, but they are not intended to take the place of detailed specifications drawn up by consulting engineers to meet individual requirements. They are confined to a statement of well-ascertained requirements, and do not recommend any special system or form of apparatus by which these may be best fulfilled.

For convenience the rules are grouped as below:

Conductors.—(1) Conductivity and size; (2) insulation;

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(3) joints; (4) general arrangement; (5) precautions where they pass through walls or partitions; (6) precautions at points of connection.

Fittings.—(7) Precautions as to switches, fuses, and other appliances; (8) switches; (9) switchboards; (10) fuse boxes and fuses.

Generating and Utilising Appliances.—(11) Dynamos and motors; (12) accumulators or other batteries; (13) transformers; (14) arc lamps.

Testing.—(15) Testing the whole and parts.

CONDUCTORS—CONDUCTIVITY AND SIZE.

1. They should be of high-conductivity copper, not less than 100 per cent. conductivity, and where sulphur or other substance liable to attack bare copper is contained in the insulation, they should be tinned with pure tin. Note.—The standard of conductivity here referred to is that the resistance of a copper wire weighing 100 grains, 100in. long, should be 0·1516 ohm at 60deg. F.

Sectional Area.—Their sectional area should be proportional to the heating effect of the current required for the maximum number of lamps, or other current-using apparatus, that can be used simultaneously on the circuit; but in no case should the sectional area of any conductor be less than that of a No. 18 S.W.G. wire. All conductors having a sectional area larger than that of a No. 14 S.W.G. wire should be stranded.

Temperature Limits.—They should be of such size that, when the maximum current is passing continuously through them, their temperature shall not exceed 130deg. F. It will, however, generally be found that if the conductors are worked up to a density of current corresponding to this increase of temperature, the resulting fall of potential or drop in volts will be inconvenient and uneconomical. It is imperative that this temperature of 130deg. F. should never be exceeded, and therefore it is necessary to take into account the maximum temperature to which they may be subjected, independently of electric heating, in each particular locality, and the greatest increment above this temperature should not be more than will raise them to a temperature of 130deg. F. If the maximum temperature of the British islands be taken as 100deg. F., then the increment due to electric heating must not exceed 30deg. F.—that is to say, the size of the wires should be such that, when carrying the maximum current continuously for many hours, the temperature does not rise more than 30deg. F. above the temperature, for the time being, of the place in which they are situated. In specially hot places the wires should be so large that the electric heating should be almost nil, and the wires should be specially insulated with insulating material which does not deteriorate at the highest temperature to which it will be subjected. The table appended shows size of conductors which will safely carry currents up to 740 amperes, and the length in yards of single conductor in circuit for each volt of fall of potential when the maximum current is in use.

INSULATION.

2. *Insulation.*—Insulated conductors may be broadly classed under two heads: (*a*) Those insulated with a material as a dielectric which is itself so impervious to moisture that it only needs further protection from mechanical injury or from vermin; (*b*) those insulated with a material as a dielectric which, in order to preserve its insulation qualities, must be kept perfectly dry, and therefore needs to be encased in a waterproof tube or envelope, generally of soft metal, such as lead, which is drawn closely over the dielectric.

When Class A is used the dielectric must be perfectly damp-proof, and not in any case less in thickness, measured radially, than 30 mils plus one-tenth of the diameter of the conductor; it should not soften at a lower temperature than 170deg. F.; the minimum insulation of a test-piece cut from it should be that given in column 7 of the table, the test being made at 60deg. F. after one minute's electrification, and after the test-piece has been immersed in water for 24 hours.

When Class B is used the same conditions as to minimum thickness and softening temperature of the dielectric should be enforced as in Class A; its covering should be such that a test-piece cut from the conductor and immersed in water will not break down when an alternating pressure of 2,500 volts having a frequency of from 40 to 100 periods per second is applied for 10 minutes between the conductor and the water, the test-piece previous to immersion having been bent six times (three times in one direction and three times in the opposite direction) round a smooth cylindrical surface not more than 12 times the diameter of the conductor, measured outside the dielectric. The coil from which the test-piece was cut should be tested in a similar manner to Class A, but the minimum insulation resistance should be that given in the table, column 8.

Conductors of Class A must be protected from mechanical injury by being covered with stout braid or taping, prepared so as to resist moisture, and must be further protected by casing, or by being drawn into pipes or conduits.

In the case of conductors insulated as in Class B great care must be taken to protect exposed ends of conductors where they enter the terminals of switches, fuses, and other appliances, from the possible access of moisture which might creep along the insulating material within the waterproof covering.

Concentric Conductors.—Concentric conductors should in all respects conform to the requirements herein laid down for single conductors; the insulation resistance of the outer dielectric should be that given in the table for single conductors having the same diameter as the outer conductor. The insulation resistance of dielectric separating the two conductors should be twice that of the outer dielectric. The bending test of concentric conductors, Class B, should be made round a cylinder 12 times the diameter of the outer dielectric.

Flexible Cord Conductors.—Flexible cord conductors—*i.e.*, those made up of a number of wires not larger than No. 29 S.W.G., which are then insulated (in many cases two such conductors are twisted together so as to form a double conductor)—should only be used for attachment to portable appliances, or for the wiring of fittings. The insulating material used as the dielectric should be either pure rubber or vulcanised rubber of the best quality. If pure rubber be used it should be laid on in two laps, care being taken that these should lap-joint. The radial thickness of the dielectric should never be less than 16 mils for pressures up to 125, or 20 mils for pressures up to 250 volts. Each coil should bear a certificate that a piece one yard in length cut from it has withstood for five minutes an alternating pressure of 1,000 volts having a frequency of from 40 to 100 periods per second applied between the two conductors twisted together, the piece being subjected during the test to the vapour arising from a pan of boiling water placed at a distance not exceeding 3ft., and immediately below it.

JOINTS.

3. *Soldering Fluids Prohibited.*—All joints in conductors must be mechanically and electrically perfect, to prevent heat being generated at these points. The use of soldering fluids containing hydrochloric acid, sal ammoniac, or other corrosive substances, should be absolutely forbidden. The insulation of all joints in insulated conductors should be most carefully attended to, the object being to make the insulation of the joints as nearly as possible equal to the insulation of the remainder of the conductor.

Jointing Precautions.—In jointing rubber-insulated cable, care should be taken that the braiding or taping is carefully removed without damage to the indiarubber, which latter should be laid bare, and tapered for sufficient length to ensure a watertight union with the insulating substance used as a covering. It should be remembered when arranging for any system of wiring that joints constitute a source of weakness, and they should, therefore, be avoided as far as possible.

GENERAL ARRANGEMENT.

4. *Distributing Centres.*—The arrangement of conductors should be carried out as far as possible from distributing centres, the cable conveying the current to them being free from joints; from these centres of distribution the use of small circuits carrying up to five amperes, and also free from joints, except at the branches and connections to

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TABLE SHOWING MAXIMUM CURRENTS, THICKNESS OF DIELECTRIC, AND INSULATION RESISTANCE FOR COPPER CONDUCTORS INSULATED AND LAID IN CASING OR TUBING.

1. Size, S.W.G.	2. Maximum current for high external temperatures.	3. Total length in yards of lead and return giving one volt drop.	4. Maximum current allowable.	5. Total length in yards of lead and return giving one volt drop.	6. Minimum thickness of dielectric in mils or thousandths of an inch.	7. Minimum insulation resistance in megohms for one mile of Class A.	8. Minimum insulation resistance in megohms for one mile of Class B.
18 or 62/38 or 97/40	3·1	23	4·2	18	35	1,200	300
3/22	3 3	23	4·4	17	36	,,	,,
17 or 130/40	4·0	25	5·4	19	36	,,	,,
3/20	4·8	26	6 6	19	38	,,	,,
16 or 110/38 or 172/40	4·9	27	6·8	19	36	,,	,,
15	5·9	28	8·2	20	37	800	,,
7/22	6·2	28	8·7	20	38	,,	,,
14 or 172/38 or 7/21½	7·0	29	9·8	21	38	,,	,,
3/18	7·5	30	11 0	20	40	600	,,
7/20	9·3	31	13·0	22	41	,,	,,
7/18	14·0	37	21·0	25	44	,,	,,
19/20	20·0	39	30·0	26	48	,,	,,
7/16	23·0	40	34 0	27	49	,,	,,
19/18	31·0	45	48·0	29	54	,,	,,
7/14	32·0	45	49·0	29	54	400	,,
19/16	49·0	51	77·0	32	62	,,	,,
19/14	70·0	56	110·0	35	70	,,	,,
37/16	83·0	59	130·0	37	75	,,	,,
19/12	100·0	66	170·0	39	82	300	,,
37/14	120·0	64	190·0	40	86	,,	,,
61/15	150·0	67	240·0	42	95	,,	,,
61/14	170·0	74	290·0	43	102	,,	,,
37/12	180·0	73	300·0	44	103	,,	,,
61/12	260·0	82	450·0	47	124	,,	,,
91/12	350·0	90	620·0	51	144	,,	,,
91/11	420·0	94	740·0	53	158	,,	,,

switches and other appliances, is recommended, in order that the fuses at these centres of distribution may amply protect every conductor beyond them, even if only a "flexible" for a single lamp. This will ensure safety, although the ideal system is to carry a conductor from each point of use back to the distributing centre without joint or tapping.

Draw-in Systems.—The use of a draw-in system in which both conductors are drawn into one strong incombustible tube or chamber, or their equivalent, is preferable to wood casing with spaced conductors, as safety is better obtained by the use of suitable insulation of the wires themselves than by trusting to the wood casing, or to the spacing for insulating purposes. The composition of the tubing or conduit used must depend on the character of the structure in which it is embedded: tubes or conduits which minimise condensation or sweating are to be preferred. When tubes are used no elbows should be employed, but corners should be turned either by means of slow bends or by the fixing of a suitable box.

Conductors Spaced from Walls.—Conductors spaced and separated away from the walls should not be permitted unless they are mechanically protected throughout their entire length. Where the distribution is effected by circuits not carrying more than five amperes, conductors of the same polarity may be "bunched" together, providing a double-pole fuse, arranged to sever the circuit before any perceptible rise of temperature can take place, is inserted at the point of distribution; conductors of opposite polarity may also be "bunched," provided that they are placed in an incombustible tube or conduit.

PRECAUTIONS WHERE CONDUCTORS PASS THROUGH WALLS OR PARTITIONS.

5. *Porcelain Tubes in Walls.*—Cables or wires passing through walls require additional protection, such as a porcelain or other tube which can be filled up with sand or other chemically inert incombustible material, so as to prevent the spread of fire through these openings.

Conductors Drawn into Channels.—Wherever conductors cannot be in sight they should be made as accessible as possible; and it is recommended that wires which must be buried within walls should not be fixed, but drawn into channels previously prepared for them, and they should preferably not be drawn in until any dampness which may exist in these channels has dried out of them.

Gas-Pipes.—Conductors should not be placed near gas-pipes.

PRECAUTIONS AT POINTS OF CONNECTION.

6. *Jointing on to Switches.*—Wherever conductors are connected on to switches, fuses, or other appliances, great care must be taken that the whole of the separate wires forming the stranded or flexible conductor are neatly twisted together and clamped into the terminal, so that no loose wire or strand can project. The insulating material or dielectric should only be bared back sufficiently to allow of the conductor entering into the terminals properly, and the ends of the insulation should be thoroughly sealed to prevent moisture creeping along the copper beneath the insulation. The braiding, lead, or other non- or semi-insulating material should be cut back for a distance of not less than ¾in. from the end of the insulating material.

PRECAUTIONS AS TO SWITCHES, FUSES, CONNECTORS, AND OTHER APPLIANCES.

7. *Bases to Switches, etc.*—These should be mounted on bases made of porcelain or other non-combustible material. If any difficulty arises through damp, this may be overcome by inserting a second base or backing of specially prepared material.

Damp Places.—In excessively damp places, such as cellars, all fittings attached to walls should as far as possible be dispensed with, the wires being carried direct from the distributing board to the lamps.

Frames for Resistances.—Resistance coils should in all cases be carried on frames or supports made of incombustible material, and preferably should be enclosed in metal cases to prevent accidental derangement.

Wiring of Fittings.—Wherever fittings, such as brackets, electroliers, or stands, require to have the conductors threaded through tubes or channels formed in the metal work, these should be designed so as to avoid sharp angles or rough projecting edges which would be liable to strip or cut or damage the insulating material in the act of drawing in the conductors, or in fastening them to the outside in the case of adapted fittings.

Adapting Gas Fittings.—The use of combined gas and electric fittings should not be permitted; where gas fittings are adapted, they should be insulated from the gas-pipe.

Jointless Conductors.—Where possible, the conductor should be carried without joint through the fitting to the

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lamps; but where connections at the back are unavoidable, special care must be taken to make this joint equal in quality, as regards conductivity and insulation, to the rest of the work.

SWITCHES.

8. Every switch, whether fixed separately or combined with lamp holders or fittings, should be constructed to comply with the following requirements: (*a*) that no overheating can take place at the point of contact or elsewhere; (*b*) that when being switched off it is impossible for a permanent arc to be formed; (*c*) that it cannot be left in an intermediate position between on and off; (*d*) the base should be of incombustible material; (*e*) the cover should also be of incombustible material, and should preferably be either made of or lined with non-conducting material; (*f*) covers of all switches should be kept clear of all the internal mechanism; (*g*) the handles of all switches should be efficiently insulated from the circuit; (*h*) in order to ascertain that switches comply with the above requirements, samples should be selected from each pattern and size used, and should be tested at an E.M.F. and current 50 per cent. in excess of that which will be used on the circuits for which they are intended.

Main switches should be placed close to the generators if the supply is generated within the building, or at the transformer if transformed within the building, or at the point of entrance of the conductors into any building supplied from an external source. When all three wires of a three-wire system are brought into a house, the member of the switch connected to the middle wire must not make contact later, or break contact sooner, than the other two members; preferably the middle member should make contact sooner and break contact later than the two outer members. Single-pole switches should not be on the middle wire of a three-wire system. In a five-wire system the same principles will apply.

SWITCHBOARDS.

9. *Diagram of Connections.*—Wherever main or centres of distribution switchboards are provided, these should be constructed of incombustible material, preferably with front connections, with circuits arranged as far as possible to form their own diagram of connections, and so labelled that they may be easily identified. Where back connections are permitted, they should be carefully soldered.

Exposed Metal Work.—Exposed metal work of different polarity on switchboards should be well separated, and preferably mounted on separate bases.

FUSE BOXES AND FUSES.

10. *Fuses on Both Poles.*—Branches from all circuits should have fuse boxes made of porcelain or other incombustible material on both poles, and the fuse in these fuse boxes, if on the same base, should be in separate compartments.

Fuses on Tapered Mains.—Where the tree, or tapered, system of wiring is allowed, fuses should be introduced at such intervals that each fuse protects the smallest branch between it and the next fuse; or, if there is no other fuse, then it must protect right up to the end of the circuit.

Fuses in Ceiling Roses.—If the above precautions are taken, it is not necessary to protect the ceiling roses which support flexible pendants by fuses at the ceiling point of junction.

Fuses in Portable Fittings.—Whenever circuits not exceeding five amperes have fuses in each pole at the distributing point, fuses in the connectors (see Section 7) are not necessary; should the current, however, exceed five amperes up to 125 volts, or three amperes up to 250 volts, all portable fittings requiring flexible cords, or adapted fittings wired with flexible cords, must be protected with a fuse at the point of junction with the circuit. Any fitting containing many lights, and wired with flexible cord, should be supplied by conductors carried back to the distributing centre. Where one of the conductors is connected to earth, all switches and fuses which will be single-pole should be arranged on the insulated side of the system. No fuses or switches should be placed in or at any point of the earthed conductor. Standard types of fuses should be so designed as to avoid the risk of inserting fuses intended for large circuits into the fuse carriers of small circuits, and *vice versâ*.

Ventilation of Fuse Boxes.—The covers of all fuse boxes—whether these be separate or grouped on switchboards—should be efficiently ventilated, so as to avoid risk of fracture by the sudden expansion of the air within them at the time the fuse melts, the covers being arranged to catch and retain the fused metal. All connectors should be capable of withstanding a test at an E.M.F. and current 50 per cent. in excess of that for which they are intended. If used in damp places, special precautions must be adopted to exclude moisture.

Connectors in Floors.—In cases where the fixed part of the connector is attached to a floor, it must be so arranged that no dust or water can accumulate in the cavity, and should have all contacts well below the floor level, to prevent any possibility of danger from contact with the carpets.

Concentric Connectors.—When concentric connectors are used they must be constructed so that they cannot be readily short-circuited by a piece of metal, such as a pin or a metal pencil-case. Clearances should be such that an arc cannot be started if the connector is pulled out at the time that the current is flowing. The insulation used between opposite poles should be such that it will not readily break or chip.

DYNAMOS AND MOTORS.

11. *Spacing of Dynamos, etc., away from Woodwork.*—Dynamos and motors should be protected from damp and dust, and should be so placed that no woodwork or inflammable material is within a distance of 12in. from them measured horizontally, or within 4ft. from them measured vertically above them; and the same precautions must be adopted in placing and fixing the starting switches or regulating resistances used in connection with any of these appliances.

Spacing of Resistance Coils.—The coils of these resistances must be so designed that in no case do they heat above 212deg. F. even if left continuously in use; and the coils must be protected by suitable metal casing or guards, which must not interfere with free circulation of the air round the coils.

Earthing the Frames.—The frames of dynamos or motors employing an E.M.F. of 250 volts or upwards should be connected to earth.

Continuous-current transformers are to be classed with dynamos and motors.

ACCUMULATORS OR OTHER BATTERIES.

12. Both accumulators and primary batteries should be placed and used under the same precautions as above described for dynamos and motors, and the room in which they are placed should be well ventilated. The accumulators and batteries should themselves be well insulated from the earth, and should be protected by fuses at both poles, and at all points of connection between the circuit and the regulating cells.

TRANSFORMERS.

13. When these are used to transform either direct or alternating currents of high E.M.F. down to the E.M.F. allowed by the Board of Trade on the consumer's premises they, together with their switches and fuse boxes, must be placed in a fire and water proof structure, preferably outside the building for which they are required, and their frames must be connected to earth. No part of such apparatus should be accessible except to the person in charge of them. In all cases conductors conveying currents of high E.M.F. inside a building must be specially insulated and encased in a fireproof conduit. Under no circumstances should transformers be allowed to heat under normal conditions of load to a temperature of 150deg. F. Transformers should be so protected by suitable apparatus that a leak between the primary and secondary coils raising the pressure to 400 volts above that of the earth should cut the transformer out of circuit.

Low-Pressure Transformers.—Low-pressure alternating transformers or choking coils may be placed within build-

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ings, but the same precautions as regards heating of the coils, distance from woodwork, and guarding must be adopted as in the case of resistances used for motors.

Arc Lamps.

14. Arc lamps must always be guarded by lanterns or netted globes, so as to prevent danger from ascending or descending sparks, and from falling glass or incandescent pieces of carbon. All parts of the lamps which are liable to be handled should be well insulated, and, in addition, an insulator must be inserted between the lamp and its support. Resistances for arc lamps should have a similar double insulation; their coils should be designed so as not to heat above 212deg. F.; they should be protected by metallic ventilating guards, and should be so placed that no woodwork is within 6in. of them measured horizontally, or within 2ft. of them measured vertically above them. When arc lamps are supplied from constant-potential mains, fuses on both mains are necessary. Arc lamps in which air can have access to the carbons during burning, should on no account be used in places where inflammable vapours or explosive mixtures of dust or gas are liable to be present.

Testing.

15. *Insulation Test.*—The conductors, fittings, and appliances must be tested in the following manner before the current is switched on: The whole of the lamps or appliances for utilising the energy having been connected to the conductors, and all fuses being in place, an E.M.F. equal to twice the E.M.F. which will be ordinarily used is to be applied, and the insulation resistance between the whole system and earth must be measured after one minute's electrification. The insulation should then not be less than 10 megohms, divided by the maximum number of amperes required for the lamps and other appliances. The installation may be then set to work, and a second and similar test should be made after an interval of 15 days. In each test, if the insulation of the whole is below standard, the work should be divided up by the departmental switches and tested separately, in order to locate the faulty section. The value of systematically testing and inspecting apparatus and circuits cannot be too strongly urged as a precaution against fire. Records should be kept of all tests, so that any gradual deterioration of the system may be detected. Cleanliness of all parts of the apparatus and fittings is essential. No repairs or alterations should be made when the current is "on."

Explanation of Table.

Column 1 gives the sizes of the conductors in common use. Cables are shown thus: 19/14—viz., 19 wires of No. 14 standard wire gauge. Column 2 gives the maximum current for situations where the external temperature is above 100deg. F. The current for any conductor may be calculated from the formula:

$$\text{Log } C = 0{\cdot}775 \log A + 0{\cdot}301,$$

or,

$$C = 2\,A^{0{\cdot}775}$$

(where C = current in amperes, A = area in one-thousandths of a square inch).

The maximum rise in temperature will be about 10deg. F. on large sizes. Column 3 gives the total length in yards of lead and return of each size of conductor causing a drop of one volt when transmitting the current shown in column 2. Column 4 gives the maximum current allowable in any situation. The current for any conductor may be calculated from the formula:

$$\text{Log } C = 0{\cdot}82 \log A + 0{\cdot}415,$$

or,

$$C = 2{\cdot}6\,A^{0{\cdot}82}$$

(where C = current in amperes, A = area in one-thousandths of a square inch). The maximum rise in temperature will will be about 20deg. F. on large sizes. Column 5 gives the total length in yards of lead and return of each size of conductor causing a drop of one volt when transmitting the current shown in column 4. Column 6 gives the minimum thickness of dielectric. This may be obtained for any conductor by adding 30 mils to one-tenth the diameter of the conductor. Columns 7 and 8 give the insulation resistances in megohms for one mile of cable of Classes A and B respectively.

THE METERS OF TO-DAY.*

BY R. F. SCHUCHARDT.

A good meter is always superior to the best contract. For the station manager the meter will give a good basis from which to estimate the schedule price, instead of making his guess at it; the ratio of income to cost of operation will be more fixed, and there will be less unnecessary burning, thereby increasing considerably the life of the lamps.

There are three classes of meters—electrolytic, clock, and motor meters. In the first, the quantity of current is measured by the amount of metal deposited or the quantity of electrolyte decomposed in an electrolytic cell. The only one of this class which has found much use in America is the Edison chemical meter, which, though exceedingly accurate under proper conditions, has the decided disadvantage of having no recording device, and like all electrolytic meters is likely to freeze unless heat is provided, thereby entailing a loss.

The majority of the clock meters consist of two clocks, one of which keeps accurate time, the other being retarded or accelerated by the action of the current on its pendulum. The objection to this type is that the clock must be wound up every month or so, and, if neglected, will run backward and destroy all former readings. Of this class the Aron is the most successful, being constructed for both direct and alternating currents.

The most important class comprises those meters which operate on the principle of the electric motor. The American meters of this class are the Thomson, of the General Electric Company; the Duncan, of the Fort Wayne Corporation; the Shallenberger, of the Westinghouse Company; and the Scheeffer, of the Diamond Electric Company. The Thomson is built to operate on both direct and alternating currents, and consists of a simple motor with no iron in the armature or the field. All of the others are induction motors.

Mr. George H. Jones, of Fond du Lac, and myself, have just completed a thesis on American electricity meters under Prof. D. C. Jackson, at the University of Wisconsin, and I have drawn largely from our thesis for this paper. The results obtained in our investigations show that the meters of the present day are not all that might be desired. It is of the utmost importance that central-station men test each meter they instal. Many managers are beginning to realise the importance of this subject, and have added meter-testing departments to their stations, where all meters are tested before they are installed. After they are once installed, they should be inspected every six months or so in order to see that they are working properly. This is hardly ever done at present.

I have with me a few curves showing the accuracy of some of the meters tested by us, which illustrate very clearly the action of these meters. Our method of calculating the error of the meter was as follows: the speed of the meter is directly proportional to the load, therefore for a given load the product of seconds per revolution of the armature and amperes (in ampere-hour meters), or watts (for watt-hour meters), equals a constant (which we call K), which varies with the make and size of the meter. As will be seen, K is the time in seconds which it takes for the armature to make one complete revolution per unit of load (ampere or watt).

The product of the observed load and seconds per revolution divided by this K, $\frac{\text{amp.} \times \text{sec.}}{K}$, or $\frac{\text{watts} \times \text{sec.}}{K}$ should then equal unity for an accurate meter, and the variation from unity will give directly the error. Should this quotient be more than unity, the meter runs too slowly on that load; and if less than unity, the error will be negative, which means that the meter is running too fast. Thus, let the time per revolution be four seconds for a load of 440 watts on a 10-ampere 100-volt Thomson watt-meter. The value of K for this meter is 1,800; then $\frac{4 \times 440}{1{,}800} = {\cdot}978$, which shows that the meter runs 2·2 per

* Abstract by the *Electrical World* of a paper read at the La Crosse meeting of the North-Western Electrical Association, July 22, 1897.

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cent. too fast on that load; or, let the time per revolution of the armature be two seconds for 3·3 amperes on a 20-ampere Shallenberger ampere-hour meter in which the value of K is 6·33; then $\frac{2 \times 3{\cdot}3}{6{\cdot}33} = 1{\cdot}042$. The meter is therefore 4·2 per cent. slow on that load.

We found our samples of the Duncan watt-hour meters to run too fast, but by properly adjusting the magnets, their error could be brought within the limits of about 5 per cent. either side. Both of the Duncan ampere-hour meters tested started much too slowly, and were also much too slow on the high loads. The effect of frequency is very marked, the difference in error at full load between frequencies of 60 and 130 being about 30 per cent.

These Scheeffer wattmeters are designed for frequencies, and when built for two frequencies are provided with a special German-silver resistance in the pressure circuit to compensate for the difference. One of the meters tested by us, built for frequencies of 60 and 130, ran with an average difference of about 6 per cent. between these frequencies.

Of the Thomson wattmeters, which are independent of frequencies, the new type started on no load, while the old ones started much too slowly. Their curve of error is a remarkably straight line after starting load.

The Shallenberger ampere-hour meters also started much too slowly. One of the three tested ran fairly uniform after starting, while the other two were too slow on high loads. The higher frequency makes them run from 5 to 15 per cent. faster. The Shallenberger watt-hour meter was found to be very fair. It started on a very light load, ran without any great error, and responded promptly to changes of load. Frequency has no appreciable effect upon it.

All of the meters tested are practically unaffected by the changes of pressure likely to occur in service. The Diamond wattmeter should not be used with inductive load, as the effect of such load is very marked, making the meter run much too slowly, and with a power factor low enough it stops entirely, and even runs backward.

Besides these meters tested in the laboratory, we were enabled, through the courtesy of the Madison Gas and Electric Company, to test meters in actual service. The general results of this test indicated that the ampere-hour meters require a comparatively large current to start them, run much too slowly on starting load and on the higher loads, while the majority of them have considerable error on overloads. The wattmeters are somewhat better, and, as a rule, run too fast on all loads, except at starting, and with a fairly uniform error. The Thomson meters show the least variation in error, but the continuous watts absorbed are more than in any of the others. A fact of great importance brought out in this test is the lack of proper attention paid to the installation of meters.

In choosing a meter the following points should be considered: It should be accurate within at least 5 per cent., either way, on all loads for which it is designed, and should begin to register on at most 1 per cent. of its full load. The power absorbed should not exceed two watts per 10 amperes capacity of wattmeter, nor should the full load drop through the meter be larger than ·5 volt. The reading should be direct and not have to be multiplied by a constant. The multiplier means extra work for the clerk, and offers a chance for an error, both in the calculation and in the possible omission. There should be no electrical contact makers, which rapidly deteriorate. Delicate mechanism should be avoided. The meter should not be liable to wear out, nor get out of order rapidly. The cover should be dust-proof and capable of being easily sealed. Last, but not least, comes the cost of meters. This is not only the amount paid for the meter, but includes the cost of energy continuously absorbed. In the case of a meter costing 10dol. and absorbing 10 watts continuously, with interest at 6 per cent., energy at four cents per kilowatt-hour, and 10 per cent. for depreciation (which probably is a low value for a cheap meter), the annual cost of the meter to the central station is 5·10dol. A meter absorbing two watts at the same rates as above would cost 3dol. per year. At the end of 10 years the first meter will have cost 61dol., while the 20dol. meter will have cost but 59dol., and it ought still to be in good condition at that time. The higher-priced meter is likely to be the more accurate. There are several ways in which a meter can be tested. In some methods the load is computed from the time per revolution of the armature, and the true load found on an indicating instrument. We think that a "per cent. error" states the condition more clearly than any method which finds the error in amperes or watts for the different loads. We also think our stop-watch method the most satisfactory, since it takes much less time and therefore less power than the five-hour full-load test used in some methods. For a satisfactory test, the starting load should be found, and also the time per revolution taken with a stop-watch, the accuracy of which can be relied upon, at starting, ¼, ½, ¾, 1, and 1¼ loads. Any number of ammeters can be connected in series and tested at the same time.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

SUMMER LOADS.

SIR,—Being a constant reader of your paper, and having some interest in electric light companies, I am writing to you in hopes of gaining a little information on the above subject.

In looking over the returns of many of the companies in England, I notice their losses occur mostly in the summer months. Now, during the last two years we have experienced exceptionally hot summers, and I find the demand for ice is largely on the increase. It has occurred to me whether our electric light stations, where there is always a plentiful supply of water and steam power constantly being wasted, could not be utilised in the making of ice. The demand for this commodity is sure to go on increasing, especially in the provincial towns, where most of the butchers sell three parts foreign meat, and are therefore bound to use a large quantity of ice. Would not this be a profitable way of making more use of the machinery during the summer months?

Any information you or your correspondents who may feel interested in this subject can give will be much esteemed.

Yours, etc.,
J. C. FIDLER.

Reading, August 7, 1897.

SHOREDITCH ELECTRICITY WORKS.

SIR,—My attention has been called to an extract from the *Rochdale Observer*, reprinted in your issue of the 6th inst., upon the combination of dust destruction and electric lighting in Shoreditch, and I write to correct an inaccuracy which appears therein—*i.e.*, that "At Shoreditch a certain amount of coal is used with the refuse to make it good fuel."

The real facts are that from Monday morning until Saturday night the refuse is burned without the addition of any coal whatsoever, and electricity is generated for lighting the streets and the general public supply from the use of ashbin refuse alone. The only time that coal is used is on Sundays and Bank Holidays, when no ashbin refuse is available, owing to the refuse carts not going to work on those days.—Yours, etc.,

H. MANSFIELD ROBINSON, solicitor and clerk.

Town Hall, Old-street, E.C., August 7, 1897.

Accumulator Cars.—The accumulators in use on the Frankfort-on-Maine street railways are said to have given great satisfaction up to the present. The tramway company has to pay a certain sum per month to the Pollak Accumulator Company, and we understand that each monthly payment has been made without the slightest deduction. As these payments are based upon the number of miles run according to the time-table, this speaks well for the accumulators.

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C Anonymous communications will not be noticed.*

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Vol. XIX. of new series of "THE ELECTRICAL ENGINEER" can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.

ELECTRIC LIGHTING RULES.

The Institution of Electrical Engineers have at last issued their general rules for wiring for the supply of electrical energy. We are reprinting these in this issue, so that our readers may compare them with other sets of rules now in force. It would, in our opinion, have been well to have printed and circulated these rules in draft form, so that the comments from the profession generally could have been considered before the rules were definitely adopted. This was the course pursued by the Board of Trade recently, when compiling their regulations under the Electric Lighting Acts for securing the safety of the public. Perhaps the great reason for adopting a similar course would be that the opinion of the fire insurance offices could then have been obtained while there was an opportunity of making modifications. If, then, these offices could have been induced to give their approval to the new rules, the whole profession would have benefited from the uniformity so obtained in safety regulations. Coming to the Institution rules, we cannot help referring to the date of the issue. If they had been prepared quickly when once undertaken, we should have had them before us many years ago. In that case, assuming the present set to have been issued then, many of the statements in them and many complete clauses would have served to educate the contractor, whereas now they are a recapitulation of well-established facts. These points have been proved by the various contractors to be good, and they have convinced the fire offices of the worth of such innovations. In fact, we do complain that the Institution rules, while being an excellent *réchauffé* of well-established facts, are not of a leading character. As an example of this, we would refer to the fourth clause, dealing with the general arrangements. We are told that a drawing-in system, where both conductors are drawn into one strong incombustible tube, is preferable to wood casing, on the ground that the extra insulation obtained by spacing the wires in wood casing cannot be depended on. We naturally expect after this some definite recommendation as to what simple drawing-in system can be universally used with safety. At any rate, some details, such as whether a metal tube should have its inner surface insulated or not, could have been discussed. Instead of this, we are told that "the composition of the tubing used must depend on the character of the structure in which it is embedded." We hardly see what the character of the structure has to do with a tube buried in the walls, and should like to hear if a carefully-laid system of common iron pipes offers an insuperable objection in buildings bearing the worst character possible. We quite realise the charitable wish of the gentlemen responsible for these new rules to frame them so widely that they included all the drawing-in and concentric systems on the market, but we do question the practical value of rules which avoid such critical points. Coming to other matters, we notice that the standard of conductivity adopted as 100 per cent. is, that the resistance of a copper wire weighing 100 grains, 100in. long should be 0·1516 ohm at

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60deg. F. We presume that there must be some hidden reasons for the 100 grains and 100in. used in the definition, but we cannot see what these reasons are. In comparing the resistances of copper wire the grain is an awkward unit of weight, and the length 100in. is neither one thing or the other. Makers' lists always use either miles, yards, or perhaps feet. As regards the carrying capacity of conductors, we are glad to see that the too much adopted 1,000 amperes per square inch limit has been discarded. The limits of current strength for different sections are determined by the temperature rises of the conductor, which is as it should be. In consequence, a No. 18 wire is to be allowed to carry 4·2 amperes, or to work at a density of 2,330 amperes per square inch. On the other hand, a cable of 91 No. 16 wire is never to carry more than 740 amperes—*i.e.*, 770 amperes per square inch. Both these values are for places where the cables are not subjected to high temperatures. When they are, the densities allowed per square inch fall to 436 amperes and 1,720 amperes respectively. We hope to hear what the various fire offices have to say on this question, but we know that one official at least considers that the smaller wires should not be allowed to carry more than the 1,000 amperes per square inch for other reasons than heating. The suggestion that fuses for different currents should not be interchangeable is good, but not novel, and in this direction there is an ample opportunity for practical suggestions wasted. We note that accumulators must be so placed that there is no wood within 12in. of them horizontally, or within 4ft. in a vertical direction. What system of stillage will comply with this we do not know, neither do we remember a case of an accumulator catching fire. There are a few other novelties in the rules which we have not space here to refer to at length, amongst which we may mention the tests of flexible cords. The method of making this seems new to us, and we are not sure that the test can be relied on to differentiate between good and bad cords. In conclusion, we would point out that the action of the fire offices has given to this country more secure installations of electric light than any other country possesses, and that hence they may not be eager to change their rules.

THE SILLY SEASON.

We have often wondered what kind of journalist is answerable for the paragraphs on scientific subjects which from time to time appear in the political papers. If newspapers had existed in olden times these paragraphs would probably have dealt with some fluid or other under the title of "elixir of life," but as they exist in an electrical age the fluid discussed is connected with either a primary or a secondary battery. The ordinary newspaper man is full to the brim with the idea that electricians want to find out some fluid, and that when found that fluid is to astonish the world and change our methods of lighting and traction. They seem to have never heard at school, or in their world, of energy. They do not seem to have any idea as to how energy is obtained and how it can be utilised. They have never heard of such a thing as chemical combination. They do not know or have forgotten that it is the energy obtained from the combination of coal which is used in steam-engines, and thus to obtain electric light and traction. It is too late to attempt to educate these woefully ignorant scribes, but, unfortunately, the greater their ignorance the greater the harm they do. Their paragraphs are read by thousands still more ignorant of these matters than themselves, the majority of whom think there must be something in it because the paper mentions the matter. The *Evening News* is the latest culprit. Fancy giving the following paragraph without comment, or only hedging by the frivolous character of the headlines. The cheapness of a battery does not depend upon a fluid, but upon what is consumed. Generally, batteries consume zinc, and so long as they do that the fluid is immaterial in the question of cheapness. We trust none of the readers of the *Evening News* will be led away to believe in any fluid, and especially that they will not be led away to invest in any company started to develop business with a "secret fluid." Here is the article to which we take exception:

"How to generate cheap electricity suitable for practical purposes at a minimum cost has been one of the puzzles troubling the scientific world. The secret is now alleged to be a secret no longer. Mr. Hurley, a practical electrician, who has long been trying to solve the mystery of how a cheap generation of the electric power can be acquired, comes to the front with a fluid which he thinks will put the matter beyond doubt. The inventor has given a demonstration of the working of his method and what it can achieve. His discovery is known only to himself, and he has been working on it for years. He professes that with a 100-cell battery, each cell containing a pint of his fluid, he can generate electricity up to 15 h.p., which would maintain its power for 10 consecutive hours. A battery of this class could be fitted to any tramcar for about £100, and would not be more than 1,000lb. in weight, and could afterwards be maintained at a cost of, say, 6s. per day of 10 hours. Mr. Hurley is so confident in his discovery that he is willing to put it to any test. Asked what would be the cost of a small battery with his fluid sufficient to illuminate a small office or dwelling-house, the reply was that the first cost would be about £2, and the after expense very little. Mr. Hurley is not averse to the scientific world knowing what ingredients he uses, for he says, if they did know, they could do nothing with them. The fluid is of the most inoffensive character. It has a pleasing, pungent smell, and will neither burn nor explode. Its greatest recommendation, however, is its cheapness. Further experiments are to be carried out, and it is suggested to place the matter before the Council committee having the electric tram system in hand in Liverpool."

We suggest that if the matter be brought before any committee they severely leave it alone until such experts as Lord Kelvin, Dr. Hopkinson, or Mr. Swinburne give their support to "that fluid."

The Arc.—Mr. A. Blondel has recently published some more observations on the nature of the electric arc. He concludes that it has now been definitely established that the electric arc behaves as a resistance, and does not offer any back E.M.F. comparable to the observed difference of potential at the terminals. The phenomena are also not due to electrolysis. With the degree of accuracy obtainable, Mr. Blondel found that if a residual counter E.M.F. should exist due to thermo-electric effect, it would not exceed a fraction of a volt. Finally, the arc is equivalent to a resistance, but up to the present the nature of the resistance has not been determined.

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REVIEWS.

Electric Movement in Air and Water, with Theoretical Inferences. By LORD ARMSTRONG, C.B., F.R.S., LL.D., D.C.L., etc. Smith, Elder, and Co., London.

This is one of the most beautifully produced books ever published upon an electrical subject. Really, it is a fine-art production, and calculated from the very great beauty and excellence of its illustrations to put one out of the calm, contemplative mood so necessary to the consideration of scientific subjects. Lord Armstrong is no new student in electrical matters. His name is to be found in almost every text-book as the discoverer of certain electrical phenomena connected with escaping high-pressure steam. That discovery was, writing from recollection, about 60 years ago. Thus the author of this work has been familiar with electrical matters from the time when Faraday's discoveries were beginning to bear fruit to the present. He has witnessed the rise of telegraphy, of electro-chemistry, of the dynamo, and electric light and traction; hence any theory propounded by him cannot be put aside without the most careful examination. This book contains the theory advanced by its author. In this notice we shall attempt to follow the method of the older critics, and to give as far as possible in the author's own words the theory he has propounded. Although we cannot accept the theory, the reasons for such non-acceptance may well be deferred. Our duty is now to give an idea of the scope and contents of the book. The author in his preface refers to an experiment of more than half a century old. He took "two wine-glasses filled to the brim with chemically pure water and connected them by a cotton thread coiled up in one glass, and having its shorter end dipped into the other. The two glasses were joined up to the machine, the one containing the coil of thread by a negative wire, and the other by a positive connection. On putting the machine into full action the coiled thread was rapidly drawn out of the negative vessel and deposited in the positive one, leaving for a few moments a rope of water about 3in. in length suspended between the lips of the two glasses."

This experiment, the author contends, is "strong evidence of two currents flowing simultaneously in opposite directions, *the negative being inside the positive* (p. 1). The italics are ours. So far as we recollect, the only author who ever adopted this view of Lord Armstrong's was the late Prof. F. Guthrie, in a text-book for students preparing for the advanced examination at South Kensington. The present writer combated Prof. Guthrie's views at the time the book appeared, about a quarter of a century ago.

Variations of the above experiment are described in the first few pages of Lord Armstrong's book, and on p. 7 he says, "Since it can be proved that positive electricity acts divergently, while negative acts convergently, it is natural that negative should draw to the interior of the string and the positive to the exterior to avoid interference." He finds analogous motions in smoke rings, and in this finds a further proof of the theory advanced, asserting that "Nature is very economical of methods, though boundless in variety of application, and it may be questioned whether a mode of conduction established in a single instance may not in all cases be essentially the same."

Various experiments are described, and reference made to the magnetic whirls which form the field around a conductor, to the vortex theory and the action at the end of the carbons in all lamps, in order to support the theory put forward. To us, however, the most fascinating part of the book is that which describes the experiments made with a large Wimshurst machine of 16 plates of nearly 3ft. diameter driven by an electromotor. The illustrations showing the dust figures obtained, Figs. 6 to 11 inclusive, are really art productions, each, according to the author, showing "the whole figure as composed of strings of cored vortices linked together by polarity, and *transmitting energy by some process of conduction.*" We again italicise these words, because there seems to be some explanation required as to how such transmission takes place. Following these are a series of photographs, each intended to form a link in the chain which builds up the theory. To discuss these pictures without having them before us is impossible, but the author himself summarises the object in view in reproducing them. His work has been to bring into one view—

"1. An intelligent explanation of the water and cotton experiment has been offered and its teaching indicated.

"2 The duality of electricity, apart from quantitative distinction, has been shown to consist largely, if not wholly, in difference of direction, the motion being in the one case outward and forward, and in the other inward and backward, as in the smoke ring.

"3. The consolidation of brush lines into main channels of conduction, and the mode in which they coalesce have been clearly illustrated.

"4. Pictorial illustrations have been exhibited showing electric configuration in various phases; and the persistency of pattern independent of magnitude has been exemplified.

"5. The double composition of conducting lines has been displayed by fracture.

"6. Novel effects due to oscillation and secondary action, as well as to modification of induction, have been exhibited.

"7. Magnetic or quasi-magnetic effects on common dust have been shown.

"8. Examples have been presented of the remarkable correspondence between some electric figures and living organised forms."

The mind of the author tends to the belief that "electricity is identical with the inherent motion of molecules," that the molecules themselves may be nothing more than "specialised motions," that, indeed, the universe consists of motion and something in motion. In reply to the question, Motion of what? Whether of the impalpable ether, or whether to "endow space with the attributes assigned to ether," and thus have motion "stand forth as the 'absolute' of matter," the author leaves the future to decide.

This work is undoubtedly the handsomest illustrated work on electricity ever published. Further, the letter-press is printed on one side of the paper only, and in large type, so that there is little strain upon the eyesight; but the value of the book will be found to be in the illustrations. These photographic enlargements will be examined as closely and as minutely as the astronomer examines the photographs of the heavens. And who shall tell what will be the ultimate result of such examination?

THE FRANKFORT ELECTRICITY WORKS.

We have referred in our previous volumes to the electricity works erected at Frankfort-on-the-Maine by Messrs. Brown, Boveri, and Co. The station, which belongs to the town of Frankfort, is remarkable for several features in its design and method of working. It is, perhaps, particularly interesting to English engineers from the fact that a large motor load has been obtained. The plant in the original station consisted of four 750-h.p. steam alternators. The engines of these sets are of the horizontal tandem type, and drive directly flywheel alternators. These machines were illustrated in vol. xvi., p. 175, of the *Electrical Engineer*, which gave a general view of the Frankfort station. The alternators are single-phase, and work at 50 frequency. In spite of the fact that the single-phase system was adopted, the engineer of the works, Mr. J. G. Melms, determined to get a motor load. We have just received from that gentleman the report and accounts for the year ending March 31, 1897.

This is the second complete year of working, and a brief *résumé* of the striking items in the report and in the accounts will be of interest to our readers. The number of consumers for light and power at the end of March this year showed a large increase over the number given in the previous account. The equivalent of 8-c.p. lamps connected to the mains at that date was 91,600. Besides these, 133 motors of an aggregate of 1,063 h.p. were being supplied. The farthest consumer is situated at a distance of about four miles from

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the central station, and his load is equivalent to 30 kilowatts. The total number of consumers is now practically 600. The use to which the electric motors are put is detailed in the report, and the following items from the list are worthy of note. Twelve motors are used for working elevators, with an aggregate power of 82 h.p.; four motors in breweries, totalling 103 h.p.; 13 in printing establishments, equal to 120 h.p.; 11 in electrolytic processes, totalling 222 h.p.; six motors working coffee-roasters, 23 h.p.; four working refrigerators, 19 h.p.; 13 in engineers' workshops, 41 h.p.; 10 in butchers' establishments, amounting to 24½ h.p.; six in emery-wheel factories, 161 h.p.; six in carpenters' shops, 34·9 h.p.; and 14 motors driving ventilating fans, 28·3 h.p. The other industries employing motors with an aggregate of 15 h.p. and under reach the number 19, from which it will be seen that the small users of power in Frankfort have found the single-phase alternate-current motors to be quite successful commercially.

There are, in all, 12 boilers in the station, with a total heating surface of 11,100 square feet. In these boilers some 5,800 tons of coal were used during the past year. It is interesting to note that the coal per unit sold for the year averages 6·4lb., whereas for the previous year it stood at 7lb. per unit. The total number of engine-hours throughout the year was 11,355, during which 1,988,966 units were generated, as against 1,430,180 in the previous 15 months.

The following are the financial figures: The gross receipts amounted to £30,437, as against £28,672 for the previous 15 months. The income from lighting is a little lower, on account of the price per unit having been reduced from 10d. to 8¾d. per unit. The receipts for power, however, have increased from £3,017 to £5,051. The cost of working was £13,495, made up of the following items: coal and other fuel, £5,250; water, £537; oil, waste, and stores, £279; odd material, £216; salaries and wages, £4,669; insurances, sick fund, etc., £80; accidental and fire insurances, £32; office expenses, £1,851; rents, £198; taxes, £30; depreciation, £237; up-keep of meters, £115. The gross profits thus amounted to £16,941, as against £15,290 for the previous 15 months. Of this sum the interest and depreciation amounted to £10,507, which leaves a net profit of £6,130. The capital expended on the works up to the present is £144,857, and details of this cost are as follows: land, £11,350; buildings, £24,682; engines and dynamos, £33,835; instruments, £300; spare parts, £1,039; transformers, £9,281; mains, £35,742; house connections, £1,237; street work, £12,742.

The following is the tariff for motors at the present time in force at Frankfort. The charge is 2½d. per unit, with the following rebates: 5 per cent. if the motor is used more than 750 hours per annum; 10 per cent. if used more than 1,000 hours; 20 per cent. if used more than 2,000 hours; and 25 per cent. if used more than 2,500 hours. It will be seen from the above that the income from the motor load pays the whole cost of coal for the station, with the exception of some £200. A very regular day load is obtained from these motors, and as the large units have to be run throughout the day this is most valuable. The station is now being enlarged, and a 1,500-h.p. steam alternator is being laid down. It is hoped that the new set will be put to work in November next. Mr. Melms is to be congratulated on the success of the station.

BRITISH ALUMINIUM COMPANY.

OPENING OF NEW CARBON FACTORY IN GREENOCK.

On the invitation of the directors of the British Aluminium Company, Limited, a large gathering of gentlemen on the 4th inst. attended the opening of the company's new carbon factory in Baker-street, Greenock. Among those present were Lord Kelvin, Mr. John Scott, C.B., Mr. Ristori, Mr. J. Cunningham, Mr. Colin MacCulloch (town clerk), Mr. Thomas Wilson (secretary and manager Greenock Harbour Trust), Mr. Robert Gilmour, C.E. (superintendent Greenock Water Trust), Mr. Alex. Orkney (architect of carbon factory), and Mr. Herbert J. Bubb (manager).

We are indebted to the *Greenock Telegraph* for the following description of the works and for Lord Kelvin's speech.

This is the fourth factory that the company has erected in Great Britain, to deal with the various processes necessary to transform the crude clay, found in abundance in the North of Ireland, into aluminium. The factory at Greenock differs from the other three in one essential particular, in that it has no dealing with the metal in any form whatsoever for the purpose of manufacture. The business carried on here is the manufacture of the carbons employed in the electric furnaces at Foyers. The raw material treated is the carbon deposited in gas retorts, in the manufacture of coal gas; a portion of the gas becomes decomposed at the exceedingly high temperature, and leaves a hard mass of carbon against the sides and ends of the retorts. This, on arrival at the works, is roasted, ground, and moulded by a special process under hydraulic pressure to the form required; it is then passed through an annealing oven, and emerges as a solid block of carbon. The company also manufactures carbons for electrolytic work for other consumers, and is already contemplating considerable additions to the plant to cope with the demand. The factory is built on the site of the old Baker-street sugar-house. It is a piece of ground about 300ft. long, extending about 200ft. along the east side of Baker-street. Of the sugar-house there is very little left standing, the fire of some 30 years ago having demolished the greater portion of the buildings. The existing packing-room and cooperage is, however, with the exception of some slight alterations and repairs, just as it was in the time of its previous occupancy, but has been fitted with suitable arrangements for the despatch of the finished products. Advantage is taken of the nature of the ground, the upper entrance from Ingleston-street being used for taking in all the raw material and coal; and from its proximity to the railway sidings, this is especially suitable. During the process of manufacture the material gradually makes its way down to the north-west corner of the factory, and is then taken out from the Baker-street gate down for shipment per the company's own steamer at the Victoria Harbour.

The buildings consist for the most part of light fireproof structures, one of which, the furnace building, extends nearly the whole length of the ground, and is about 250ft. long by 40ft. wide. Adjoining this are other buildings of a similar construction, which have all been designed for the special purpose of this manufacture. In the large building is a long annealing furnace, novel in design, especially constructed for the process. It consists of a brick arch nearly 180ft. long, and is heated by gas, produced in an adjoining building, by the process of the Dowson Economic Gas and Power Company, Limited. The various contractors for the buildings and machinery are as follows: Brownlie and Murray, ironwork; A. Whitelaw and Co., buildings, excavation, and furnaces; Austin and Kinnaird, joinery work; Blake, Barclay, and Co., gearing, mixing, and conveying plant; John Wilson and Sons, hydraulic plant; the Greenock Foundry, furnace carriages; D. Stewart and Co., Limited, steel troughs; Gilbert Gilkes and Co., Limited, turbine; Alexander Brown and Sons, mill gearing; Robert Patrick, furnace fittings and ironwork. The engineers and architects were Messrs. M'Arthur and Orkney, and the construction of the entire works has been supervised by Mr. H. J. Bubb, the company's resident manager.

The company invited to the inaugural ceremony at the factory were entertained to cake and wine in the offices of the works. On the motion of Councillor John Black, Lord Kelvin was called to the chair. After the usual loyal toast,

Lord KELVIN, who was cordially received, said the occasion that brought them together was the inauguration of a factory for carrying on a new branch of industry. The great development in the application of electricity to the arts which had been made within the 60 years of the reign of Queen Victoria, with the increased vigour and rapidity of production within the last 20 years, had led to new ideas in respect to mechanical engineering generally—new ideas as to the possibilities of chemical work and new developments all round. He need not speak of these two

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larger subjects. One very important development was the electric furnace. The application of power for generating heat was not as a rule an economical way of producing heat. In the first place, generally they got heat first, and then got power from it. If they got power first, then the use of that power for the generation of heat was part of the economy of the forces of nature. Without going deeply into the subject, to those who would follow him in the science of thermo-dynamics he would say it was a very important proposition regarding the relation between heat and power—if heat was wanted at a low temperature, as, for instance, the heating of a building for warming the air within the building, it would be an exceedingly uneconomical way even if water power was used to produce heat from friction. On the other hand, if they wanted heat at a temperature of 1,200deg. or 1,000deg. C., it could be obtained with exceedingly good economy. Motive power might be applied in friction, but that would be a crude and inconvenient way of taking heat from power. On the other hand, electricity did it directly. There was no mechanism whatever in the development of heat, only that exceedingly simple and beautiful machine—the electro-dynamo. In the water power driven dynamo they had one of the best pieces of mechanism founded on scientific principles which they possibly could have for the generation of heat at a high temperature—that was the electric furnace, which had already been turned to splendid account in scientific investigations by the great French chemical discoverer, Moissan. In the arts there were more applications of it than he could tell them of just then—in fact, he did not know quite all of them; he had only heard of some of them. There was one very splendid application of the electric furnace for the arts in Scotland at the Falls of Foyers. That magnificent piece of work of the Aluminium Company was, he thought, the beginning of something that would transform the whole social economy of countries such as the Highlands of Scotland, where water power abounded. He looked forward to the time when the Highlands would be repeopled to some degree not with cultivators of the soil, but repeopled with industrious artisans doing a large part of the work of the United Kingdom from the water power of Scotland. The aluminium works were exceedingly popular in the locality. He believed all the residents were very glad to have the Aluminium Company with them. He thought it was only at a distance that the sentimental question as to what would become of the beautiful Falls of Foyers disturbed people. The Falls of Foyers were going on in all their beauty, and many a long year might they be doing so. He did not utter the aspiration of himself that they should go on, because he thought when the time came that every drop of water that now tumbled over that magnificent waterfall was turned to work for the benefit of the people, no wise man in the neighbourhood who thought of the good of the people would regret that the power in that waterfall was being turned to account for the good of mankind. Having alluded to the part played by the electric furnace in the production of aluminium, Lord Kelvin said that until recently, at all events, they had none of the fundamental buildings, so to speak, of the electric furnace made in this country. Until this factory in Greenock was started they depended for the carbons with which the electric furnace was lined—the building stones of the furnace had to be got from abroad. Now they were produced in Greenock. That, however, was a comparatively small part of the work for which that factory was destined, for the walls of the furnace lasted for six months. If the renewal of these furnace walls every six months was all that was wanted, there would not be much work for the factory; but that was not all. In the preparation of aluminium, carbon was given and aluminium taken in virtue of power supplied by the waterfall. For every ton of aluminium taken about one ton of carbon must be used, and this involved a pretty rapid consumption of carbon. A large part of that work would be devoted to the manufacture of great blocks of consolidated carbon, the process of making which some of those present had already seen, and which they were all going to look at presently. It was, he was sure, an interesting thing to have in Greenock a work immediately useful in supplying the aluminium works at Foyers with their requisites, and useful also for the calcium carbide process which at that moment was being carried on at Foyers, and used in connection with other developments of science. This was the first factory in the British dominions in which carbon was prepared in proper shape for use in the electric furnace. He was sure they would all consider it an exceedingly interesting subject to think of that day, that their meeting was for viewing and inaugurating a process of very great importance, and of extreme scientific and practical interest to them all. He had the honour to propose, in connection with the opening of this work, "Success to the Town and Trade of Greenock." So far as trade was concerned, this new factory was not a large addition to the works being carried on, but in these times the addition of a work such as this in any town of the United Kingdom was welcome. He was sure Greenock would be glad to see that a place which till two years ago was occupied by an old sugar refinery was now turned to good account.

Other speeches followed, after which the works were inspected by all present.

ELECTRIC METERING FROM THE STATION STANDPOINT.*

BY CARYL D. HASKINS.

It has occurred to me that in presenting a paper to the institute upon such a subject as that which I have selected, I may appear to have departed too entirely from the technical side of our profession, and to have selected a line of argument which would have been more appropriate before a more commercial body. But in my opinion such is not the case, for I find that almost every merit in, or objection to, metering apparatus, or in connection with the use of it, is dependent upon some point involving engineering skill.

The general adoption of the electric meter is in itself an endorsement of the precise methods which characterise engineering practice. It is, indeed, a well-established fact to-day, well borne out by data from widely separated portions of the country, that the average electric lighting station can do one-third more business with the same station capacity on a meter basis than it could upon a contract basis, under what were nominally equivalent contract rates, netting at the same time the same revenue per light as formerly. In other words, it is apparently well established that 33⅓ per cent. represents the average wastefulness of average human nature in connection with the use of light.

In many central stations to-day I find that, whilst managers are almost universal in favour of an exclusively meter basis, a large proportion are still in ignorance as to what qualities they should seek and what they should avoid in selecting a meter.

In response to an enquiry as to what merits in a meter are necessary to success, a common reply is, accuracy, durability, registration in a simple unit easily comprehended by the customer, and ability to withstand tampering. These points are probably of importance in about the sequence in which they are commonly stated; but they are too sweeping, too entirely generic, and too slightly specific to be in any high degree helpful.

Let us, for example, consider the broad question of accuracy. A meter which will be accurate under commercial conditions from quarter load to full load within one-tenth of 1 per cent., or a meter which will start on 1 per cent. of its rated capacity, are neither of them necessarily either the most accurate or the best for general commercial use. This latter point is one which is frequently raised. The fact that a meter will start on 1 per cent. of its rated capacity is in reality no sure criterion of the accuracy of that meter, even on light roads. It is not necessarily even good evidence; yet I find that

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in very many cases this is almost the only test applied to meters at the time of purchase. The percentage of accuracy at light loads is very important, more important, I believe, than is commonly appreciated; but I am perfectly safe in saying that a meter which will run within 5 per cent. of zero error on 5 per cent. of its rated capacity may readily be a much better meter, even though it will not run at all on 1 per cent. of its rated capacity, than one which will run on 1 per cent. of its rated capacity, but in regard to which no evidence is at hand as to its percentage of accuracy at reasonably low loads.

Ability to start on very light loads is certainly an indication of merit, and is important, but it is not nearly as important a point to determine as is the lowest load at which a meter begins to register with fair accuracy. I have inspected a very large number of meters which would start on phenomenally low loads and which would yet fail to give anything like approximate accuracy at reasonably low loads.

In considering the question of accuracy, therefore, the first two steps should be to determine the accuracy of the meter by actual measurements at full and medium load; and also at a reasonably low load; say, for example, 5 per cent. of the meter's rating.

That low-load accuracy is really of vital importance is well shown by the fact, that with the average 24-hour station, in the neighbourhood of 15 per cent. of the total station output goes to feed one and two lamp loads. Yet in the face of this I have seen large installations of meters reported as entirely satisfactory, tested with frequency and care under admirable systems, but only at full or medium loads, and yet failing to account for more than 50 per cent. of the one and two lamp loads, or, in other words, losing to the illuminating company an average of probably 7½ per cent. of the revenue which their measured station output should give them, after deducting for legitimate losses.

Granting that, having determined the actual percentage of accuracy obtainable at light, medium, and full loads, a very important, and, in fact, probably the most important evidence as to accuracy has been obtained, there still remains much information of vital importance which should be sought and which should materially influence a decision.

One point which is very commonly neglected, but which is nevertheless quite essential, is the ability of a meter to give accurate results for brief periods on overloads. This is a point at which many meters fail, and it is also a point which, odd as it may seem, is intimately related to light-load accuracy. It may be laid down, as a rule, that in station operation the smallest meter which will do the work should always be used. Otherwise, however good the meter on light loads, much of the light-load revenue must be lost in the effort to take care of occasional heavy loads. Extremely heavy loads are generally of brief duration, and on these loads a meter should operate with accuracy and also without injury to itself. This, therefore, should be an early point of investigation in selecting a meter.

On alternating circuits, inductive loads are becoming commoner every day. The wider use of fan motors and other alternating power devices, the rapidly growing popularity of alternating-circuit arc lamps, and the commoner use of inductive dimmers, all render it essential that a meter should be accurate irrespective of the power factor. The company which insists upon charging its patrons for power delivered to fan motors on a basis of volt-amperes, is obviously rendering itself unpopular, greatly limiting its business, and giving its competitor or competitors the best of opportunity for intruding, yet many such companies exist to-day, and they exist not because they are following a wise policy in their own estimation, but because they are ignorant of what they should look for in the meter which they are using.

Again, there are a few electric light stations to-day of any considerable size and age which are not operating some smooth-core and some tooth-core alternating armatures. It is therefore important that the meters in service at such stations should be equally accurate on any shape of wave, yet many meters fail in this particular, and seldom, if ever, is the point made a subject for investigation in selecting measuring apparatus.

This same consideration holds good in connection with frequency, and this is a point which it is difficult to overcome in most metering devices, but it is one which should be earnestly sought, and which is of importance both to the station and to the consumer.

Even after this long list of points which must be investigated, as contributing to the broad question of accuracy, there are others which also merit consideration, but to a less degree. Such, for example, as barometric conditions (more especially altitude), temperature, and humidity. These all have direct bearing upon the question, and all enter into the everyday conditions of central-station practice.

Summing up the question of accuracy, we may say, therefore, that the following points should be investigated with care: ordinary volt-ampere accuracy; accuracy on inductive loads; accuracy on varying wave forms; accuracy on overload; accuracy on varying frequencies; influence on accuracy of variations of temperature, barometric conditions, and humidity.

The second point, which is commonly given consideration in the selection of a meter, is that of life. This is a question which must depend more upon good judgment than upon any test which can be applied; for it is in reality no test of the enduring qualities of a meter to run it at excessively high speed for a relatively brief time. The life of a meter, in other words, cannot be measured by revolutions, irrespective of the speed of those revolutions, nor can it be determined by the speed at which it rotates alone.

Ninety per cent. of all the wear in a meter centres in the case of motor meters at the single jewel bearing, which is almost universal. The two chief factors which have influence upon the mere mechanical life are the weight of the moving mechanism and its speed, the variation of the area of the point of contact being of course always so small as to be out of consideration.

A low-speed meter is usually the best meter, provided the speed be not carried so very low as to threaten the accuracy of the meter on light loads, by reason of being held up by intermittent friction in the form of dust or a spider. Practice has indicated that low speed is more conducive to long life than is light weight of the moving mechanism, although both are, of course, very important. More important than either, however, is the quality of the material used at the points of friction and the ease with which the friction parts can be renewed. The best of sapphire is barely good enough, and the pivot end must be of correct shape, burnished to the highest degree, and its point must be absolutely concentric with the centre of movement.

More than half of the meter jewels which are destroyed are rendered useless, not by the rotary motion of the shaft, but by reciprocating motion of the shaft, due to vibration. Hence it is very necessary that the jewels should be in some way cushioned, for vibration cannot be always avoided.

These are all, I admit, mechanical considerations, but they compass much of failure or success in electric metering The purely electrical features of the meter contribute no grave factor of consideration in connection with the life question, always supposing that the copper is ample and the potential windings are so distributed and so ventilated as to preclude a burn-out.

Passing over the central-station man's third factor for consideration, that of the best unit of measurement, as one which is practically a closed question, we are brought face to face with his lamentable fourth point, the necessity that the meter should be able to withstand tampering. It is a regrettable fact that this is a consideration which is coming daily into more prominence; but light has to be sold to all sorts and conditions of people; and apparently the transgressor against meters is even more common than the transgressor against taxes; and this is a growing evil, largely, perhaps, because of the lax conditions of the laws, which can be invoked to protect the meter owner in many of our States.

The methods which are commonly practised in tampering with meters can scarcely form any proper part of a technical paper; but as this paper may go into the hands of some who need the knowledge to guard themselves and their interests, it can do no harm to briefly state the common

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methods used, not only that they may be guarded against, but also that meters may be selected which lend themselves least readily to such practices. It is not unusual to place large masses of iron above, below, or at the side of meters, but this practice is falling somewhat into disrepute among its advocates, since even they have in time discovered that there is a class of meter which it accelerates. Electromagnets, drawing their energy from the circuits under measurement and used as the iron was formerly used, are now not uncommon, and it is difficult to prove in court deliberate evil intent. Meter covers and bases are drilled and wires, broom straws, and the like inserted. Covers are pried up and healthy colonies of spiders introduced. Ingenious individuals have even been reported as finding profit in a clever apparatus for injecting fine iron filings into meters by means of a bellows. All of these things need to be watched for and guarded against.

The question of installation and care of meters is a wide subject, and in connection with it I shall endeavour to mention only a few salient points, selecting those which are most commonly overlooked or neglected. The most radical cause of trouble in connection with installation is vibration and the consequent reciprocating motion of the shaft; for this reason the most solid of foundations should be selected, the neighbourhood of moving machinery should be avoided, as should also partitions of light construction in which doors are located. The rhythmic vibration of moving machinery is infinitely more dangerous than occasional heavy shocks. Meters should be installed as near to the foundation as possible, not, as is now quite common, at the top of buildings, where the amplitude of all vibrations is of course much greater. Locations where great variations of temperature occur are undesirable. For this reason, also, basements are preferable to attics.

A very common error, causing the loss of very many meters annually, by the burning out of the potential circuits, occurs in connection with the metering of power delivered to motors. In the effort to save the very trivial amount of energy passing through a potential circuit, it is very common to instal meters on the motor side of the controlling switch. This not only exposes the meter to the full force of the field discharge, but it also results in the constant cooling and heating of the potential winding, and the resultant expansion and contraction chafes and weakens the insulation, and also weakens the wire itself at the turns, opening the path for a final breakdown either by a lightning discharge or by a field discharge.

As to care of meters. It is a fallacy to suppose, as many insist upon doing to-day, that meters should require no care whatever. Almost all meters will continue operative for a very long period without any care whatever; but the cost of a cleaning and testing visit twice annually is trivial as compared with the good results which follow such a system, by reason of the better light-load accuracy obtained. It is not, I think, too strong a statement to say that such a system will have an influence for good, amounting to from 3 to 5 per cent. on the meter readings annually.

Central-station managements have probably given more attention to systematic methods of meter reading than to any other one point contributing to success. The old and faulty plan of reading the dials of a meter at the time of the visit to the meter is fast giving place to the better system, which provides the reader with a *fac-simile* of the meter dial in blank upon a page of his meter-book. This *fac-simile* is roughly marked in pencil to indicate the position of the hand at the time of the visit. These *fac-similes* are taken into the office and are all read by one individual, who is an expert in meter reading, and who sets down the consumption under the *fac-simile* on each page. Such a system commonly reduces the errors from about 10 per cent. per month where they not uncommonly stood under the old system, to materially less than 1 per cent. under the new, for, surprising as it may seem, it is an extremely easy thing to make mistakes in reading meter dials.

In changing from the old and not infrequently popular contract system, a good many central stations in the earlier days made the grave blunder of going on to the new basis during the winter months, with the result that the highest bills of the year reached the customer after a long period of indulgence under the contract system, and the result at times proved temporarily disastrous.

Even to-day the pernicious influence of uniform bills the year through, which was created by the contract system, still lingers, and the proportion of customers who complain because their winter bills are materially higher than their autumn and summer bills is quite considerable.

It will be said that the explanation is sufficiently simple, but, unfortunately, however good and however simple the explanation, it has proved no simple matter to secure its acceptance and credence. I have lately been much impressed by a system which has recently been adopted by a prominent Western company to at least partially offset this difficulty. During the months which are growing darker, they read their meters a day or two earlier each month, thus arbitrarily creating shorter months, whilst as the year progresses to the period of lighter days, the months are lengthened. This tends somewhat to even up the bill, is apparently quite as satisfactory to the customer, and is certainly entirely just and has created a very great falling off in the complaint list, for the character of the complaint keeps pace with the period of the year. Out of the hundreds of complaints which I receive annually, I find that by far the greater proportion in the summer are of slow meters and in the winter of fast meters.

I do not feel that I shall be doing justice to my subject should I fail to make at least brief mention of the application of meters to the measurement of station output. The gas companies, to whom all central stations look for precedents, long ago found it imperative that they should have some means of determining just how much of their commodity they produced and sent out through their mains. In all commercial enterprises it is difficult to satisfactorily guide and control a business, unless there be some positive means of determining how much of anything is produced, and it is surely just as important to all electric lighting companies to know how much of their commodity they manufacture as for any other concern. Until quite recently it has not been possible to obtain recording meters sufficiently large to care for the heavy outputs which are now so common, but such meters are now readily obtainable.

The value of a system of station meters must necessarily prove very great, since it furnishes an absolute check system upon coal and water consumption, and engine and dynamo efficiency, whilst it also furnishes a ready means for comparison between station output, customers' meter indications, line losses, leaks, and grounds.

(To be concluded.)

CIRCUIT BREAKERS A STEP BACKWARDS IN ELECTRICAL PROGRESS.*

BY HARRY H. CUTLER.

A great deal of interest is being taken of late on the subject of the unreliability of fuses, and the advisability of more thoroughly protecting electrical circuits by means of circuit breakers. We have read many excellent articles in the leading electrical journals, showing the wide variations of current at which fuses blow, and giving elaborate tables and plotted curves.

The drift of most of this work, however, appears to be in the direction of attempting to prove that fuses are unreliable, rather than in searching for a way to make fuses reliable. Everybody knows who has given electrical matters any study at all, that electric lighting and electric transmission of power would have no commercial existence at the present time, if it had not been for the fuse. We might possibly get along without them now, with our present knowledge of electrical devices, but the development of incandescent lighting in the early eighties could never have been accomplished without this same much-abused fuse.

I have heard people, supposed to be well posted in electrical matters, state that fuses are unreliable because they know of three instances where they had been taken out and copper wires substituted for them, even in one case inserting a "rusty nail." Therefore, they agreed that as

* From the *American Electrician.*

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fuses were easily tampered with, they should be protected by circuit breakers. One would think from this that a circuit breaker could not be tampered with.

I have also heard a great many people state that electricity is dangerous, and that quite a number of people have been killed by it; therefore, it follows from the above method of reasoning, that a man should always be careful to drop a nickel in the slot, and take out an accident policy, before entering a street car.

I have heard others give as a reason for preferring circuit breakers, that fuses do not act quick enough. It is for this reason that we see great long rows of circuit breakers on the switchboard of every railway power-house, with a man chasing himself up and down, to throw them in every time they go off with a flash and a bang, like the discharge of firearms. This is all very nice for the manufacturer of circuit breakers, but very expensive and annoying for the railway companies, and, in my opinion, entirely unnecessary, and a step backward in electrical progress.

A fuse properly constructed is the most reliable of anything on the market for opening a circuit under any and all conditions. A circuit breaker, as usually constructed, is, in nine cases out of ten, nothing but a nuisance, because it operates nine times out of ten, when there is no real necessity for its doing so, and the tenth time, when it is actually necessary to open the circuit, a properly constructed fuse would have answered just as well. I know that this is a very broad and sweeping statement, and will be promptly turned down by most engineers who read this article as utterly absurd. The whole trouble with fuses is that they are not made right. They are constructed in direct defiance to the very laws which cause them to act. In the early days, when I was running my first central station, in 1885, a fuse consisted of a round thread of lead wrapped around a screw head fastened to a wooden block. This same fuse is in extensive use to-day, and can be purchased in any size at any supply store. I have a big one on my dynamo at my factory to-day. Many a time, in the early days, I have been rung up by 'phone in the middle of the night, and have gone down to some old saloon full of drunkards, crawled up on a step ladder, and tackled a rosette, arranged so that if I could walk on the ceiling like a fly I could have more easily removed the fuse, burned out under the screw-head, and put in another.

I soon got sick of this sort of thing, and clamped all my fuses with pieces of sheet copper, and put the copper under the screw-head, and my troubles on this score ceased. Other people, naturally enough, discovered the same remedy. Someone, I forgot his name, patented it, and put the well-known copper tip fuse on the market. This was a great step in advance. But here we have stopped.

Electric lighting then made enormous strides, and fuses of greater carrying capacity were required, so flat strips of lead were securely fastened to copper terminals, and screwed or bolted to large blocks of copper or brass. This is the standard Edison fuse of to-day—a monument of monstrous stupidity, and a disgrace to the electrical profession.

Now, let us consider what it is that causes a fuse to blow and open the circuit. Is it not simply that the fuse offers a resistance to the passage of the current, gradually getting hotter and hotter, and finally getting so hot that it fuses, hence its name? Of course, fuses are frequently burned out by having a poor contact on the terminal, but this is remedied by the copper tip, as pointed out above. If there is any other cause of fuses blowing I do not know it, and should like to be informed.

I take the ground, then, that fuses blow because they get hot and melt, and that this is the reason why they blow at almost any amount of current they may feel like accommodating at the time.

What causes anything to get hot? The source of heat is supplied faster than it can be dissipated. How is heat dissipated? Chiefly by radiation and conduction.

How can we increase the properties of a body to dissipate heat? In two principal ways: first, by increasing the radiating surface in proportion to the cross-section; and second, by increasing the amount of heat-conducting or heat-absorbing material in the immediate vicinity.

There used to be an old rule in practice amongst electricians that a copper bar having a cross-section of one square inch would carry 1,000 amperes without heating, and larger bars in this proportion. This is mere nonsense, but still to be found in many recent books and engineering leaflets. All up-to-date central stations save copper by using laminated 'bus bars, each bar being wide and thin, thereby securing a large radiating surface. Three thousand amperes can easily be carried per square inch of cross-section in this way. Edward Weston uses the same principle in his shunt block for his switchboard instruments.

The much-abused fuse is also made thin and wide for large sizes, thereby dissipating the heat to the best advantage, to say nothing of the enormous heat-absorbing power of the massive blocks to which large-sized fuses are connected. This is just what is not wanted. No wonder fuses are slow in blowing and unreliable, exposed to draughts of air, and their action retarded by the slowness with which large masses increase in temperature. In regard to this latter property, I spent a great deal of time and money some years ago experimenting with hot wires. I constructed several large ammeters, based on the principle of the expansion of wires by the heating effect of the current passing through them. I built one ammeter reading to 500 amperes on this system. It took, I believe, about ¼ h.p. to operate it, and I abandoned the principle for that reason.

Now, if the 500 amperes had been carried through one large ribbon, it would have taken at least three minutes to heat up and cause the needle to move over the scale to the 500-ampere mark. The instrument was constructed differently, however; it had a very fine wire, which carried a very small proportion of the current, and therefore got hot very quickly. The rest of the current was shunted around the fine wire. The result was an absolutely dead-beat instrument, with a rapidly moving needle. The Cardew voltmeter is another well-known device, having an extremely fine wire which expands instantly the current passes through it.

With the above facts before us, can we not see how fuses should be constructed? If a quick and accurate blowing fuse is desired, it can be constructed as follows: First, so enclose it as to protect it from draughts of air, thereby stopping the dissipation of heat through radiation and convection. Second, make the distance between the fuse proper and its terminal block so great that little heat can be lost through conduction. Third, make the main fuse out of a number of small round fuses connected in multiple to the two terminal blocks. I will guarantee to connect such a fuse in series with any circuit breaker ever yet put on the market, short-circuit 220 or 500 volts through these devices, and blow the fuse.

But do we want a fuse that will blow as quickly as this? In my opinion, no. It would be just as much of a nuisance as a circuit breaker is. A word as to why it is not advisable to open a circuit too quickly.

First, then, why do we want to open the circuit at all with overload devices? Because, if a large amount of current were allowed to flow, much damage would be done to the motors, generators, lines, etc. What would this damage consist of? The armatures of the motors would get hot, and burn out. Their commutators would be scarred. The lines, switches, etc., would get hot and fuse, if we did not protect them. The trouble, then, is almost entirely caused by heat. Does anything get hot instantly? I think I have made it clear that it takes time to heat anything. Why, then, do we want to open a circuit instantly? There are other reasons, which I will mention later.

Every electrical engineer knows that any good motor will stand a 100 per cent. overload for a few seconds without damaging it in the least. If this load continued for, say, a minute or two, the armature would probably burn out. A great many motors have to be started under full load, especially those operating street cars, elevators, hoists, long lines of shafting, etc. In all of these cases the motor cannot be started except with a current which, if continued for a minute or two, would be liable to damage the motor. The fire departments of some of our large cities are going so far as to compel the installing of circuit breakers on motors operating electric elevators, with these results.

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The elevator, as a rule, cannot be started when loaded with passengers or freight, except by using much more current than is required after the motor attains full speed. If a motor is used of the proper size to operate the elevator at full load, it becomes overloaded at the start. This means that the circuit breaker has to be set so high that it becomes of no practical use whatever. If set for 50 per cent. overload it would not operate to protect the motor after it is running and warming up, and would therefore be of only imaginary protection.

If set below 50 per cent. overload it would be continually going off, while starting, stalling the elevator, and obliging the operator to crawl out of the car the best he could, and go down to the cellar and thrown in the circuit breaker. I have seen a great many circuit breakers on electric elevators, and have always noted one or the other of two things. First, the circuit breaker was set so high as to be of no protection whatever; or second, the motor was a great deal larger than there was any real necessity for; so that the starting load never exceeded the maximum continuous safe carrying capacity of the motor. In other words, the motor was installed to fit the circuit breaker. One prominent elevator company that I know of uses a 30-h.p. motor to do 15 h.p. work, and goes about blowing that its starting current is less than its running current.

Now a fuse of large cross-section, protected from the air, is ideal for this class of work, because, first, it has a time limit, and, second, it has no machinery to get out of order. Why, then, do we use circuit breakers? I say it is because we can buy no good fuses on the market. What's the matter with making some good fuses, built on correct principles? I saw some the other day. I don't own the patent. I wish I did. They are enclosed air-tight. They are accurate. They don't make any flash, or spark, or noise. You wouldn't know the circuit had been opened, and have to test it to see if it really has. I saw several blow at 150 amperes and 3,000 volts. You would never know anything had touched them. Figure out the horse-power of these figures, and imagine how a circuit breaker would have to be built, and what it would do under these conditions. This same make of fuses was tested recently for the benefit of the electrical inspection department of one of our large cities. The chief of this department did not even take the trouble to be present while they were tested, but was present when a certain circuit breaker was tested, and has passed a rule obliging all motors to be installed with an approved circuit breaker, thereby compelling people to go to the expense of purchasing an instrument that in nine cases out of ten will prove nothing but a nuisance. Now, I manufacture circuit breakers; I sell lots of them, and expect to continue to. My circuit breaker is as good as any circuit breaker on the market; better than a great many of them, but not as good as a good fuse.

A word more about using circuit breakers on the feeders of street railway lines. It is claimed that circuit breakers in these feeder circuits must act instantly, otherwise there is a liability of diminishing the voltage on the other feeders, or of throwing the main circuit breakers, and thereby shutting down the whole plant There is a great deal that could be said on this question, both for and against, but argument aside, if you must have the feeder circuit open quickly, why not use multiple fuses, contained in one cartridge, and have several extra cartridges ready to connect in with a plug or switch. I think personally that every circuit breaker should have a time limit. I know of at least one other manufacturer of circuit breakers who agrees with me, but he is a thorough electrical engineer of wide experience. The other manufacturers of circuit breakers are sitting up nights trying to design circuit breakers that will act quicker than the other fellows', and will probably promptly deny that a fuse can be made to act quicker than a circuit breaker, and will shed salt tears if they come out to Chicago, and bring one of their circuit breakers with them, and hitch it up in series with a properly designed fuse, and see the fuse blow.

Manufacturers of circuit breakers need have no fears, however, that their business will suffer through this article. It takes times to blow the fuses we now have in common use, and it takes time—a very long time—for the public to find out what is good and what is bad. If someone should discover to-morrow how to obtain power from the sun to run their machine while the sun shone, and store up enough power to keep going on cloudy days, people would keep right along buying steam-engines for 50 years to come.

It will take the managers of steam railways 10 years to wake up to a realisation that they can operate their roads to better advantage by using electricity. It will take time to get good fuses on the market, and I hope some time in the near future to have the pleasure of reading an article which will attempt to prove that a circuit breaker is more reliable than the properly constructed fuses to which I have referred.

THE BRITISH ASSOCIATION.

The *Times* has published a good forecast of the proceedings of the above association, which meets at Toronto on August 18. The papers and authors in the following section will show our readers what subjects are to be under discussion:

Section A (Mathematics and Physics) will be presided over by Prof. A. R. Forsyth, F.R.S., of Cambridge, and the following papers will be read:

"Vector Analysis." Prof. Henrici.

"The Historical Development of the Abelian Functions." Dr. Harris Hancock.

"On a New Method of Determining the Specific Heat of a Liquid in Terms of the International Electrical Units." Prof. H. E. Callendar and H. T. Barnes.

"On a Simple Modification of the Board of Trade Form of the Standard Clark Cell." Prof. H. E. Callendar and H. T. Barnes.

"On the Behaviour of Argon in X-Ray Tubes. Prof. H. E. Callendar and H. T. Barnes.

"On a Research in Thermo-Electricity by Means of a Platinum-Resistance Pyrometer." H. M. Tong (communicated by Prof. H. E. Callendar).

"On the Determination of the State of Ionisation in Dilute Aqueous Solutions containing Two Electrolytes." Prof. J. G. MacGregor.

"The Great Lakes as a Sensitive Barometer." F. Napier Denison.

"On the Canadian Standards of Length and Weight." J. Loudon, B.A. (University of Toronto).

"Observations on the X Rays." J. C. M'Lennan, B.A. (University of Toronto).

"An Imperial Hydrographic Survey." Prof. A. Johnson, M.A., LL.D., Montreal.

"On the Solution of the Cubic Equation." Alex Macfarlane.

"Monthly and Annual Rainfall in the British Empire, 1877-96." John Hopkinson, F.R.Met.Soc.

"Multiple Partitions of Numbers which Possess Symmetrical and Quasi-Symmetrical Graphs in Three Dimensions." Major P. A. Macmahon, F.R.S.

"On the Variation of Magnetic Hysteresis with Temperature." F. H. Pitcher, M.A. (University of Montreal).

"On Certain Points Connected with the Electric Arc." Mrs. Ayrton.

"On the Determination of the Ohm by Lorenz's Method." Prof. W. E. Ayrton, F.R.S., and Prof. J. Viriamu Jones, F.R.S.

"On the Use of a Constant Total Current Shunt with Ballistic Galvanometers." Prof. W. E. Aryton, F.R.S., and J. Mather.

"The Sensibility of Galvanometers." Prof. W. E. Ayrton, F.R.S., and J. Mather.

"Short *versus* Long Period Galvanometers for Very Sensitive Zero Tests." Prof. W. E. Ayrton, F.R.S., and J. Mather.

"Oscillagraphs." W. D. B. Duddell.

"The Variation of the Constants of Some Important Direct-Current Electric Supply Meters with Temperature and the Current Passing." G. W. D. Ricks.

"On the Cyclical Variation with Temperature of the E.M.F. of the H Form of Clark's Cells." F. S. Spiers, B.Sc., F. Twyman, and W. L. Waters.

Report on Electrolysis III.—"The Theory of the Migra-

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tion of Ions and of Specific Ionic Velocities." W. E. Dampier Whetham, M.A.

Prof. O. Lodge has also promised an account of Zeeman's discovery of the effect of a magnetic field on the lines in the spectrum with a view to discussion on the subject, and it is expected that there will be an important discussion on the report on electrolysis.

Section B (Chemistry) will be presided over by Prof. W. Ramsay, F.R.S., of University College, London, whose name is so intimately associated with that of Lord Rayleigh in connection with argon. The subject of his presidential address is, "An Undiscovered Element." It will deal with arguments, based on the periodic arrangements of the elements (Mendeléef's table), to show why it is reasonable to suppose that an element with atomic weight 20, and density 10, should exist, with properties similar to those of helium and argon. It will also give an account of a search for such an element, which, unfortunately, has failed to yield any positive results as to its existence, although a number of other matters turn up incidentally, not directly connected with the main question. Apart from the president's address, the most important feature will probably be a discussion on the essential nature of the elements, to be held if possible in conjunction with Section A, and in which the president, Prof. FitzGerald, Prof. Brauner, of Prague, Prof. Richards, of Harvard, and others are expected to take part. Another interesting item will be the demonstration of the properties of fluorine by Prof. Mislans. In addition to these there will be a number of papers dealing with miscellaneous subjects, the most important of which are: "Explosion Flames," by Prof. H. B. Dixon; "Spectroscopic Examination of Minerals and Metals," by Prof. W. Hartley and H. Ramage; the absorptive powers of substances of different chemical constitution for the Röntgen rays, being one paper by Dr. Gladstone and W. Hibbert and a second by Dr. J. Waddell; "The Chemistry of Methylene," by Prof. Nef; "The Composition of Canadian Virgin Soils," by F. T. Shute; "The Structure of Crystals," by Mr. Addison; "The Plaster-of-Paris Method in Blowpipe Analysis," by Prof. Andrews.

Mr. G. F. Deacon will be president of Section G. Among papers promised for this section are the following: "A New Method of Measuring Hysteresis in Iron," by J. L. W. Gill; "A New Method of Investigating the Variation of the Magnetic Qualities of Iron with Temperature," by F. H. Pitcher; "Tests on the Triple-Expansion Engine at Massachusetts Institute of Technology," by Prof. C. H. Peabody; "The Strength of Columns," by Gaetano Lanza; "The Present Tendencies of Electric Tramway Traction," by J. G. W. Aldridge.

SHEFFIELD TRAMWAY REPORT.

The Traction Sub-Committee of the Sheffield Tramways Committee have recently visited Leeds to see the electric traction scheme nearly completed there, and have since reported to the Corporation as follows:

The sub-committee report that the following members of the Tramways Sub-Committee—Alderman Clegg (chairman), Sir Charles Skelton (deputy-mayor), and Councillor Carr, accompanied by the City Surveyor and Councillor Joshua Maxfield—visited Leeds on the 16th inst. to inspect the system of overhead electric tramways just about completed. The members were received by the deputy-chairman of the Leeds Highway Committee (Councillor Henry), Councillor Carter, and Councillor Ringrose; Dr. J. Hopkinson, the electrical adviser of the Leeds Corporation; Mr. Prince, the highway surveyor; and Mr. Wharam, the general manager of the tramways; and visited those sections of the old tramways which were being reconstructed and equipped for overhead electric traction. The rails which were being laid were of the girder section, weighing 100lb. to the yard. The Corporation purchase the rails by tender, and the laying is done by the Corporation workmen. Hitherto the copper bonds have been supplied and fixed by a firm of contractors, but the Corporation, finding the work could be more expeditiously carried out by their own workmen, are now doing the bonding, as well as the platelaying and paving, themselves, altogether about 1,000 men being employed.

In addition to the lines immediately to be worked by electric traction, the whole of the other lines, where heavy girder rails are not already laid, are being taken up. The old light rails are being replaced with the new pattern, electrically bonded; concrete is being laid where not previously used; the old concrete is being floated up to a proper contour to receive the flanges of the rails; and the tracks throughout are being repaved with granite from quarries in different parts of the United Kingdom, similar to those which are supplying the city of Sheffield. On certain routes where macadam was previously laid between the track and the channel, the space is now being paved with granite. The deputy-chairman of the Leeds Highway Committee stated that on steep gradients Dalbeattie, Llanbedrog, Newry, and Aberdeen granites were being used, but no whinstone was being used in Leeds at present.

After considering the information obtained at Leeds, the sub-committee consider it advisable that the city surveyor should be instructed to obtain tenders for girder rails of an approved section and weight, with the necessary fishplates, etc., and for the copper bonds, the laying and bonding to be done by the Corporation workmen; that when tenders have been accepted the sections extending from Nether Edge terminus to the Tinsley terminus, including the extensions in the centre of the city, should be commenced and carried out with as much despatch as possible, and in the manner following:

Existing Lines.—Nether Edge terminus to Sheffield Moor, opposite Brunswick Chapel.—With few exceptions, the whole of the rails need renewal. The paving, which is granite or concrete, is generally much worn, and should be taken up and relaid. Brunswick Chapel to Moorhead.—The rails are in fairly good condition, but, except for a few yards, of the old light pattern. These will, of course, have to be renewed. The paving, too, is fairly satisfactory, but some parts will have to be relaid with the lines.

New Lines.—Pinstone-street.—Partly old gritstone and partly new wood. The gritstone is worn out, and it is suggested it should be replaced by wood. It will, unfortunately, also be necessary to disturb the new wood paving, and the sub-committee recommend that hard wood should be laid between and immediately adjoining the rails, both throughout this street and in any other street where the lines pass through wood paving. Where red deal would, apart from the tramways, be preferable, it might be used between the track and the kerb, and this applies to Pinstone-street. Fargate.—The paving here is of wood, in good condition, laid in 1894. The remarks as to Pinstone-street apply here. High-street.—The paving from Fargate to Angel-street is in poor condition, being gritstone, temporarily laid. For this part of the street the sub-committee suggest hard wood between the rails and also one row outside each outer rail, with red deal at the sides of the track. The lower part of the street, formerly known as the Fruit Market, is of 10in. grit setts, recently laid, and in good condition. This material might be retained at the sides between the track and the channel, but it is thought that Dalbeattie or wood paving might be laid between the rails, and for about 18in. outside. It would be a difficult matter to maintain a good surface near the rails if gritstone was carried right across, on account of the great difference in the degree of hardness of the two materials, and also because the gritstone is laid in oblique courses. The gradient of the lower part of High-street is 1 in 17. Fitzalan-square.—The paving here is of gritstone in fair condition, and the same course might be adopted as in the lower part of High-street. Haymarket.—The paving in the Haymarket is of Dalbeattie granite on concrete, and was laid about 12 years ago. This would be retained, but the disturbance caused by laying the rails would necessitate the taking up and relaying of a large portion of the street. Advantage might be taken of the relaying to obtain a flatter crossfall. Waingate.—It is recommended that the whole length of Waingate be entirely paved with new gritstone setts laid on concrete. The gradient of Waingate is 1 in 15.

Existing Lines.—Lady's Bridge to Tinsley Terminus.—The rails from Waingate to the Golden Ball are generally in good condition, but of the light section, and will have to be replaced. From the Golden Ball to Tinsley most of the rails are worn out, and need early attention. The paving is of granite, most of it being on concrete. A considerable portion of the paving (particularly between the Golden Ball and Tinsley) would need taking up and relaying, and where there is no concrete bed one would have to be provided. The short length of girder rail in the Wicker, laid last autumn, is satisfactory, and could remain, bonding only being necessary. Briefly, the work included means the laying of new girder rails throughout the route (except where such rails already exist) electrically bonded, laid on a concrete foundation, with the necessary repaving. The rails would weigh 108½lb. per lineal yard, being of the section shown in the sketch submitted to the sub-committee by the city surveyor, and would be strong enough to carry any traffic that might be put upon them, whether worked by electricity, steam, or horses. No sole-plates are provided for, as, in the opinion of those members who visited Leeds, their advantages are counterbalanced by their drawbacks. In view of the information obtained during the visit to Leeds, the sub-committee recommend that tenders be invited for the supply of these rails, according to the specification and quantities

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presented by the city surveyor. It is recommended that the rails should be electrically bonded as they are laid. The cost of this work is small (in Leeds about £180 per mile of single track, but in Sheffield it would be rather more, on account of the longer bonds used), and it is certainly more economical to do it at once, as in Leeds, where some of the rails were nearly new and of satisfactory section, but had to be bonded *in situ*. The sub-committee understand the work cost about £1,200 per mile of single track. From the enquiries made it is considered very little disturbance of the rails and paving will afterwards be necessary in connection with the electrical equipment.

In view of the foregoing information, the Traction Sub-Committee make the following recommendations: "That it is desirable that the Corporation should themselves execute the works as above suggested. That the city surveyor be instructed to at once take steps to carry out the recommendations contained in this report of the sub-committee. That the class of rail suggested by the city surveyor be adopted."

The sub-committee gave instructions that the following firms be asked to revise and amplify, according to particulars to be submitted to them by the city surveyor, the tenders they sent in for the electrical equipment of about five miles of double line of tramway—viz., Nether Edge to Tinsley: the British Thomson-Houston Company, Messrs. Siemens Bros., Messrs. Dick, Kerr, and Co., and Messrs. Davey Bros., Limited. They also recommend that the assistance of an electrical expert be obtained, to go through and advise on such revised tenders, when received.

Tramway Extensions.—The Traction Sub-Committee further recommend that the following extensions of the tramway system be executed as rapidly as possible: (1) A connecting tramway between the Moorhead and Lady's Bridge. (2) The conversion of all the existing lines into the electrical overhead system. (3) The construction of the following tramways: from the present tramway on South-street, Moor, along Ecclesall-road, as far as Rustlings-road; from the present tramway near the Wicker Arches to Firth-park; from the proposed central terminus in Fitzalan-square, *viâ* High-street, West-street, Hounsfield-road, Crookes Valley-road, to the end of South-road, Walkley; from the proposed central terminus to Deep Pits, Intake, *viâ* Commercial-street, Sheaf-street, Duke-street, and Intake-road; from the proposed central terminus to Hallamgate-road, Crookes, *viâ* High-street, West-street, Hounsfield-road, Western Bank, Whitham-road, and Crookes-road.

This report was adopted by the committee, and will become operative immediately it has received the sanction of the Council.

HAMPSTEAD ELECTRICITY ACCOUNTS.

The following report, showing the working of the electric lighting department of the Vestry of St. John, Hampstead, has been sent us by Mr. Arthur P. Johnson, the vestry clerk:

I beg to submit the accounts in respect of the electric lighting undertaking for the period of 15 months from Christmas, 1895, to Lady Day, 1897. The figures indicate a rapid growth of the undertaking; indeed, it has assumed proportions which have exceeded the most sanguine expectations that were formed when the scheme was first mooted, as the following details, explanatory of the accounts annexed, will fully show. A new loan of £30,000 has been granted by and obtained from the London County Council during the period under review, and the total amount of principal now repaid is £1,058. 16s. 2d. The new loan bears interest at a much lower rate than those previously obtained, which is, of course, a considerable advantage to the Vestry, inasmuch as it is doubtful whether money will always be as cheap as at the present time. The policy first adopted by the committee, of laying down mains in districts likely to furnish consumers of the light, had been continued, having proved itself to be a sound one, as the revenue account amply testifies. The capital expenditure has consequently increased largely, although a part of same must necessarily be temporarily unremunerative; but this, as pointed out in my previous report, is likely to be counterbalanced by increasing profits in future years. The capital expenditure has increased from £56,522 at the end of 1895, to £83,331 at March, 1897, being an outlay of £26,809 for the 15 months. The bulk of this has been in connection with the laying of mains, this item alone being responsible for £14,590. Under this head are included house connections, etc., and it would be well perhaps to consider, in conjunction with this, the increase in the cost of meters fixed on installations, which has risen from £1,170 at Christmas, 1895, to £2,878 at March, 1897. The item for preliminary expenses (£68 13s. 6d.) has been written off in accordance with the resolution of the Lighting Committee, and charged to revenue account. There is now a considerable overdraft at the bankers, and it will therefore be necessary, almost immediately, to consider the question of applying for a further loan. The working profit for the 15 months amounts to £5,257. 12s., which is equivalent to 6·3 per cent. on the total capital expenditure, a result highly gratifying to the Vestry, and this despite the fact that the expenditure on this account has increased from £5,608. 17s. 9d. to £8,168. 5s. 11d. The total revenue, compared with the previous like period, shows an increase of 291 per cent., but even this very satisfactory feature is eclipsed by the comparison between the revenue from private consumers for the two periods, where the increase reaches 334 per cent, the figures being £11,948 as against £3,573. Last year, it will be remembered, the cost per unit for coal (2·53d.) came out extraordinarily large as compared with the municipal authorities elsewhere. This year, however, it compares very favourably, having been reduced to 1·36d. per unit. The management expenses have shown little increase, the figures being £1,316 as against £1,115. There has been an increase of £1,418. 12s. 1d. in the amount paid for interest and principal of loans, this being due largely to the fact that not only have we had an additional loan of £30,000, but there have also been large overdrafts at the bank during a considerable portion of the year. Indeed, under this head alone (interest on overdrafts) the figures have risen from £437 to £1,066. The interest on mortgages shows also a considerable advance, being £1,692, as against £1,034. The balance-sheet is self-explanatory. Summarising the 15 months' revenue account, the net profit, after paying off interest and principal of loans (the latter, in the case of a company, being equivalent to making contributions to a sinking fund) is £1,900. Assuming, however, that, trading as a company, the Vestry put aside as a contribution to a sinking fund the amount paid for instalments of principal of loans and declared a dividend on the remainder, the amount so declared would be £4,662, equal to 5·59 per cent. on the capital. It should be borne in mind, however, in perusing the accounts, that the period to which they refer is for 15 months and includes three heavy quarters, so that the comparison of future years' accounts with those now presented will probably appear unfavourable. It is satisfactory to note that in the 2½ years' working the amount of bad debts out of a total revenue of £18,032 is only £8. 12s. 2d. While this is an extremely gratifying feature of the accounts, it is only reasonable to anticipate that with the continued steady growth of the undertaking the loss under this head will considerably increase.

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T.U.	720,780
Quantity sold { Public lamps, 58,800 / Private consumers by meter, 489,120 }	547,920
Quantity used on works (alternating)	821
" " (continuous)	15,500
Total quantity accounted for	563,420
Quantity not accounted for	156,539
Number of public lamps	24
Total maximum supply demanded (kilowatts)	440

Revenue Account for the Fifteen Months ended March 25, 1897.

Dr.				£	s.	d.
Generation.						
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works	£3,100	12	11½			
Oil, waste, water, and engine-room stores	352	17	1			
Wages at generating station	1,100	11	9½			
Repairs and maintenance of—buildings, £13. 17s. 1d.; engines and boilers, £776. 17s. 9½d.; dynamos, etc., £7. 12s. 0½d.; machinery, instruments, tools, etc., £21. 0s. 9d.	818	17	8			
				5,372	19	6
Distribution.						
Repairs and maintenance of mains	115	2	8			
Transformers, meters, switches, and other apparatus on consumers' premises	14	19	3			
Apparatus at distributing stations	104	6	5½			
				234	8	4½
Public lamps, repairs, and renewals				259	7	0½
Rates and taxes				442	1	11
				6,308	16	10
Management Expenses.						
Salaries of engineers	875	2	7½			
Stationery and printing	158	15	7			
General establishment charges	282	0	10½			
				1,315	19	1
Special Charges.						
Insurances	116	12	7			
Discount—public lighting, £199. 14s. 2d.; and private consumers, £156. 2s. 8d.	355	16	10			
Testing and certification of meters	1	18	0			
Expenses obtaining loans	44	17	0			
Sundries	24	5	7	543	10	0
				8,168	5	11
Balance carried to net revenue account				5,257	12	0
				£13,425	17	11

Cr.	£	s.	d.
Sale of current per meter at 4d. and 6d. per B.T.U.	11,583	4	7
Public lighting	1,470	0	8
	13,053	5	3
Rental of meters	364	19	8
Sundry receipts	7	13	0
	£13,425	17	11

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BALANCE SHEET AT MARCH 25, 1897.

Liabilities.	£	s.	d.
Capital account—amount received	60,560	0	0
Sundry creditors	4,781	13	9
Amount contributed by the general account out of lighting rate towards deficits on revenue account	1,659	5	11
Balance due to treasurer	23,721	1	6
	£90,722	1	2

Assets.	£	s.	d.
Capital account—amount expended for works	83,331	4	10
Stores on hand, March 25, 1897: coal, £62. 10s. 6d.; oils, waste, etc., £42. 7s. 1d.; general, £1,941. 3s. 7d.	2,046	1	2
Sundry debtors for current supplied to Lady Day, 1897 £4,021 8 8			
Other debtors 238 16 3			
	4,260	4	11
Net revenue account	1,084	10	3
	£90,722	1	2

COMPANIES' MEETINGS AND REPORTS.

LIVERPOOL OVERHEAD RAILWAY COMPANY.

The eighteenth half-yearly meeting of the shareholders of the Liverpool Overhead Railway Company was held on Tuesday last at the Law Association Rooms, Liverpool. We are indebted to the *Liverpool Courier* for the following report:

Sir William B. Forwood, the chairman of the Company, presided, and in moving the adoption of the report and statement of accounts said that that was the first half-yearly meeting since the opening of their extension to the Dingle, and he was very glad to be able to meet them that day with such a very satisfactory statement of accounts. Comparing the half-year with the similar half-year of last year they had increased over half a million in the number of passengers carried, the exact figures being 529,000. The first-class passengers had increased by 153,000. He thought that that increase in first-class passengers was due to the opening of the Dingle Station. Their revenue for the half-year had amounted to £36,025, as compared with £31,622 for the corresponding half of last year, or an increase, in round figures, of about £4,700. Their working expenses had been £22,789, as against £19,694. Those, of course, had increased in consequence of the extended line to the Dingle. They had an extra station, and extra power was required for working the extension. The interest on mortgages was £2,890, as against £2,500 in the corresponding half of the previous year. They had brought forward £3,064, giving a gross profit of £13,410, against £11,115 in the same half of last year. They proposed, with the approval of the shareholders, to pay a dividend at the rate of 5 per cent. per annum on the preference shares, which would absorb £2,050, as against £2,700, and of 3 per cent. per annum on the ordinary shares, which would absorb £6,750 In the same half of last year they paid on the ordinary shares at the rate of 2¾ per cent., and that took £5,568. They would carry forward a balance of £3,810, against a balance of £2,800 in the same half of last year. It had always been the desire of the directors to keep the Company in a thoroughly sound financial position, and looking at the accounts a little more in detail, it would be seen that they had expended during the past half-year rather more in maintenance and up-keep. In the first place they had renewed a large portion of the bonds on the negative line by copper instead of the wrought-iron bonds. They had increased the efficiency of the line, and their lighting had consequently been improved They were, however, still experimenting in the matter, and they hoped before the year was out to give a very steady and efficient light on the Dingle end of the line. Then they had spent rather more in the up-keep of their rolling stocks and the up-keep of their permanent way, and they had spent £511 in compensation. They unfortunately had a small accident at the Dingle, and they thought it better to pay that small compensation out of the revenue than to entrench on the contingent fund, which was being gradually built up to meet claims of that character. He thought it was a wise thing to wipe out that item at once. The revenue they had derived per passenger during the past half-year had amounted to 1·99d. per passenger, as against 1 96d. per passenger in the previous half-year. That item had been increasing gradually, for in December, 1894, the revenue was only 1 64d., which indicated that they were carrying a larger proportion of first-class passengers. The expenditure had been 63·17 per cent., and in the half-year ending December it was 63·92 per cent., so that they had a slight reduction in the proportion of their expenditure. But as compared with the same half of last year there was a slight increase, as it was then only 63·5 per cent.—an increase of ·12 per cent. The expenditure per train mile during the past half-year was 15·3d., as against 15·10d. in the same half of last year. Their train mileage had gone up in consequence of the opening of the Dingle Station from 360 992 miles to 363,399 miles. He was glad to be able to assure them that everything in regard to structure, electrical equipment, and also in regard to their coaches had been got up to the very highest state of efficiency, their desire at all times being that their line should be thoroughly well maintained. They thought that in the end that was the truest economy. They had given the tramway company six months' notice to terminate their agreement with them. It was not necessary for him to state what that agreement was; they were all aware of it, but they felt the time had arrived when they might give that notice. That notice had been given and would terminate at the end of this year. As would have been seen from the public prints, the Liverpool Corporation, in taking over the tramway system, had decided to start the first experimental line of electric trams from the Dingle to St George's Church, Castle-street. The chairman of the Tramways Committee had stated that that body had no wish to do anything antagonistic to the interests of the Overhead Railway Company, but that the route presented conveniences for the experiment which no other line at their disposal did. Personally, he could only regret that the experiment was not to be made at some other part of the town, because the Corporation had only taken over the tramway system in the interests of a more efficient service, and it was admitted that so far as Dingle was concerned further conveniences and facilities were unnecessary. In other directions, such as Old Swan and West Derby, the tramway service was notoriously inefficient, and therefore he was sorry that they had not selected one of these lines for the purposes of their experiment. He understood there would be an express line of tramways from the Dingle along Park-lane to St. George's Church at frequent intervals. But he hoped the shareholders of the Overhead Railway Company would not take alarm, because he believed they would be able to maintain their traffic, and by increasing their facilities and expediting their trains, so serve the public that they would continue to extend their patronage. He accepted in its fullest sense the statement of the Tramways Committee, that they wished no ill to the Company, and he did feel that the Company deserved well at the hands of the Corporation, for that body was dependent entirely upon the prosperity of the port, and there was no institution during the past half-century which had given a greater impetus to the trade and prosperity of the port than the Overhead Railway Company. They had increased the facilities and reduced the charges of the port by enabling men engaged in the different processes connected with the shipping industry to be transported from one part of the docks to another in the shortest possible time and at the least expense. Being such an institution, they merited, and should hope to enjoy, the most careful consideration from the Corporation. He hoped the shareholders would believe that the directors would safeguard their interests in every possible direction. He did not think there was in this competition which they would have to meet anything whatever to cause them anxiety and trouble. The Company might lose some little traffic, but, on the other hand, they could expect to develop new sources of traffic which afford ample compensation, and a reserve power and increased facilities which the public would greatly appreciate. The Company had but recently expended from £120,000 to £130,000, and it might seem to the shareholders a little bit rough this early to encounter such competition. But he hoped it would not be a serious matter, and, at any rate, they should save the amount which they had undertaken to pay to the tramway company, and which would now be available to swell their net revenue. It would be noticed that they had on credit on premium on issue of mortgage debentures, £4,471. The debentures issue that year had enabled them to pay for the southern extension, and they had that amount to the credit of the account.

Mr. Edward Lawrence seconded the motion, which was agreed to without discussion.

On the motion of the same gentleman it was decided to declare the following dividends (less income tax): 5 per cent. per annum on preference shares, and 3 per cent, per annum on ordinary shares.

BRISTOL TRAMWAYS AND CARRIAGE COMPANY, LIMITED.

In the report of the directors of this Company for the half-year ending June 30, 1897, it is stated that the gross receipts for the half-year amount to £59,704. 19s. 9d., and the working and general expenses and renewals are £45,839. 8s. 4d., leaving a net balance of £13,865. 11s. 5d., which it is proposed to appropriate as follows:

	£	s.	d.
Interest on 4 per cent. mortgage debenture stock, etc.	1,815	9	5
Dividend at the rate of 6 per cent. per annum (free of income tax), for the half-year ending June 30	7,750	0	0
Balance carried to reserve and renewal funds—viz.:			
Leased premises redemption £250 0 0			
Permanent-way renewals 1,500 0 0			
Contingencies 1,380 13 8			
Electrical renewals 1,169 8 4			
	4,300	2	0
	£13,865	11	5

The receipts from the tramways department show an increase of £4,515, and the carriage department returns an increase of £837. The total number of passengers (excluding postal riders) carried during the six months on the Company's cars and omnibuses was 9,497,693. The directors have pleasure in reporting that the Company's Bill has received the Royal assent, and the construction of the authorised extension of the electric tramways to Staple-hill is now being so vigorously proceeded with that the line will be completed and in operation during the current half-year. The proposal for a light railway from St. George to Hanham, intended to be worked by electricity from the St. George power station, has received the approval of all the local and road authorities concerned, and the requisite formalities have been complied with preparatory to the consideration of the order of the Light Railway Commissioners.

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CROMPTON AND CO., LIMITED.

An extraordinary general meeting of this Company was held on Monday, 9th inst., at Cannon-street Hotel, Mr. John Trotter presiding.

The **Chairman** said that the business was purely formal; all that they had to do was to confirm the following resolution, which was passed at an extraordinary general meeting on the 22nd ult.: "That the articles of association of the Company be amended by the addition of the following article:—29A. Whenever the capital, by the reason of the issue of preference shares or otherwise, is divided into different classes, all or any of the rights and privileges attaching to each class may be modified, commuted, affected, or abrogated, by agreement between the Company and any person purporting to contract on behalf of that class, provided such agreement is confirmed by an extraordinary resolution passed at a separate general meeting of the holders of shares of that class, and all the provisions hereinafter contained as to general meetings, shall *mutatis mutandis* apply to every such meeting but so that the quorum thereof shall be members holding or representing by proxy not less than two-thirds of the nominal amount of the issue of shares of the class."

On the motion of the **Chairman**, seconded by **Mr. R. E. B. Crompton**, the resolution was confirmed.

CONTRACTS FOR ELECTRICAL SUPPLIES

CONTRACTS OPEN.

Switzerland.—Tenders are invited at Lausanne for a concession for erection and lease of electric works. Applications to be made to the Municipality before September 25.

Sydney (New South Wales).—Tenders are required by October 18, at noon, at the General Post Office, for supplies to the Telegraph, Telephone, and Post Office Departments, including iron, copper, and insulated wire, insulators, nails, screws, nuts, bolts, electric batteries with all accessories and chemicals, diaphragms, arc lamps, incandescent lights, 11,000ft. carbon for arc lamps, and various other appliances.

Burnley.—Tenders are advertised by the Corporation for a lightning conductor in connection with the chimney at the Health Depôt. Specification and form of tender may be obtained on application to Mr. G. H. Pickles, A.M.I.C.E., borough surveyor. All tenders, which must be made out on the form supplied, and endorsed "Tender for Lightning Conductor," and addressed to the Chairman of the Health Committee, shall be delivered at the office of Mr. W. T. Fullalove, town clerk, Town Hall, Burnley, not later than noon on August 21.

Derby.—The Corporation are prepared to receive tenders for the supply of one alternating-current dynamo and engine and for the supply to the present engine of one continuous-current dynamo. Specifications, etc., form of tender may be had on deposit of £1. 1s. (which will be returned on receipt of a bona fide tender) from Mr. J. E. Stewart, engineer, Electric Lighting Station, Derby, on and after 7th inst. Tenders, endorsed "Electric Lighting, Tender for Dynamo, etc.." to be sent to Mr. H. F. Gadsby, town clerk, by 12 noon on 30th inst.

Wallasey.—The Urban District Council invite tenders for the supply and delivery of alternating current transformers, as advertised. Copies of the specification may be obtained on application to the engineer, Mr. J. H. Crowther, at his office, Great Float, near Birkenhead. Sealed tenders, on the form provided for the purpose, addressed to the Chairman of the Gas, Water, and Electricity Committee, and endorsed "Tender for Transformers," will be received at the Public Offices, Church-street, Egremont, Cheshire, not later than 4 o'clock in the afternoon on August 19.

Ludlow.—The Corporation offers a prize of £20 for the best and most economical scheme of electric lighting for the borough. The scheme must deal exhaustively with the whole matter, and give definite information of the cost of steam and water power for the purpose of comparison with the total cost of the undertaking and working expenses. Schemes to be delivered at the offices of Mr. John Herbert Williams, town clerk, Ludlow, marked "Scheme for Electric Lighting," before 4 p m. on October 1. Should the Corporation employ the engineer whose scheme is awarded the prize to carry the work out, then the £20 will merge in the commission to which he would then be entitled to.

Egypt.—The Secretary of State for Foreign Affairs has received a despatch from her Majesty's Agent and Consul-General at Cairo, drawing attention to a notice published in the *Official Journal* of the Egyptian Government of 23rd ult., in which it is stated that tenders are invited by the Egyptian Government for Welsh coal for the use of the Administration of Railways and the Port of Alexandria. Tenders should be sent under cover by registered post, and should reach the President of the Administrative Council by October 15 next. Such further particulars as have been received may be seen at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 6 p.m.

Carlisle.—Tenders are invited by the Corporation for the following work in connection with their electric lighting station in Carlisle: (Contract No. 1) boilers (Lancashire) and mechanical stokers; (2) engines, dynamos, condensers, pumps, etc., steam, exhaust, feed, and drain pipes; (3) storage battery; (4, section A) switchboard for dynamos and feeders (section B) boosters and switchboard for batteries and boosters; (5) arc lamps and their erection; (6) feeders, mains, and arc lamp leads. In contract No. 2 it is a condition that the dynamo makers must have already constructed dynamos of at least 100 units capacity. Copies of any of the specifications, with forms of tender and general conditions, can be obtained on payment of £1. 1s. each (to be returned on receipt by the Corporation of a bona fide tender), at the office of Mr. Henry C. Marks, city surveyor, Fisher-street, Carlisle; or Dr. A. B. W. Kennedy, 17, Victoria-street, Westminster, London, S.W. Tenders, on the prescribed forms, enclosed separately in sealed envelopes, and marked "Electric Lighting, Tender for Contract No. —," must be delivered at the office of the City Surveyor, Carlisle, by August 19.

Madras.—Tenders are invited for the utilisation of water flowing from the Periyár Lake for purposes other than irrigation and not incompatible with the use of the water for drinking. The irrigating season extends over nine to ten months, during which time the discharge is likely to be from 1,100 to about 500 cubic feet a second, according to the demands for irrigation and the available quantity in the lake. Subject to the risk of interruption by accident or drought, supply can be given throughout the irrigation season. No supply can be guaranteed at other times, but, so long as water is available, the Government will be prepared to issue it in such daily quantities as may seem to it advisable with reference to the time which is likely to elapse before the supply is replenished by the setting in of the rains. The fall from the tunnel to the foot of the hills is approximately 900ft., and the distance measured along the course of the stream about 6,800ft. One cubic foot per second falling 900ft. is estimated to produce over 60 effective horse-power. Intending lessees should state the quantity of water required in cubic feet per second and the annual rent offered for each cubic foot per second. No rent will be charged for the first year from the date of the concession; for the second year the charge will be one-fifth, and an additional charge of one-fifth will be made every year until the full rent is reached. The whole or part of the concession may be surrendered on a year's notice being given. Lessees will construct at their own expense, on plans to be approved by Government, all the weirs and other works required to divert the water from the river below the tunnel. For further information, application may be made to the Chief Engineer for Irrigation, Madras, by whom tenders will be received up to October 31, 1897.

Port Elizabeth (Cape Colony).—The Town Council of Port Elizabeth (Cape Colony) invite tenders for lighting the streets and municipal buildings of Port Elizabeth by electricity, in consideration of the grant of a concession for the exclusive right of supplying electric current through the streets and roads of the town, to private houses, stores, etc., for terms of 5, 15, 20, 25, or 30 years respectively. There are approximately about 54 miles of streets in the town, as follows: main thoroughfare, 5 miles 1,196 yards; principal streets, 16 miles 1,433 yards; minor streets, 32 miles. The streets of the town are at present lighted by 380 gas lamps of reputed 16-c.p. The municipal buildings consist of town hall, municipal offices, morning market, feather market, wool market, and museum. The main streets are to be lighted by arc lamps, and the side streets and municipal buildings by incandescent lamps. Tenderers must state at what sum per annum they are prepared to adequately light the streets and municipal buildings for the various periods mentioned above, if they are granted a concession for any one of the periods referred to. The concession will provide, inter alia, that the particular system and plant to be adopted by the concessionaires shall be subject to the approval of Council; the charge for supplying current to private houses shall not exceed 1s. 9d. per London Board of Trade unit; and that the Council will have the option of taking over the whole undertaking, etc., at a valuation to be made in case of difference by two arbitrators or their umpire at the end of the period of the concession at the then value of the plant and mains. Tenders, endorsed "Port Elizabeth Electric Lighting," should be delivered to the agents of the Municipality, Messrs. Davis and Soper, 54, St. Mary-axe, London, E.C. (from whom further information may be obtained), on or before September 21.

BUSINESS NOTES.

Formby.—An electric lighting scheme is under discussion.

Conisborough.—The Council intend to introduce the electric light.

Bradford.—The Council have decided (after much discussion) to erect an installation of electric light in Lister Park.

Pontiland.—An agreement is likely to be arrived at shortly regarding the construction of a light railway in the district.

Winchester.—The electric light question has been further discussed, the proposed site not meeting with unanimous approval.

Change of Address.—Mr. Arthur Ardron, F.R.I.B.A., architect and surveyor, has removed to 8, Delahay-street, Westminster, S.W.

Bideford.—A telephone exchange is to be established at Bideford, Torrington, and Barnstaple, the necessary subscribers having been secured.

Middleton.—The Town Council having obtained electric lighting powers, are now only awaiting a favourable opportunity of putting them into effect.

Lincoln.—The City Council have resolved to apply to the Local Government Board for sanction to borrow £21,000 for electric lighting purposes.

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Bridgwater.—The Town Council have adopted a report of the Lighting Committee in favour of lighting the borough by electricity at an estimated cost of £14,672.

Birkenhead.—Colonel W. R. Slacke, R E., has held a Local Government Board enquiry into the Corporation's application to borrow £20,000 for electric lighting.

The Westminster Electric Supply Corporation, Limited have given notice that the directors have decided to pay off the debentures numbered 1 to 1,000 on March 1, 1898.

Ludlow.—The time for competing for the £20 for the best scheme for electric lighting, particulars of which we give elsewhere, has been extended for another month.

Thornaby.—The Corporation have assented to the proposal of the Electric Tramway Company to make their projected lines on the Middlesborough road double instead of single.

Peterborough.—An enquiry has been held at Peterborough into the application for an order to authorise the construction of a light railway for the Crowland district, which at present has no railway service.

Doncaster.—The district authorities are considering the question of electric lighting for the district on account of a petition presented to the Corporation, asking that body to introduce the electric light.

Harrogate.—The Council will apply to the Local Government Board for a further £16,500 to extend the electric light works. They have now 6,100 8-c.p. lamps. These they propose to increase to 7,000.

Brighton.—Five hundred and twenty pounds are to be expended for additional mains, etc., for the electric light. The question of laying mains in Wellington-villas at a cost of £169 is postponed until next month.

Liverpool Overhead Railway—The traffic receipts of this railway for the week ended August 8 amounted to £1,781, as compared with £1,700 in the corresponding week of the previous year, being an increase of £81.

Simon Berry and Co have opened a branch at 65, King-street, Manchester. We understand that the firm are agents for Siemens Bros. and Co.. Limited, London and Woolwich, for the counties of Lancashire, Yorkshire, and Cheshire.

Thetford.—We wish to remind our readers that the sale of the station belonging to the Thetford Electric Lighting Company, Limited (in liquidation), advertised in our last issue, by Messrs. Oldman and Son, takes place on August 17.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended August 6 were £3,562. 9s. 6d., compared with £3,210. 3s. 4d. for the corresponding period of last year, being an increase of £352. 6s. 2d.

Loughton.—The report of the Lighting Committee to be read at a public meeting this week contains a recommendation for the installation of 30 electric lights. The cost of erection and maintenance (£300) is to be spread over three years.

The Northern Telephone System.—An area will be formed to include Buckie, Keith, and other places, and the existing Elgin area will be extended to include Dufftown, Craigellachie, and Aberlour. Keith will be served through Buckie.

Burnley.—On the application of the Electric Lighting Committee, sanction has been given to the borrowing of £25,000 for the enlargement of the electric lighting station and proposed extension of the mains to other parts of the borough.

Lowestoft.—The Town Council have received notices from various companies notifying them of their intention of applying to the Board of Trade for a provisional order for lighting the borough with electricity. No action appears to have been taken.

W. Willson Cobbett, Limited.—The business of Mr. W. Willson Cobbett, 59, Southwark-street, London, and New Lanark, N.B., manufacturer of textile belting, has been formed into a private company under the style of W. Willson Cobbett, Limited.

Airdrie—With regard to the proposed Airdrie and Coatbridge Tramways, negotiations are still continuing. At the last meeting of the Town Council the offers of two electric construction companies who were anxious to submit schemes were discussed.

East Riding.—The Council intend to borrow of the Light Railway Commissioners £10,000 for the North Holderness light railway, and also to extend the system from Bridlington to Rillington, and from Bridlington to Beeford and North Frodingham.

Blackpool.—The electricity mains are to be extended along the roadway from the Imperial Hotel to Derby-road. It was stated at the formal opening of the Hotel Metropole that it is the intention of the directors to instal electric lighting into their buildings.

Electrical Company, Limited.—We are informed that from July 31 Mr. E. T. Eggers ceased to be managing director and secretary of this Company, Mr. Otto Loewi and Mr. Jacob Stottner having been appointed managers, and Mr. O. Loewi secretary.

South Staffordshire Tramways.—The British Electric Traction Company have taken over the agreement made by the Electric Construction Company with the South Staffordshire Tramways Company for the electrical equipment and working of these tramways.

Derby.—The Council are imbued with the proper spirit, for besides carrying out the works referred to in our last issue, they have more than once given the broadest of hints to all their committees to make use of electricity as far as possible in the lighting of the public buildings.

The Western and Brazilian Telegraph Company, Limited, notify that the cables of the River Plate Telegraph Company between Monte Video and Buenos Ayres, which have been closed by order of the Argentine Government for some months past, were on Monday reopened for all classes of traffic.

Sheffield.—The Corporation are about to introduce the electrical overhead system on all the present tramway routes within the city, and also to make extensions to many of the populous suburbs. Since the Corporation took over the tramways there has been a remarkable growth of traffic.

Cambridge Electric Supply Company, Limited.—At an extraordinary general meeting of the Electric Supply Company, held at the Company's Office, Thompson's-lane, on Tuesday afternoon, it was resolved that the capital of the Company be increased to £100,000 by the creation of 5,000 new ordinary shares of £10 each.

City and South London Railway.—The returns for the week ended August 8 were £939, compared with £895 for the corresponding period of last year, being an increase of £44. The total receipts for the half-year 1897 amounted to £5,456, compared with £5,419 for the corresponding period last year, being an increase of £37.

Halifax.—The Board of Trade have intimated to the Halifax Corporation that they approve of the proposed system of electric traction described in the town clerk's letter to them, but subject to any requirements and regulations which may be imposed after inspection. It is anticipated that cars will be running within 12 months.

Prestwich.—At the last meeting of the Urban Council it was reported that the Council had advertised their intention to apply for powers for the electric lighting of the district, and notice had also been given by the Electrical Supply Corporation, Limited, of their intention to apply for a provisional order to light the Prestwich district.

Fraserburgh.—Negotiations have been almost completed with the Great North of Scotland Railway Company for the promotion of a light railway from Fraserburgh to Rosehearty. The length of the proposed line, which will pass through Middleburgh, is given as five miles and six yards, and the estimated cost is from £30,000 to £40,000.

Morecambe.—The contracts for the electric light installation have been let, and it is expected that they will be completed early next year. Application has been made to the Board of Trade for powers to borrow £4,000 for the construction of a tramway along the new promenade to Bare, and the date for an enquiry has already been fixed.

Electrical Extension Company, Limited.—This Company has been registered, with a capital of £50,000 in £1 shares, to carry on at Liverpool and elsewhere the business of electricians, mechanical engineers, etc. The subscribers are Messrs. Jacob Atherton, James B. Atherton, Frank J. Leslie, Charles O. Grindrod, Albert E. Haptie, Frederick W. Lintern, and Allen Ruckley.

Tramways Union Company, Limited.—An extraordinary general meeting of the shareholders of this Company passed a resolution authorising the Company to raise £150,000 by the issue of debentures, for the purpose of adapting and equipping their tramways at Madrid with electric traction. The Company have received the grant of a working concession for 60 years.

Wannsee Prize Competition.—We referred in our last number to this curious competition, which, according to a memorial just received, evolves itself simply into a problem how to provide a time-table to suit the increased traffic (and the future increase of it as well) of this suburban railway. All of which is no compliment to the powers ruling the Prussian Government railways.

Newcastle.—A new committee has been appointed by the City Council to consider and prepare a scheme for providing the city with a tramway service which shall be sufficient to meet present requirements and anticipate possible extensions in the near future. The committee was authorised to secure the assistance of experts on tramways, provided the latter are not financially interested in any system of tramway working.

Switzerland.—The municipal authorities of Lausanne will receive tenders until September 25 for the concession to erect and to work an electric light system in that town. They also offer a prize of £880 for plans for three bridges over the valley of Flon, near Lausanne. This competition is open until December 15 to all engineers, native or foreign, provided they reside in Switzerland, and there appears to be no time limit fixed as far as residence is concerned.

Wakefield.—The Electric Lighting Committee have fixed the standard pressure at which supply of electricity shall be given to consumers at 200 volts. The electric cables from the works to Calder Vale-road will be partly laid in separate iron pipes and partly in Doulton's stoneware casing, instead of wholly in iron pipes. It was also stated that the engineers' strike would affect the completion of the contract, and the use of a temporary plant was suggested.

Brechin.—The agreement made between the Commission and Edmundson's, Limited, with regard to the electric lighting of the town, contains the stipulation that the town, which was bound to allow the company to light the street lamps with electric light, should only do so on condition that these did not cost more than the present cost of gas. The maximum price to be charged for street lighting, public offices, etc., in the agreement was not to exceed 4d. per unit.

Islington.—According to a report of the Islington Vestry issued this week, it has been decided to seek a loan of £14,250 from the

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London County Council for the purpose of laying electric mains, for both public and private supply, in Camden, Archway, and Junction roads, to the parish boundary; also on both sides of Highgate-hill to the parish boundary. The question of laying electric mains along Essex-road and in the residential district of Highbury is deferred for future consideration.

Manchester.—The special committee appointed by the City Council to consider the question of the working of the Manchester tramways have come to a decision of some importance—namely, that the Council be recommended, in the event of any change being made in the motive power used, to sanction electricity only, to be supplied from the electricity works of the Corporation. This, it is understood, will take effect whether the tramlines are released by the Carriage Company or worked by the Corporation.

Grimsby.—A special meeting of the Town Council in committee has been held, under the presidency of the Mayor (Mr. Sutcliffe), to consider some correspondence from two electric lighting firms in London, asking the Corporation whether they were willing to transfer their provisional order for the electric lighting of the town to them, and giving notice of their intention to apply to the Board of Trade to revoke the present order, which had not been put into force. The Public Lighting Committee were empowered to employ an expert and instructed to report the result of the enquiries to the Council.

Aberystwith.—On Saturday, July 31, there was opened in this town the Hotel Cambria, a magnificent building under the management of Mr. Thierry, late of the Hotel Cecil, London. The hotel has been splendidly furnished, the electric light being installed throughout every room. The fittings have been chosen to suit the decorations and furniture of the various rooms, and were supplied by the General Electric Company. The whole of the lighting, which has several special features, has been carried out by Mr. E. E. Putland, A.I.E.E., who is also the manager and electrical engineer to the Electricity Supply Company.

Wimbledon.—The Lighting Committee have reported, with reference to the electric light provisional order, that the order had now been confirmed by Parliament, and recommended that the Board of Trade be informed that the system by which energy was proposed to be supplied was as stated in Mr. A. H. Preece's report, and that the Council hold a special meeting after the recess, at which Mr. Preece should be invited to attend. It was stated that if a company controlled the system for a certain period, there would be no difficulty in their subsequently handing over the control to the Council. Mr. Preece was asked to specially report on this question at the special meeting after the recess.

Whitehaven Harbour Commissioners.—At the last meeting of this body it was stated that since the last letter of the Commissioners to the Corporation a further communication had been received regarding the modification of the lighting, which letter would be considered by the Electric Lighting Committee at an early dute. The correspondence and negotiation they had had with the Town Council had been somewhat protracted by the difficulties with which they had had to deal; but he thought those difficulties were now pretty well cleared away, and they were within measurable distance of an arrangement so that the work might go on to the termination of the contract without further friction.

Personal.—We hear from Liverpool that Sir A. B. Forwood, M.P., has resigned the chairmanship of the Electric Tramway Committee of the City Council, in consequence of an adverse vote as to the appointment of an American engineer to take charge of the construction of an experimental line.—Mr. B. H. Jenkinson, formerly with Messrs. Crompton and Co., Limited, has been appointed engineer and works manager to the National Electric Free Wiring Company, Limited; and Mr. H. J. Nisbett district manager of the Blackpool centre.—Mr. F. W. Northey has been appointed receiver and manager of the Epstein Electric Accumulator Company, Limited, with a view to reconstructing the same at an early date if possible.

General Electric Company, Limited. — The above company have forwarded to us a new sheet of their catalogue, which mentions several novelties manufactured by this firm, amongst which we note a chandelier-like fixture for temporary lighting. This consists of several tiers of lamps in a galvanised wire framework suspended by chains. The lamps are fed by flexible cords, so that when not required the apparatus will collapse into small space for storage purposes. There is also a correspondence telephone outfit on the microtelephone system, which enables, for instance, a manager seated at his table to dictate a letter to a clerk at a desk in an outside office. The apparatus is constructed on the principle used in most general telephone exchanges.

Selby.—A question which at present agitates the minds of many rural councillors was discussed at the last meeting of the Urban District Council. A letter was read from the Urban District Councils Association, stating that a large number of notices had been served upon the more important towns in the kingdom and probably Selby amongst the number, of the intention of certain companies to apply for powers to supply electricity for lighting and other purposes within the town. It might therefore be useful to direct the Council's attention to the importance of keeping these powers in their own control. The Chairman remarked that they were associated with the Urban District Councils Association. It was resolved to discuss the matter at the next meeting.

New Traction Company, Limited.— This Company was formed in March, 1896, with a capital of £270,000, divided into 30,000 6 per cent. cumulative preference shares of £5 each, and 24,000 ordinary shares of £5 each, for the purpose, *inter alia*, of installing systems of traction for light railways, tramways, and street railways, either by applying electric or other power to existing systems, or by assisting in the promotion of new schemes. The Railway Share Trust and Agency Company, Limited, are now offering the 20,000 unissued preference shares at a premium of 2s. per £5 share. With this new capital the directors propose to still further extend the tramway system of Coventry and to lay down about 20 miles of electric tramways in the city of Norwich.

Glasgow.—A notice has been tabled to be discussed at the next meeting of the Corporation which reads as follows: "That, in view of the fact that electric energy for power purposes for the general public could be generated at the same cost as for tramway traction if both were dealt with by the same department, whereas the cost to the public must be much higher if dealt with by a separate department, a committee be appointed to reconsider the whole question and to report." At the meeting of the Telephone Committee of Glasgow Corporation it was intimated that the Government had appointed Sheriff Jameson, Perth, to hold an enquiry in Glasgow on the advisability of municipalising the telephone. Evidence will be given at the enquiry on behalf of the Treasury, the Post Office, and the Corporation.

Bootle.—The town is to be lighted by electricity. At the Town Council's monthly meeting, a letter was submitted from the Board of Trade, stating that as it is proposed to use a pressure of 220 volts at consumers' terminals, or from 440 to 500 volts between the outer conductors, it would be necessary, in order to comply with the regulations of the Department, that the intermediate conductor should be maintained very nearly at the potential of the earth, and asking how it was proposed to secure this condition. It was resolved on receipt of the approval of the Board of Trade to the proposed system of supply to order the preparation of complete working and detail drawings and other particulars. The borough engineer was authorised to proceed at once with the plans of the engine-house for electrical purposes.

Audenshaw.—At the last meeting of the Council a letter was read from the secretary to the Electric Traction Company, Limited, enclosing a copy of memorial to the Board of Trade for extension of time. The clerk read a letter from the Board of Trade of July 8, also letter from the secretary of the same company of July 13, that the company were asking for extension of time. Resolved, that the clerk again write to the Board of Trade stating that the Council continue their opposition. Councillor Davies reported the attendance at the House of Commons on behalf of the Manchester Carriage Company in opposition to the scheme of the Manchester Corporation, and that the Carriage Company withdrew their opposition until the matter comes before the House of Lords' Committee. The preamble of the Bill was accordingly passed.

Hastings. — The committee of the Town Council have recommended that Mr. Leonard Andrews, the electrical engineer to the Hastings and St. Leonards Electric Light Company, be appointed engineer of the works temporarily, to take charge of the Corporation's electric light works. The committee further recommended the temporary continuance of the lighting of the lamps on the Front line, pending the completion of the Corporation's own installation, and have received a letter from the secretary to the Hastings and St. Leonards Electric Light Company, stating that the directors have resolved to continue the lighting until the end of August upon the terms and conditions of the previous contract, which expired on June 30 last, and under which the sum payable for the lighting was at the rate of £25 per lamp per annum.

Hampstead.—The report of the Electric Light Department of the Hampstead Vestry—the second London vestry to undertake an electric installation—has been issued. It covers the 15 months from Christmas, 1895, to Lady Day, 1897. The document states that the capital expenditure has increased from £56,522 to £83,331 during that period; £22,771 is due to the bankers, and will be met by a new loan. The working profits for the 15 months amounted to £5,257. 12s., equivalent to 6·3 per cent. on the capital. The net profit, after paying off interest and a proportion of the principal of the loans, and providing for a sinking fund, was £1,900. The private consumption of the electric light had increased at the rate of 334 per cent. in Hampstead during the 15 months, and during the 2½ years since the system had been worked the bad debts only amounted to £8. 12s. 2d. out of £18,032.

Westminster Electric Supply Corporation.—On Saturday, Mr. Justice Stirling had before him a petition for the reduction of the capital of this Company. The capital was £400,000, divided into £500 founders' shares and £399,500 in ordinary shares, and the object of the petition was to obtain the sanction of the Court to a reduction in the capital by which the 500 founders' shares were to be surrendered and cancelled. The mode in which this was carried out was by allotting the holders of the founders' shares a certain number of ordinary shares to be taken and paid for by the holders of the founders' shares at par. Inasmuch as the ordinary shares stand at a large premium in the market, the holders of the founders' shares obtain a very large advantage from the allotment to them of ordinary shares at par, and in consideration of this benefit, they surrendered their founders' shares. Mr. Justice Stirling sanctioned the petition.

Larne.—The manager of the electric light works has attended a meeting by permission of the Board of Town Commissioners and stated that his company were prepared to send in an amended tender for the lighting of the town with electric light for three years from August 1 next—*i.e.*, if the Board were willing to receive

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it. They now proposed to make the alterations asked for in Main-street, and erect the 12 incandescent lamps throughout the town free of charge, merely charging the cost of lighting. These alterations would mean an expenditure on the part of the company of about £145. It was pointed out that the gas company had been written to informing them of having obtained the contract, but a councillor undertook to have a letter sent from the gas company releasing the Commissioners under the circumstances, and stating they had no desire to take up the contract. It was arranged that on receipt of the amended tender from the Larne Electric Light Works, Limited, the clerk should call a special meeting of the Board.

Newport.—A Local Government Board enquiry took place the other day referring to an application by the Town Council to borrow £31,000 for an extension of the electrical installation. The Town Clerk said that £40,000 had been expended in providing the present supply. The increase in the number of lamps between June, 1896, and June of the present year was equal to 50 per cent., being the difference between 9,252 lamps and 13,500 lamps. The annual loss on the undertaking, after providing for repayments, etc., had also been reduced from £1,410 up to March, 1896, to £962 for the year ending March, 1897. There was every probability of an increased demand in the near future equal to 50 per cent., and to meet this the Corporation were without funds. One district of the borough (Maindee) was practically untouched, although the Corporlation were under compulsion to supply electricity to the whoe of the area. It had been found necessary to ask for a further loan of £5,000 in addition to the £31,000, and this would come before the next meeting of the Council.

Wireless Telegraph and Signal Company, Limited.—This Company has been registered, with a capital of £100,000 in £1 shares, to adopt and carry into effect an agreement expressed to be made between G. Marconi of the one part and this Company of the other part, for the acquisition by purchase from the said G. Marconi of certain letters patent and provisional protection, patent rights, and inventions relating to or in connection with telegraphy; to acquire, work, and turn to account any other patents and inventions; to acquire by purchase or otherwise any lands, buildings, and other property, and to turn to account the same, as electrical and general engineers, etc. The signatories are: J. F. Bannatyne, Summerville, Limerick; T. Wiles, 2, Catherine-court, E.C.; H. J. Davis, 82, Mark-lane, E.C.; H. Obre, 6, Crosby-square, E.C.; M. T. Goodbody, 6, Crosby-square, E.C.; C. F. Bennett, 6, Crosby-square, E C.; S. W. Ellerby, Southsea House, E.C.; and two others. The number of directors is to be not less than three nor more than seven. The first are E. Appleby, W. Smith, J. F. Bannatyne, H. J. Davis, and G. Marconi. Qualification, £500. Remuneration as fixed by the Company.

West Hartlepool.—The Council have adopted the report which they had obtained from Prof. Kennedy on the lighting of the town. The professor recommended the laying of distributing mains in the central district. He favoured the three-wire system, with lamps running at 210 volts, which would enable the supply of the current to Seaton Carew and the district of the park The best site for a generating station was in the neighbourhood of the Burn-road. The cost would be about £10,000; cost of buildings, say, £6,000; mains, feeders, etc., £7,000; meters and connections for the first 100 consumers, £1,200—total, from £25,000 to £27,000, exclusive of engineering charges; and he recommended that borrowing powers be obtained for £30,000, though he thought that the cost would be considerably less. The committee recommended that steps be taken to borrow the money, and to acquire the site for a generating station; also that Prof. Kennedy be instructed to prepare plans and specifications, with a view to obtaining tenders for carrying out the work, and that the Health Committee be asked to consider the desirability of erecting a destructor for the town refuse, which could be utilised in connection with the electric lighting.

Accrington.—The Council have received a communication from the Imperial Electric Light and Power Company, London, giving notice that they intended to apply during the next session of Parliament for the provisional order for the electric lighting of the district, and to ask the Board of Trade to revoke the order of the Corporation on the ground of failure to carry out its provisions; and a letter from Messrs. Crompton and Co., Limited, London, asking on behalf of the Electric Supply Association whether the Corporation were prepared to transfer their order on certain terms. In reply to these letters, the town clerk was authorised to state that the Corporation had already carried their order into effect to the extent of obtaining sanction by the Local Government Board to the borrowing of £10,000 for the purpose and for purchasing a site for the proposed works, and were about to advertise for tenders for the erection of a central station and the provision of the necessary plant at an expenditure of the full amount of the sanction. The committee also resolved to recommend the Council to proceed forthwith with the establishment of the electric lighting works to the extent of their borrowing powers—£10,000; and the Council were recommended to give authority to the committee to instruct their engineer, Mr. Shoolbred, to prepare the necessary particulars and advertise for tenders for the work.

Liverpool Electric Supply.—In the Municipal Buildings, Dale-street, on Tuesday, a Local Government Board enquiry was held before Major-General H. Darley Crozier, R.E., with regard to the application made to the Board by the Corporation for sanction to the borrowing of £100,000 for the purpose of electric lighting, and £8,000 for public walks and pleasure grounds. Present representing the Corporation were Councillor C. Petrie (chairman of the Lighting Committee), Alderman J. Ball (chairman of the Parks, Gardens, and Improvement Committee), Alderman J. Miles, Alderman Stolterfoht, Councillors T. May Smith and R. R. Meade-King; Mr. Harcourt E. Clare (town clerk), Mr. Pickmere (deputy town clerk), Mr. Bromley Holmes (city electrical engineer), Mr. Pugh (deputy treasurer), and Mr. Turton (deputy city surveyor). The Town Clerk explained that under the Liverpool Electric Supply Act, 1896, the Corporation acquired the electric light undertaking which then belonged to a company. By that Act the Corporation were authorised to borrow the sum of £500,000 for the purpose of paying the purchase-money and carrying on the undertaking. On July 1, 1896, when the Corporation came into possession of the undertaking, the capital expenditure was this—the Corporation paid £400,000 to the shareholders, and as they had by the Act to take over all debts owing by the company, including the money which the company had spent as capital in addition to their share capital, the total capital account was brought up to £436,474. Since the Corporation had been in possession of the undertaking, the demand for electricity had been increasing at a very rapid rate. The actual capital which had been spent up to the present day since July 1, 1896, was £43,500; that was in addition to the £436,474, which brought the actual capital expenditure up to £479,000; that was the sum that had actually been paid by the city treasurer. But works were in progress involving a further estimated expenditure of £45,000, plus the sum they were committed to by their contracts, which would bring the total capital expenditure up to, in round figures, £524,000. The borrowing powers were at present limited to £500,000. The total capital expenditure was practically in excess of the present borrowing powers by £24,000. The electric lighting order threw upon the Corporation the obligation to extend their mains and works according as they might be required by people who had the right to demand a supply within the area of supply. The powers of the Corporation extended over the whole of the city, but their obligations to supply extended to only a portion of it. The reason the Corporation asked to be authorised to borrow the extra £76,000 was that they anticipated that within the next 12 or 18 months all that capital expenditure would be required in fulfilling the obligations cast upon them by the electric lighting order of 1896 and in extending the electric light undertaking in a manner which they thought would be needed by the city. As an indication of the tremendous growth that there had been of the electric light supply in the city, the Town Clerk pointed out that on July 1, 1896, the number of lights was 41,500, mainly incandescent, but arc lights in the streets were included. On December 31, 1896, that number had been increased to 52,500, and by July 1, 1897, the number had been increased to 63,162. At the present time the Lighting Committee found a great difficulty in meeting the increased demand. Then alongside of the increasing quantity of electricity supplied the profits of the undertaking to the Corporation were proportionately greater than they were when the electric supply was taken over. Although the Corporation were continually spending fresh capital on the undertaking in order to give the supply demanded, they were at the same time getting a better return for the larger capital than they were for the smaller capital when the undertaking was acquired. When the Corporation purchased the undertaking, on the figures that they had to deal with, they anticipated that they might have a surplus after paying all working expenses and maintenance and keeping the undertaking in a thoroughly efficient state, of about £3,000 a year after paying interest and sinking fund on the capital they had spent. On December 31, 1896, when the accounts were made out, they showed that in round figures, after paying interest and sinking fund out of the net revenue, there remained a surplus of £11,000 to the credit of the undertaking. Having regard to the character of the undertaking and the development which was advisable, the committee thought that the money should be appropriated in this way—£5,000 to renewal fund and £6,000 to reserve fund. The Lighting Committee, it was proposed, should, with the sanction of the Council, have power to deal with the surplus as they thought fit. Replying to the inspector, the Town Clerk said none of the profits had been carried to the city fund. Having regard to the satisfactory position in which the undertaking was, the committee in April reduced the price for the ordinary supply of electricity down to 6d. for the first thousand units per month, and of 4d. for every other thousand units. They also reduced the price for electrical power down to 3d. for small supplies and 2d. for large supplies per unit, as against 5d. and 4d. respectively. Even with these substantial reductions the income was still progressing. He had been told by the city treasurer that the net profit for the six months up to the end of June last was nearly £13,000; of course, out of that the Corporation would have to pay interest and sinking fund. Of the £76,000 required, they estimated that £32,000 would be required for mains; £24,000 for plant; and possibly £20,000 for land and buildings. It was absolutely essential, in view of the increasing demand, that the Corporation should have power to borrow at least that sum in the interests of the undertaking, and for the benefit of the city. Mr. Bromley Holmes gave details of the work already completed, the work in hand, and the prospective extensions, including an extension of the supply to the northern part of the city, adjacent to the docks. There were at present four generating stations, two others were to be erected, and then such arrangements for distribution would be made as would ensure a continuous supply of electricity throughout Liverpool. Mr. C. Petrie endorsed the remarks that had been made by the town clerk as to the increasing demand for electricity, and the desire of the committee to extend the supply to every part of the city, and at a reasonable price. Subsequently the inspector received information in support of the application for power to borrow £8,000 for park improvement purposes. Mr. Pickmere mentioned that the money was required for the purpose of laying-out a piece of land on the north-east side

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of Newsham Park as a boulevard and ornamental grounds. The land contained altogether about 16 acres, and there was a frontage of 1,370 yards. It extended from Sheil-road to Prescot-road. There would be several fountains and a band-stand on the boulevard, which would be an improvement greatly required. Attempts had been made to sell the land for building purposes, but unsuccessfully, and the Council, acting on the recommendation of the Parks Committee, had decided to make this very desirable change in that neighbourhood. Mr. Turton, deputy surveyor, described the scheme in detail. Alderman J. Ball pointed out to the inspector that this improvement had long been needed in that portion of Newsham Park. It would increase the value of property in that district, and by that means add to the corporate income to such an extent as to recoup them the expenditure involved in making the change. Mr. Bartley, solicitor, and Councillor T. May Smith spoke favourably of the proposed improvement. This closed the enquiry, and the inspector afterwards visited Newsham Park, as well as the electric light generating station.—*Liverpool Courier.*

PROVISIONAL PATENTS, 1897.

AUGUST 3.

18095. Improvements in method of and means for operating alternating-current motors. The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. (Charles P. Steinmetz, United States.) (Complete specification.)

18113. Improvements in or relating to winding apparatus for field telephones, wires, or the like. Leonidas Boije, 18, Buckingham-street, Strand, London.

18118. Improvements in plug switches for electric circuits. Thomas Herbert Marsh and Albert Vandam, 47, Lincoln's-inn-fields, London.

18119. Improvements in incandescence electric lampholders. Thomas Herbert Marsh and Albert Vandam, 47, Lincoln's-inn-fields, London.

18120. Improvements in the manufacture and production of electric cables. Henry Edmunds, 47, Lincoln's-inn-fields, London.

18122. Improvements in transmitting sounds by telephony. John Wesley Gibboney, 322, High Holborn, London. (Complete specification.)

AUGUST 4.

18173. Instruments for measuring and recording the supply of electric current. William Arthur Price, Teign House, Westcombe Park-road, London.

18176. Improvements in or relating to electrical accumulators or storage batteries. Albrecht Heil, 55, Chancery-lane, London.

AUGUST 5.

18200. Improvements in apparatus for transmitting electrical impulses and signals. Herbert Godsall, 13, Bruton-street, Berkeley-square, London.

18219. Improvements in electric pendulum indicators, and also in electric bell-pushes. David Fraser Laing, 115, St. Vincent-street, Glasgow.

18230. Improvements in apparatus for electrically actuating and controlling ships' rudders or other mechanism. Sydney Pitt, 24, Southampton-buildings, Chancery-lane, London. (Société Sautter, Harlé, et Compagnie, France.) (Complete specification.)

18235. Improvements in connection with arc lamps. Walter John Hubert Jones, Frederick John Chaplin, and Samuel Jevons, 77, Colmore-row, Birmingham.

18236. Improvements in electric furnaces. Thomas Jackson, 8, Quality-court, Chancery-lane, London.

18272. Improvements in the manufacture by electrolysis of sheets or objects of polished metal. Louis Emile Dessolle, 18, Buckingham-street, Strand, London.

18274. Improvements in electrically-operated hand-tools. Ernst Waldemar Jungner, 18, Buckingham-street, Strand, London.

18276. Improvements in electric lamps for miners' use. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Otto Siedentopf, Germany.) (Complete specification.)

18278. Improvements in and relating to brushes for electro-dynamo machines. George Croydon Marks, 18, Southampton-buildings, Chancery-lane, London. (Alfred Bouvier, France.)

AUGUST 6.

18289. Improvements connected with the ignition of gas lights by means of electric sparks. Ridley James Urquhart, 57, Barton-arcade, Manchester. (The Actiengesellschaft für Fabrikation von Broncewaaren und Zinkguss vorm. J. C. Spinn und Sohn and S. J. von Romocki, Germany.)

18290. Improvements in apparatus for electrically controlling and igniting gas-burners. Ridley James Urquhart, 57, Barton-arcade, Manchester. (The Actiengesellschaft für Fabrikation von Broncewaaren und Zinkguss vorm. J. C. Spinn und Sohn and S. J. von Romocki, Germany.)

18337. Improvements in electrical cut-outs. Hugo Hirst, 73, St. Stephen's-road, Upton Park, London.

18354. Improvements in apparatus for measuring and recording electric currents. Hermann Aron, 6, Lord-street, Liverpool.

18371. Improvements in electric demand meters. Arthur Wright, Norfolk House, Norfolk-street, London.

AUGUST 7.

18393. Improvements in dynamo-electric machines. Henry Chitty, St. George's House, Eastcheap, London.

18398. A device for controlling or "dimming" electric lights. Norman Staniland and Oliver Prescott Macfarlane, 31, Birnam-road, Tollington-park, London.

18399. Electric safety or protective device. Norman Staniland and Oliver Prescott Macfarlane, 31, Birnam-road, Tollington-park, London.

18416. Improvements in or relating to electric traction. Silvanus Phillips Thompson and Miles Walker, 322, High Holborn, London.

18430. Improvements in the manufacture of electric accumulators. Frederico Pescetto, 24, Southampton-buildings, Chancery-lane, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1896.

15782. Electric railways. Brintnell and Baker.

18485. Acid-proof electrical non-conducting articles and composition therefor. Morison.

22333. Method of exciting synchronous or asynchronous dynamo-electric machines or motors working with alternating currents of constant potential. Imray. (La Société Anonyme pour la transmission de la force par L'electricité).

1897.

12019. Apparatus for maintaining a constant temperature of metallic wires heated by an electric current. Berglund and de Wendel.

13414. Safety fuses for electric circuits. Hall and Fuller.

13973. Pneumatically-actuated open-circuit controllers for electric motors. The British Thomson-Houston Company, Limited. (Priest and Merrick.)

14520. Electric and other autocars. Leigh. (Société Charles Mildé fils et Compagnie, Mandos, et Courtante.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	9½-9¾
Brush Company, Ordinary	8	¾-1¼
—— Non. Cum., 6 per cent. Pref.	2	1½-1¾
—— 4½ per cent. Debenture Stock	100	105-109
—— 4½ per cent. 2nd Debenture Stock	100	93-97
Callender's Cable Company, Debentures	100	108-113
—— Ordinary	5	6½-7¼
Central London Railway, Ordinary	10	9½-10½
——	6	5½-6½
Charing Cross and Strand	5	12½-13¾
Chelsea Electricity Company	5	9¾-10¼
—— 4½ per cent. Debentures	100	110-113
City of London, Ordinary	10	23½-24½
—— 6 per cent. Cumulative Pref.	10	16½-17½
—— 5 per cent. Debenture Stock	100	130-135
City and South London Railway, Consolidated Ordinary	100	64-66
—— 4 per cent. Debenture Stock	100	139-141
—— 5 per cent. Pref. Shares	10	15½ 16
County of London and Brush Provincial Co., Ordinary	10	13-14
—— 6 per cent. Cum. Pref.	10	15-15½
—— 4½ per cent. 2nd Debenture Stock	10	15-15½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1⅛ 1⅜
—— 5 per cent. Debentures	—	89-94
Edison and Swan United Ordinary	2	2½-2¾
—— 5 per cent. Debentures	5	4½-4¾
Electric Construction, Limited	2	1¾-2 xd
—— 7 per cent. Cumulative Pref.	2	2¾-3¼ xd
Elmore's Copper Depositing	1	¾-1
Elmore's Wire Company	2	2-2¼
W. T. Henley's Telegraph Works, Ordinary	10	18½-19½
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	108-113
House-to-House Company, Ordinary	5	8¾-9½
—— 7 per cent. Preference	5	10½-10¾
India Rubber and Gutta Percha Works	10	20½-21½
—— 4½ per cent. Debentures	100	105-108
Kensington and Knightsbridge Ordinary	5	13-13½
—— 6 per cent. Pref.	5	8-8½
London Electric Supply	5	1¾-2
Metropolitan Electric Supply	10	16½-17½
—— 4½ per cent. First Mortgage Debenture Stock	100	118-122
National Telephone, Ordinary	5	6½-6¾
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	15-17
—— 5 per cent. Non. Cum. Third Pref.	5	6-6½
—— 3½ per cent. Deb. Stock	100	105-110
Notting Hill Company	10	15-16
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8½-8¾
—— £4½ shares	4½	7½-7¾
Oriental Telephone and Electric Company	1	1½-2
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	102-104
St. James's and Pall Mall, Ordinary	5	16½-17½
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	38-39
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	8	10¾-11½
Westminster Electric Supply, Ordinary	5	14½-15½
Yorkshire House-to-House	5	8-8½

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NOTES.

Traction Bills.—The following Bills opening up a field for the supply of electrical machinery received the Royal consent on the 6th inst.: the Dublin United Tramways, the Coventry Electric Tramways, and the Norwich Tramways.

New Cable.—A syndicate has been formed in Yokohama for the purpose of telegraphically connecting Yokohama direct with San Francisco *vid* Hawaii. The cable will cost £2,200,000, and the Japanese Government has promised to defray £100,000 of that sum.

Madrid Exhibition.—A Royal decree by the Queen Regent of Spain has been issued for the holding of an exhibition of Spanish industries in the Palace of Industry and Art at Madrid in the autumn of the present year. The exhibition will be opened on October 20 next.

Horseless Carriage Exhibition.—We understand that for this exhibition, which opens at the Agricultural Hall, Islington, on Monday next, upwards of 30 vehicles will be on view. These will include electric cabs and other vehicles with motors actuated by the expansive power of steam and the explosive force of oil gas.

The New Corps of Electrical Engineers.—The following appointments in the newly-formed corps of Electrical Engineer Volunteers were announced this week in the *Gazette*: William, Lord Kelvin, is appointed to the honorary colonelcy of the corps. Rookes Evelyn Bell Crompton (late lieutenant 57th Foot), Alfred Ebenezer Mavor, and Robert Stewart Erskine are appointed captains. The undermentioned gentlemen are to be lieutenants: Alfred Ernest Le Rossignol, Walter Adolph Vignoles, and Henry Meredith Leaf.

Illuminated Fountains. — The electric coloured fountains at the Brussels Exhibition have at last been made to work satisfactorily. The installation is hidden underneath the reservoir, and there are some 48 hand projectors used. These throw the light vertically upwards through openings which are glassed over. The central space is surrounded by lead pipes, from which 150 jets throw the water to a height of from seven to eight yards. These being lit up from underneath by different colours alternatively blending produce an ever-varying effect with brightest hues.

Electric Lighting Provisional Orders.—The following towns and urban districts may now expect the electric light at an early date, as their provisional orders under the 1888 Electric Lighting Act received the Royal assent on the 6th inst.: Denton, Droylsden, Levenshulme, Moss Side, Stretford, Withington, Bangor, Bexhill, Epsom, Galway, Northwich, St. George-in-the-East, Mile End Old Town and Limehouse, Holborn Liberty of Charterhouse and Shoreditch, Fulham and Westminster, Newmarket, Poole, Branksome, Blackheath and Greenwich district, and Newington.

Tesla Electrifies the Earth.—It is queer that the American inventors cannot dispense with sensational interviews. We sometimes are inclined to doubt whether an untechnical interviewer is always at fault. Thus the New York *Journal* announces the completion of Mr. Tesla's work for the transmission of messages from one point to another on the earth without the aid of wires. To give an idea of the high potential currents used in this work, he showed the interviewer a large disc, from the centre of which protruded a spherical electrode shooting forth long streams of ethereal flame. Mr. Tesla stated that the electrical disturbance thus created was felt throughout the globe.

High-Speed Engines.—The practice of using high-speed engines for direct driving of dynamos is essentially an English custom. Due to the ingenuity and scientific ability of the late Mr. Willans, the difficulty of running at high speeds was rapidly surmounted. The success of these first engines urged other engine builders to follow suit, with the result that now a number of firms are able to supply satisfactory high-speed engines. We note that the Willans engine is now doing similar pioneering work in America, where it is being manufactured by M. C. Bullock and Co., of Chicago. We have just received an illustration of a 240-kw. two-phase alternator coupled to an engine of this type. We trust that the numerous belts and countershafts so much favoured for lighting plants in the States will be superseded in all new stations.

Isolated Plants —This question is still being discussed by American contemporaries, many writers being in favour of isolated plants. There is just one point in the question which, so far as we have seen, the writers carefully avoid. We have at various times heard the opinions of various people as to the salubrity or otherwise of stokeholds in steamships in the Red Sea. A concensus of opinion seems to infer there is only one hotter place in creation, but of this we cannot speak personally, except to say it is not Aden. Now if some of the writers would only spend a single week in the engine-rooms of some of our isolated plants, their language would require a dash of ice to make it presentable. Owing to the value of land in the large towns where isolated plants are applicable, the machine department is too often some distance below the surface of the ground, and very badly ventilated. Habit is said to be second nature, but it requires a considerable amount of habitual working in these rooms to come to look upon them as a natural habitat for humanity to work in.

Proposed Lighthouse for Sokotra.—On Wednesday, the 11th inst., Mr. Ritchie, Sir Courtenay Boyle, and Captain Vereker received at the Board of Trade representatives of the Peninsular and Oriental, the Orient, the British India, the Glen, and the Clan lines of steamships, in order to discuss whether any, and, if so, what, steps should be taken to light the east end of the Gulf of Aden. The Admiralty, the Trinity House, and Lloyd's were also represented. The general opinion of the representatives of the shipping companies present was in favour of the erection of a lighthouse on the east point of the island of Sokotra. We understand that one great difficulty in this scheme is the unfriendly nature of the natives on Sokotra, who, it would seem, are anxious to appropriate the portable property of all strangers sojourning with them. An electric lighthouse could be arranged to effectively light the Gulf from this point, and at the same time some electric fortification could easily be erected to protect the lighthouse keepers from night attack. For details of such a scheme our readers should read the novel entitled "The Yankee in the Court of King Arthur."

Telephone Troubles.—The *Daily Telegraph* gives details of a very curious case of lunacy which is attributed to a too assiduous use of the telephone. An individual about 40 years of age was noticed by the passers-by lying on the Boulevard des Capucines with his mouth against a metal plate affixed to the footpath pavement. What was he doing, people asked in wonderment, for he appeared to be speaking to some subterranean being. "Don't you see that I am telephoning?" he exclaimed, raising himself on his elbow. "I am a clerk in the employ of a man of business at Rouen; I telephone from morning to night, and

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I am requesting him to forward me some money." "But this is not the post office," objected the by-standers. "It is," replied the stranger, "and the proof is that he has just promised to send me 15fr." The police, who had come up, perceiving the state of things, induced the poor fellow to accompany them by offering to conduct him to the post office, where the letter containing the order must, as they added, have arrived by that time. It is worthy of notice that all his experience had not shaken his belief in the efficacy of the telephone as a means of communication.

Motorcar Racing.—Our prediction in our note on the Paris-Dieppe race has come too true. Thus in the motorcar race from Paris to Trouville, which took place last Saturday, 22 motorcars of various designs and 26 motor-cycles started from St. Germain. The distance to Trouville is about 108 miles, and the motor cycle and car first in the Dieppe race were again first here, M. Jannin on his cycle doing the distance under four hours, while M. Gille's Hourgières-Bollée carriage covered the 108 miles in 4 hours and 20 minutes. These vehicles arrived safely, but M. Viette, who was riding a motor-cycle, was not so fortunate. He came into collision with a heavier vehicle, and now is suffering from concussion of the brain and a smashed jaw. It was said that he was killed, but by the latest accounts he is still alive, though in a very precarious condition. In this respect the Electrical Cab Company, of London, has set a good example. It is impossible for a driver to go faster than nine miles an hour with the present gear on an ordinary level road. Down-hill this speed could be increased, but only through a neglect of the ample brake power provided. This limiting speed will be appreciated in the light of the above catastrophe.

Finsbury Technical College. — The following students have successfully completed their respective courses at the Finsbury Technical College. In the electrical engineering department, which is under the direction of Prof. S. P. Thompson, D.Sc., F.R.S., the usual course takes two years. The students who have completed their term this year are F. J. Benton, T. Bowden, W. W. Bradfield, H. M. Dowsett, B. Handley, F. J. Hawkins, C. S. Franklin, R. Grigg, J. Kingston, C. J. Lockyer, J. H. McDowell, G. Morrison, M. Packer, F. Powell, E. E. Tasker, E. A. Tunbridge, and P. R. Wray. In the mechanical engineering department, under Prof. W. E. Dalby, M.A., B.Sc., a two years' course is also given, and the following have now qualified by passing all the examinations: A. Bromley-Smith, D. D. Crookston, F. C. Hibberd, J. W. Johnston, A. Locket, P. C. London, H. W. S. Martin, E. A. Matzinger, W. J. Morison, E. A. Nesbit, and J. T. Turner. Prof. R. Meldola, F.R.S., has turned out the remaining gentlemen after a successful three years' course: W. Butter, A. W. Comber, A. N. Coomes, C. R. Dow, R. G. Grimwood, H. W. Hill, F. de Mersan, W. P. Paul, P. P. Phillips, B. W. J. Warren, and F. T. Wood.

Telephone Enquiries. — In our last issue we announced the fact that the Government had appointed Sheriff Jameson, of Perth, to hold an enquiry in Glasgow on the advisability of municipalising the telephone. The fact that the enquiry is to be local is interesting reading after our persistent advocacy of the method of procedure. Thus, our leader for our issue of March 12 this year concluded as follows: "But the Glasgow Corporation, the States of Guernsey, and the Town Council of Tunbridge Wells, the most sturdy of the applicants for licenses, are not easily defeated by a policy of not-answer-the-door. Their persistent baiting led Mr. Hanbury to promise on Monday night that careful enquiry shall be made into every application. This is a step in the right direction if a real and not a bogus enquiry is intended. There must be no repetition of the Select Committee of 1895, nor must the Post Office be entrusted with the position of judge, for which its pro-National Telephone Company leanings entirely disqualify it. We suggest that the procedure adopted in the case of applications for provisional electric light orders is eminently suitable for applications for telephone licenses too, and that the enquiries be conducted by the Board of Trade in the town or locality concerned."

Manganese Dioxide in Lead Accumulators.—The experimental evidence adduced by Mr. G. von Knorre in the *Zeitschrift für Elektrochemie* should make electricians cautious as to the use of manganese in accumulators. A freshly charged positive plate, dipped into sulphuric acid containing manganese sulphate, at once gave the pink colour and the absorption spectrum of permanganate. The same acid is formed when a positive plate on which some manganese dioxide is spread is immersed in sulphuric acid. On the other hand, a permanganate solution is discoloured by a negative plate and a lead glycerate plate containing manganese dioxide and coupled as cathode with another plate during formation, soon made the anode red, although the sulphuric acid and the anode were free of manganese. The author concludes that there is little doubt but that the manganese acts as oxygen carrier from the positive over to the negative plate, and impairs the capacity of the cell. That we do not notice the colour reaction in ordinary cells is due to the circumstances that the oxidation and reduction proceed simultaneously. An accumulator which has been prepared with manganese salts, is said to become quickly discharged. The author strongly advises that manganese compounds should be avoided in electric accumulators.

Electric Power in Mines.—The transmission of power by electricity is, in some cases, retarded in coalpits because of their fiery nature, which renders it imperative that no sparking shall ever take place where it could ignite a fiery mixture of air and gas. With direct-current motors it has therefore been necessary to completely box in the commutator and brushes, which renders them rather inaccessible. The great advantages of a three-phase or a two-phase alternate-current system for such work cannot be too largely brought to the notice of the public. When motors of the above type and of reasonable output are used, a simple throw-on switch is all that is required in the way of regulating gear, and the contacts of this switch are the only points at which sparking can occur. It is a comparatively easy task to box in this switch-gear. The motors being without commutators or collecting rings, are absolutely free from sparking. The cables leading to the motors only need protection, and there is no lack on the market of well-protected concentrics which will give safety in this direction. The motors have a good starting torque, and can be relied on to drive coal-cutting machinery and hauling ropes. We must admit, however, that up to the present we have not seen a satisfactory arrangement for an electric locomotive to be worked in fiery pits.

An Electrical Pioneer.—Prof. A. E. Dolbear recently delivered an address at Greenacre, U.S.A., on the pioneering work of Moses G. Farmer. The first name of this gentleman was too much for the professor, and as a result the address is half-cousin to a sermon on the travels of the Israelites. He sums up the subject in hand in the following way: "Thus it appears that Mr. Farmer traversed this promised land from Dan to Beersheba; he did more than simply blaze the way, he raised a memorial at every place where he stopped. At twenty-six he had built an electrical railroad, at twenty-eight he had improved the telegraph, at

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thirty he had invented and constructed the fire-alarm system with water-power driven dynamos, at thirty-five he had discovered the means for duplex and quadruplex telegraphy, and at thirty-six the art of depositing aluminium electrolytically. At that age he read a paper before the American Association for the Advancement of Science on multiplex telegraphy. At thirty-nine he had lighted his parlour in Salem with incandescent lamps, at forty-four he had greatly improved thermo-electric generators, at forty-six he had invented the modern dynamo with self-exciting field, and at forty-eight had lighted a house in Cambridge with 40 incandescent lamps in multiple circuit and all properly self-regulating." The professor concludes that "there is good reason for believing that the introduction of the condenser into telegraph work, which so enormously increased the working capacity of the line, was his invention."

Conduits for Electric Wires.—It will be remembered that in our last week's issue we commented on the fact that the Institution of Electrical Engineers' new rules for electric wiring did not express any opinion as to whether insulated or uninsulated conduits should be used for electric wires. The same matter is agitating the profession in America, and is well summed up by a correspondent in our New York namesake. He concludes that the real question is "which is the safer conduit for electric conductors, insulated or uninsulated? This is, after all, the sum of the matter, in so far as it comes within the purview of the underwriters. In the argument for uninsulated conduits there must necessarily be assumed an insulation upon the conductors themselves sufficient to ensure a reliable and durable service. The only question involved in this assumption is as to whether the wire insulations of commerce can and do afford the requisite reliability. The contention, of course, is that they do. If this contention is well founded then no auxiliary insulation is essential for this specific purpose, and the whole subject is reduced to a question of relative safety. In recently promulgating the decree that conduits are merely wire raceways, and must not be depended upon for insulation, and in the logical supplementing of such decree by the further one permitting the use of uninsulated conduits, the American underwriters have apparently concluded that the insulation of a conduit adds nothing to its efficacy as a safeguard against fire."

The Contract System.—The system of paying for electric energy by meter has become so general in England that our inventors have ceased to pay attention to the older method of payment of a certain sum per lamp fixed. This latter system, which was in vogue before reliable meters could be obtained, is, however, still much used abroad. This is specially the case in village installations run from water power, in which case the cost to the company is not a function of the length of time current is used. On the other hand, the candle-power of the lamps used by the consumers does make a considerable difference by limiting the possible number supplied. Hence it is necessary to see that the candle-power of the lamps is not altered without notice, and also to charge a sum per lamp varying with its candle-power. A device for preventing large candle-power lamps being substituted for smaller ones has been introduced in Bavaria. It consists of a variation in the holders, which are of the screw-socket type, and in the lamps, so that the relative depth of the inner contact is changed. This depth is made longest for small candle-power and shortest for high candle power. Hence the 50-c.p. lamp will not screw down far enough to make contact in a 32-c.p. holder, and so on. Of course, the small lamp can be used in any holder for higher candle-power lamps. The system is simple, but, after all, the inability to temporarily increase one's light is not convenient, and it does away with much of the flexibility of electric illumination.

Electricity in Agriculture.—Amongst the reports sent in to the Society for the Encouragement of National Industry (France) is one under this title by M. Paul Renard, who observes that Messrs. Felix and Chretien long ago made a successful trial at Sermaise of electrical power for ploughing. Since then the work has been taken up by others, and the author describes a certain number of applications. A really practical installation has been made in France by M. Felix Prat, in the department of Tarn. The power is derived from a turbine working a dynamo, the current from which is distributed to different points on the estate by four overhead lines, with copper conductors, in the form of a cable. Two of these lines are 1,800 and the remaining two 1,600 metres in length. These lines, wherever possible, are supported on trees—strong poplars—in order to economise posts whilst securing rigid supports. The plough is drawn by a simple windlass worked by the dynamo, and can be worked to a distance of 450 metres on each side of the cable line. This installation cost 12,600fr., part of this sum, however, being expended for electric lighting. The author describes also an installation carried out by M. Vergnes at Montlaur, in the department of Areyron, for the supply of electric lighting and of power applicable in irrigation, ploughing, threshing, etc. The memoir describes also some agricultural appliances, to be worked by electricity, of American manufacture, and also a plough for use in vineyards, which has been adopted by M. Abel Pilon at Ben-Sala, near Boufarick.

German Postal and Telegraph Reforms.—The new Postmaster-General of Germany, von Podbielski, has signified his intention of actively pushing forward the desired and proposed reforms to be made in his department. In the course of next year he proposes taking up the question of reform in the matter of letter and news paper postage, and also of the telephone service. With regard to the last, very important reforms are to be introduced, and it has already been definitely decided that a reduction of the telephone charges in general must undoubtedly be attempted, but here also Herr von Podbielski intends to follow his rule of causing those who make special claims on the department to pay special rates. Herr von Podbielski has already taken steps for procuring information as to the telephone arrangements in force in other countries. Four officials have been sent to Sweden to study the telephone system there. Stockholm is said to have the most extensive telephone system of any city in the world; there are two separate services there—the Allmanna and the Riks telephone, the latter being the Government system. The Allmanna system's subscription covers a radius of 43 English miles around Stockholm, and the company has besides 2,500 instruments outside the city, with which the subscribers in Stockholm can be connected free of charge. The total number of subscribers is 15,500, or one telephone to every 18 inhabitants. The company supplies private houses with telephones for £2 per annum, while offices and shops have to pay £3. 6s. The cost of fixing up the instruments has, however, to be added to these rates.

American Practices.—The phrase "home truths," commonly used, is based, we suppose, on the fact that relations are apt to quarrel, and that in such a case the opinions expressed are remarkable for their veracity. In this light we read the columns of our American contemporary, *Electricity*, which week by week tilts at the two large electrical companies doing business on that side of the water. Thus

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the fact that the orders for the machinery for the Central London Railway went to America is explained by our contemporary on the grounds that "these concerns are not carried on with the view of making profits on the manufacture of electrical apparatus, but their profits are intended to come from the manufacture of electrical stocks and bonds." This class of competition has, however, to be met even on this side of the ocean, as contracts have repeatedly being taken for advertising purposes at a price which precluded any profit whatever. This however, is not the only basis of complaint which our contemporary finds. It says editorially that the firms in question were deficient in technical matters. It adds: "The modern direct-connected multipolar dynamo originated in Europe, and was extensively used there long before it came into use in America. In fact, the manufacture of this type of dynamo was not undertaken there until several of the more prominent local electric lighting companies threatened to desert the parent companies and import machines of this class from Europe. The American manufacturers resisted the efforts made to force them into the manufacture of this type of machine, and when they were finally forced to enter upon its manufacture they imported machines from Europe, and copied them in almost every detail, or so modified them as to make them inferior to the originals." These critical home truths must be much appreciated by the American nation at large, but perhaps a grain of salt would be advisable, to assist digestion.

A Protest.—We think it only just to the profession generally to protest against the proposed appointment of a foreign engineer to advise the Liverpool Corporation over their traction work. We do so not from any personal motives, as we are convinced that Mr. Pearson is well qualified to carry out the work, and that he would use his best endeavours to make the same a thorough success. What we do say most emphatically is, that we have many consulting engineers in England who are quite as capable from a technical point of view, and who, both from their residence here and their knowledge of English municipal practice, should not be lightly passed over. The fact that we have not had so many lines laid down on this side is the fault, not of our engineers, but of that of our democratic tramway laws; and we would say unreservedly that the English lines equipped by English engineers are not behind the American practice in any way. Perhaps one reason for this may be gathered from the fact that here we are not in the hands of the contracting firms, who in America control the industry. In other words, the English consulting engineer does design the work to suit the locality, whereas much of the work carried out on the other side is on the standard system. If the standard system does not suit the locality, so much the worse for the local people. Something beyond giving an order for so many miles of track with all needful gear is considered necessary here, and the fact that the General Electric Company can despatch tramways much as some grocers fulfil their weekly orders, is not in our eyes a recommendation to the professional skill of the resident engineers. We put this to the Liverpool people as a reason for considering before finally committing themselves to the report of the Tramway Committee, and trust that the Corporation will decide that English tramway experts should have a large voice in the electrical traction schemes they are proposing. They cannot plead a want of knowledge, as the Liverpool Overhead Railway is a practical example of what original thought and careful design has accomplished.

Motive Power at Geneva.—At its last sitting the Municipal Council of Geneva voted a credit of 2,000,000fr. for the development of the continually increasing municipal service. This sum will be distributed as follows: Water supply (Coulouvrenière).—Establishment of a regulator for low-pressure hydraulic supply, 40,000fr.; new mains, 50,000fr.—total, 90,000fr. Supply of motive power (Chèvres).—For the completion of turbine-house No. 2, 200,000fr.; three groups of turbines and dynamos, at 180,000fr. each, 540,000fr.; tools for the works, 20,000fr.; extension of the underground network, 500,000fr.; ditto of the overhead network, 300,000fr.; transformers and huts, 250,000fr.—total, 1,810,000fr. Grand total, 2,000,000fr. The distribution at the Chèvres works of electrical energy utilised, or shortly to be utilised when the junction of the town with the suburban districts is carried out, is about as follows:

	Horse-power at Geneva.		
Private electric lighting.	1897.		1898.
In the town (26,000 lamps)	1,200	.....	1,500
,, Plainpalais	50	.....	200
,, Eaux-Vives	50	.....	100
,, Petit-Saconnex	50	.....	200
Public electric lighting.			
In the town	180	.....	250
,, Plainpalais	—	.....	30
,, Eaux-Vives	—	.....	10
,, Petit Sacconex	—	.....	5
,, Tramways	400	.....	500
,, Minoteries	170	.....	170
,, Sécheron	200	.....	200
,, Gasworks.....	80	.....	80
,, Various motors	50	.....	200
Totals	2,430	.....	3,445

To ensure a regular supply, a second underground line, directly connecting the town with the works, is to be established. In regard to the other parts of the canton, the electric energy will be distributed as at present, by overhead lines at a high voltage. Transformer stations will be established in the vicinity of the villages, and the overhead lines proceeding from them will distribute the energy at a safe voltage, as in the urban network.

Osmotic Pressure and Electrolytic Dissociation.—A carefully written paper by Mr. Holland Crompton in the *Journal* of the Chemical Society discusses the theory of osmotic pressure and the hypothesis of electrolytic dissociation In the first place, Mr. Crompton gives Van t'Hoff's well-known theory that "a substance in solution is in a condition strictly comparable with that of the same substance in the gaseous state, and exercises a pressure—its osmotic pressure—which is equal to that which would be produced if the solvent were entirely removed, and the substance thus left in the state of gas in a volume equal to that originally occupied by the solution In other words, if one gramme-molecule of any substance is dissolved in any solvent, the solvent being taken in such quantity that the solution formed has in all cases a volume of one litre, the osmotic pressure will always be the same, and given in the customary units by 22·32 + 760mm. at 0deg. C. That this is actually the case was shown by Van t'Hoff for a solution of cane-sugar in water, making use of Pfeffer's directly determined values for the osmotic pressure." Upon this theory the hypothesis of electrolytic dissociation is founded, but to meet the requirements of aqueous solutions a coefficient was found necessary. Mr. Crompton says the law is wrong. "Not only," he says, "do the deductions made here lead to the conclusion that the hypothesis of electrolytic dissociation is entirely unnecessary for the explanation of exceptions to Van t'Hoff's law of osmotic pressure, but they are incompatible with that hypothesis in its present form. For a monomolecular compound in an associated solvent, $E = 0{\cdot}01976\ T^2x/ra$, and this gives a

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value of 55·3 for water. Now, if this monomolecular compound dissociates further into ions, and these act as separate molecules, as I presume no one would claim association for the ions, a compound giving rise to two ions should have a value for E of 110·6, and one giving rise to three ions a value of 165·9. This, of course, is quite contrary to the observed facts." In concluding the paper, he gives his conclusions, but of these the fourth and fifth only concern us. They are as follows: "(4) Exceptions to Van t'Hoff's formula, for the molecular reduction of the freezing point, appear therefore whenever association of either dissolved substance or solvent takes place, and the hypothesis of electrolytic dissociation is not only unnecessary in explanation of these exceptions, but inconsistent with what is now known of the nature of liquids; (5) electrolytes are salts in an approximately monomolecular fluid state in solution in associated solvents."

Test of Power Plant.—The electric traction plant and equipment for the Fairmount Park, Philadelphia, is described fully in the current number of the *Street Railway Journal*. The dynamos used are of 500 kw. capacity of the General Electric type, coupled direct to tandem compound-condensing engines by R. Wetherill and Co. The following is a report of a test made February 9 by Axel H. Engstrom, chief engineer of the company, of one engine and two boilers of the station. The test was conducted to determine the economy of engines and boilers, and for this reason condenser pumps, feed pumps, fan engines, etc., were furnished with steam from a separate boiler. The feed-water for the boilers which were being tested was measured by a Worthington water-meter. The electrical measuring instruments were calibrated before and after the test by the Weston Electrical Instrument Company, four voltmeters, two ampere-meters, and one Thomson recording wattmeter being used. The load was applied to the generators by means of a water-rheostat of ample capacity. Live steam was not used in the receiver. The duration of the test was 10 hours, and the following are the figures obtained: Total kilowatt-hours, 4,859; average output per hour in kilowatts, 486; total electrical horse-power hours, 6,511; average current density in amperes, 884; average potential pressure in volts, 549; total indicated horse-power hours, 7,869; average indicated horse-power hours, 787; pounds of steam per indicated horse-power per hour, 14·42; combined effort of engine and generator as a unit, 84 per cent.; total amount of water evaporated, 113,511lb.; water evaporated per pound of coal, 9·79lb.; water evaporated per pound combustible, 11·27lb.; total amount of coal burned, 11,589lb.; coal burned per indicated horse-power hour, 1·473lb.; coal burned per electrical horse-power hour, 1·743lb.; coal burned per kilowatt-hour, 2·332lb.; water evaporated from and at 212deg. per pound coal, 11·76lb.: temperature of water at hot-well, 96·51deg.; temperature of water leaving heater, 174·02deg.; temperature of water entering boilers, 216·1deg.; temperature of gases leaving boilers, 402·5deg.; temperature of gases entering economiser, 350deg.; temperature of gases leaving economiser, 230deg.; steam pressure in boilers, 140lb.; steam pressure in horse-power cylinder, 134lb.; steam pressure in receiver, 14·5lb.; vacuum in inches, 25·5lb.; average draught in boiler, 0·15in.; average draught at fan, 0·19in.; revolutions per minute of fan wheel, 17; percentage of combustible in 1lb. of coal, 86·83; moisture in coal, 1·17 per cent.; percentage of ash in coal, 12 per cent.

Another Prize Competition.—The Société Industrielle of Mulhouse offers eight prizes for the solution of electric engineering problems. As foreigners are entitled to compete (in fact, the only men barred are the members of the council and committees of the society itself), we give particulars of the questions, which may be of interest to English competitors. The papers must be sent in before February 15, 1898, addressed to the president of the society, and must be marked with a short device or epigraph; the name and address of competitor is to be forwarded in a separate closed envelope. The problems are numbered as follows: No. 89 refers to an electric motor of variable power and velocity. A medal of honour will be awarded for an electric motor capable of developing power at a speed changeable at will in the ratio of at least 1 to 10, which, when connected to a network of electrical distribution, shall have, according to the various velocities, a minimum efficiency of 20 per cent. The power of the motor at normal speed to be at least 10 h.p., and at that power and velocity the efficiency must be equal to that of motors working under constant speed. No. 90 is a prize of either a medal or a sum of money for an improved and easily replaceable commutator. This must be applied for six months to an apparatus at work in the province of Upper Alsace. No. 91B is a silver medal for an essay upon lighting a factory; 91 a medal of honour for an essay upon lighting a town of 50,000 inhabitants. No. 92 deals with the E.M.F. of alternators. A medal of honour and a prize varying from £20 to £40 according to the merit of the work submitted will be awarded in this section. This is for a treatise describing the form which the E.M.F. curve takes in the single or multi-phase alternators, according to the relative disposition of their armature coils and magnet poles. The author must also go into the question whether the curve given by a machine running without a load undergoes modifications of form when it is running with a load, and especially with a load which gives a large lead or lag. This treatise, worked out upon a theoretical basis, should be amplified by experiments made with machines of various types. All particulars which might have an influence upon the E.M.F. curve must be given. In conclusion, the author must seek a way to calculate the coefficient which enters into the formula of the effective E.M.F. in a manner sufficiently correct to be of use in the construction of alternators. No. 93 is for an electric brake to measure the power. A medal of honour will be awarded for the design and description of an electric brake capable of measuring 20 h.p. The cooling should be effected solely by air in contact with the revolving parts. The constructor should make this brake in such a way that the force absorbed by the friction of the air need not be taken into account, being very small in comparison with the power to be measured; but he should at the same time indicate a formula which permits the calculation of the work absorbed by the friction of the air for all speeds at which the brake is capable of acting. He should also furnish the brake with a lever acting in the same direction as the power to be measured, and a weight sliding on the lever, the position of which is graduated empirically in a manner to eliminate the friction of the different speeds. This brake must have been tried by a competent authority, and the results of the trial, as well as a design of the brake, must be attached. No. 94: wattmeter register. A medal of honour is offered for a registering wattmeter. This instrument must be capable of being employed to measure the energy of either a continuous or alternating current in industrial installations. These indications must be independent of the frequency of the alternating currents; its self-induction must be practically nil. It should trace a continuous curve with ink on a sheet of paper, of which the given points are proportionate to the number of true watts which are to be measured. The paper must be moved, thus indicating time.

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THE MECHANICAL CONSTRUCTION OF ELECTRICAL MACHINERY.

BY F. M. WEYMOUTH.

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THE DYNAMO.

(Continued from page 200.)

Bearings (continued).—A further example of a self-oiling bearing is presented herewith in Figs. 261 and 262. This

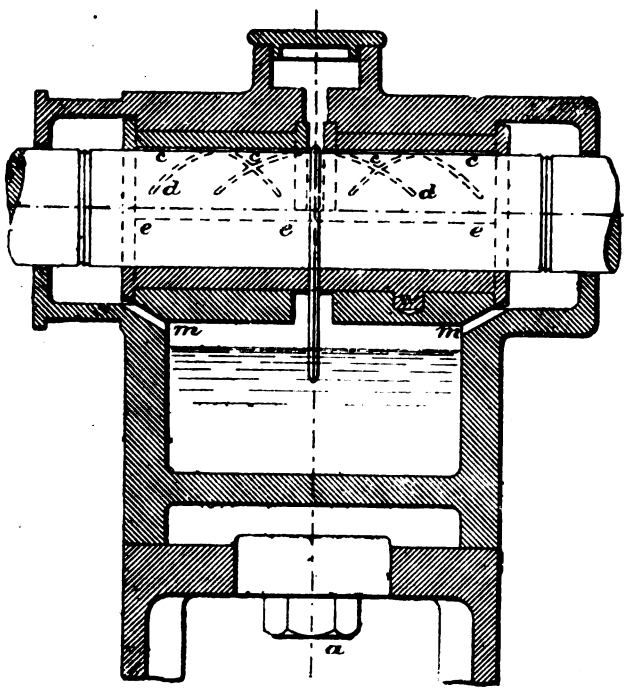

FIG. 261.

is a design produced at the Newton Electrical Works, Taunton; and we have to thank that firm very much for the drawings of which not only the first-named illustrations, but also Figs. 263 to 266, are a reproduction. In these latter views are depicted the bed-plate and slide rails; and

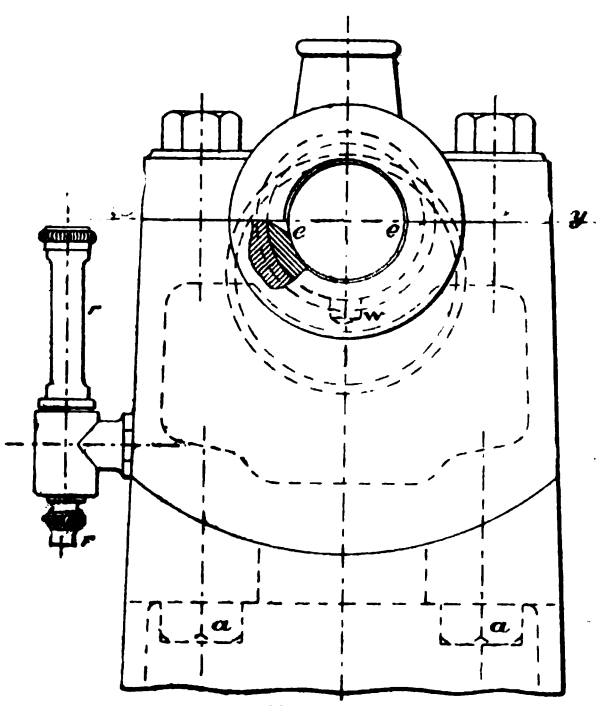

FIG. 262.

we interpolate these here inasmuch as to do so affords the opportunity of showing how the bearings are fitted and held on the pedestals, and through the drawings not having been to hand before closing that subject.

It will be observed that these bearings have a cylindrical seating, but exhibit a peculiarity as compared with those shown Figs. 217 and 220 in the method of holding down. This is accomplished by means of tap-bolts inserted from below, instead of above, the bearing, as shown at *a a*; and hand-holes are provided in the sides of the pedestals for the purpose, as shown. Great compactness is thus arrived at; and the absence of flanges on the bearing enables the pedestal to be made comparatively narrow across the top, as may be seen in the end view, Fig. 265.

To glance more particularly at the bearing itself, we may note that this again has only one oiling ring. We are informed, however, that in the case of large bearings two, or sometimes three, rings are employed in the designs by this firm. In this present instance with the single ring there are three brasses, the lower one continuing throughout the length of the bearing. It will be perceived that the ring has practically a triangular section with the apex on the outer periphery. Oil can thus lie in a thin stream between the ring and the brass ends even when touching; and there is no flat side to the ring making it liable to

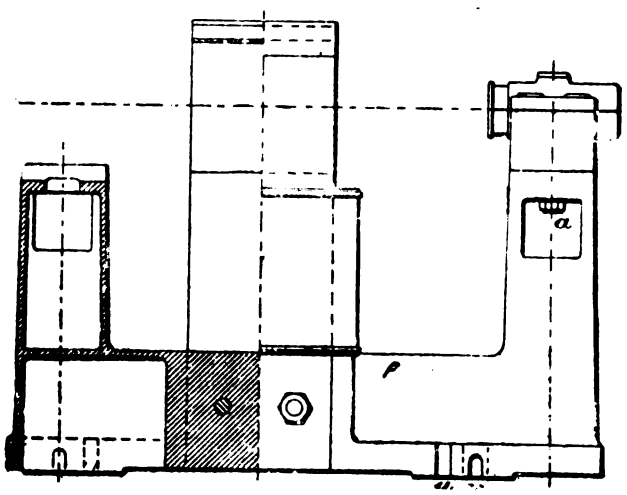

FIG. 263.

adhere to the flat brass ends. Ample means are used to facilitate the entrance of the oil within the brasses. In the upper brasses, oil grooves, *c c*, with ends open toward the ring, are cut straight along the top, and from these there branch off spiral grooves as shown dotted at *d d*. Further than this, however, the upper edges of the lower brass are bevelled inwards as shown at *e e*, Fig. 262, on one side in section; and this bevelling, as shown dotted at *e e* in Fig. 261, is continued each way nearly the whole length of the brass, forming thereby what may perhaps be termed a triangular trough along each side of the journal. Hence, in addition to the oil that may enter the grooves in the upper brasses, a large quantity will be caught in this bevelled trough, and will flow therein both ways along the bearing. It would thus seem that there would be a good circulation of oil within the brasses. The oil exuding from the ends will return to the reservoir below by the drain-holes, *m m*, as in other cases. A combined oil-tap and

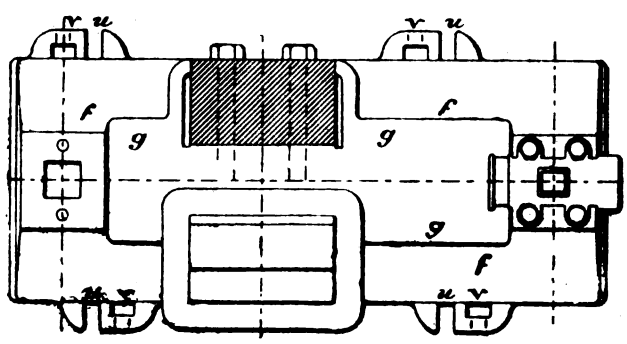

FIG. 264.

gauge-glass, *r r*, is provided at the side whereby the height of the oil inside may be watched, or the oil may be drawn off if desired. In Fig. 261 the oil itself is indicated, presumably at about its working level.

As regards general construction it will be noted that the joint between the cap and the base is entirely in one plane

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through the horizontal centre line, *x y*, and the steadiment of the cap and upper brasses is dependent on the fit of the holding-down bolts of the cap. The brasses are prevented from rotating by a snug, *w*, on the lower brass, as shown.

Inasmuch as we have introduced the bed-plate and slide rails here, these may receive some attention. It will be noted that the bed-plate is for an over-type machine; and the yoke is cast within it. Recesses either side receive the lower ends of the magnets; and these latter are fastened with bolts passing through both the magnets and the yoke. The sides of the base of the bed-plate curve inwards as they rise, as is more clearly evident at *f f*, Fig. 265; and this curvature has the effect of making the upper table, *g g*, of the base correspondingly narrow. As only a small machine is here represented, about 3ft. 6in. in length, no additional ribbing is apparently considered necessary in respect of the mass of iron cast in the centre.

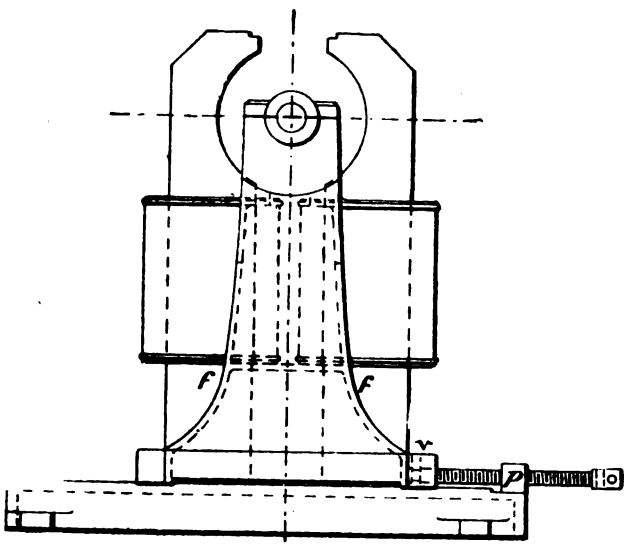

FIG. 265.

A novel feature, however, is presented in connection with the slide rails and tightening screws. For the latter are here suited for pull as well as for thrust; and thus by their means the machine can be drawn back toward, as well as moved from, the engine. It will be seen in Fig. 266, which shows the rail to a larger scale, that the tightening screw has a neck, *i*, turned in its further end, leaving a collar or flange, *o*, beyond. This latter, in order to pass through the screwed hole in

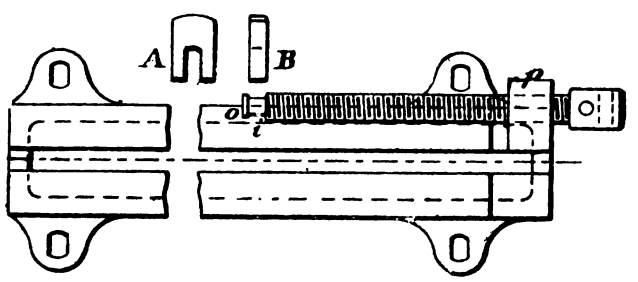

FIG. 266.

the boss, *p*, must either be similarly screwed on its edge, or else have a diameter small enough to clear the threads in the hole; and consequently the neck, *i*, must have a yet smaller diameter. The end, *o i*, is received in a recess, *v*, in the snugs on the bed-plate, as shown Fig. 265; and there is then dropped over the neck a small inverted U-shaped casting, shown in end-view and side-view elevation at A and B, Fig. 266, which locks and prevents the end of the screw from being withdrawn from the snug. Thus, on reversing the action of the screw, this will exert a pull on the snug, and so draw the bed-plate toward the boss, *p*. By this arrangement, however, the bed-plate holding-down bolt does not come in the same vertical plane with the tightening screw. The holding-down bolts are received in the slots, *u u*, which will be observed to be opposite one another (in pairs) in the plan Fig. 266; and the tightening screw has to be put at the side of the rail, as illustrated. An advantage attending the use of the slots, *u u*, is, of course, that it does not become necessary, if it be desired to remove the machine from the rails, to do more than merely slacken the nuts on the holding-down bolts, and then shift these sideways out of the slots. The nuts remaining on them, the bolts cannot drop through the slot of the rail whence their recovery would cause waste of time. This especially applies to this design of rail which consists of a long, narrow box open at the bottom, and with a slot along the top; and wherewith it is necessary to insert the holding-down bolts before the rail itself is bolted down to the foundation.

We now return once again to our more immediate subject—self-oiling bearings. In doing so, however, we shall approach an entirely different principle to that we have hitherto illustrated, although we have made some slight allusion thereto in our opening remarks in this direction.

The principle we now touch on is that of raising the oil from a reservoir, not by means of a rotating ring, but through the agency of a fixed collar of large diameter on the shaft, whose lower periphery dips into the oil, and thus by centrifugal force flings it all round and consequently upwards. The oil thrown thus upwards is then caught in small receptacles or troughs, from which it is

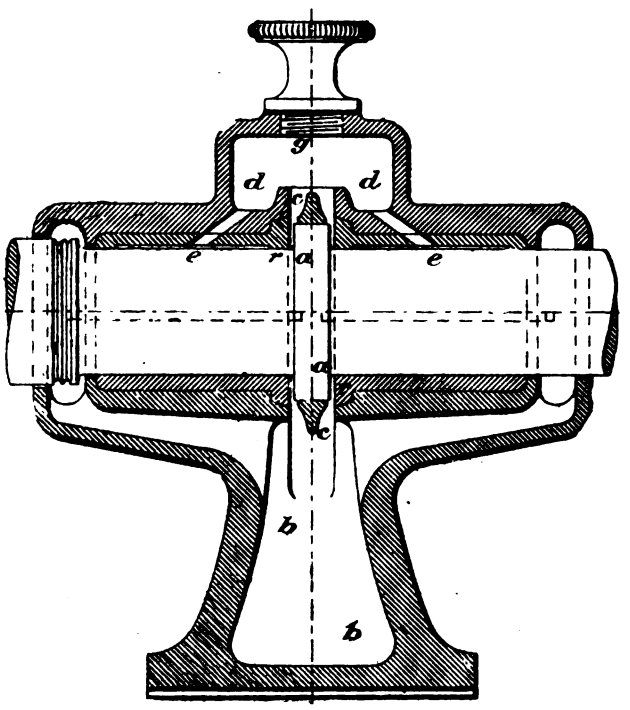

FIG. 267.

conducted by suitable passages to the journal and brasses so as to maintain their lubrication.

An example of this method is hence presented in Figs. 267 and 268 herewith. These illustrate a design patented by Messrs. P. R. Jackson and Co., Limited, Salford Rolling Mills, Manchester; and our drawings are copied from their patent specification (No. 6,791, 1895). It will thus be observed that a collar, *a a*, is formed on the shaft, and that outside this is carried a further paddle wheel or collar, *c c*, the lower side of which latter reaches down into oil contained in the reservoir, *b b*. The oil thus thrown up by the outer collar, *c c*, is caught in the oil-box, *d d*, above. From thence it is led direct to oil-grooves in the upper linings, as shown at *e e*; and exuding from the bearings, returns once more to the reservoir, *b b*, below.

It is to be noted that this bearing represents another case wherein the anti-friction lining is run in and lies in direct contact with the cast iron, and there are no "brasses." This will be recognised as similar to the case shown Fig. 240. We are informed, however, that in this present instance allowance is made for boring the lining to a final fit on the shaft. The lining is made with flanges, as shown at *r r*, against which the main collar, *a a*, can bear, so as to effect endways steadiment of the shaft: and further collars or shoulders for this purpose are therefore

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not required. In a bearing not taking end thrust, and wherewith there is no main collar on the shaft such as that shown *a a*, the paddle wheel or loose collar, *c c*, will then come on the normal diameter of the journal. A small point that may perhaps be noted is that the oil-box, *d d*, is stopped, not by a lid or cover, but by a screw-plug, *g*, which may be screwed down sufficiently hard to prevent exudation of the oil, which may presumably, especially with high speeds, be flung up with some force, and so be liable

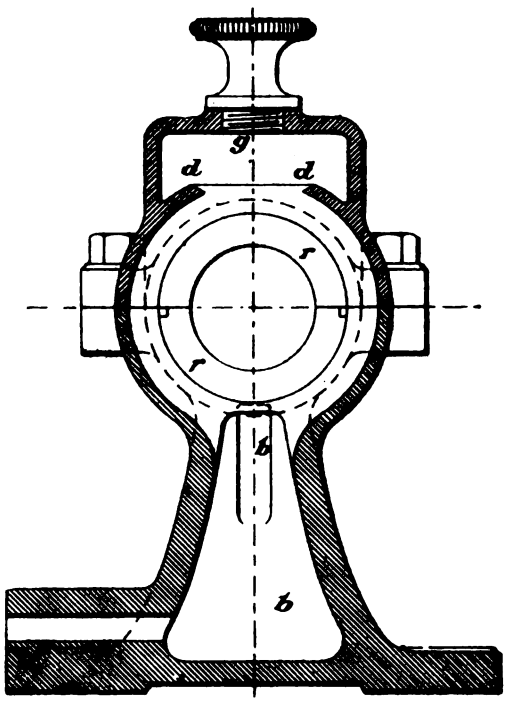


FIG. 268.

to escape above if not withheld from so doing by an oil-tight joint. Messrs Jackson and Co. inform the writer that they make bearings after this pattern of all sizes, ranging from ⅜in. diameter to 9in. diameter, and find them give great satisfaction.

(To be continued.)

TRACTION ACCUMULATORS—LAW OF MAXIMUM WORK. LAW OF MAXIMUM USEFUL WORK.

BY DESMOND G. FITZ-GERALD.

A friend, commercially interested in accumulators, recently requested me to report as to the weight and cost of a "cell suitable for running 18 hours." The speed during the run was to average between seven and ten miles per hour.

I reported that no such cell is, or likely to be, in existence.

My opinion has been called into question. "Surely," it is said, "if we are not limited as to weight of accumulators to be used, we can find a traction battery that will run for 18 hours, or even much longer."

That would be true if the accumulators had not to *transport themselves*, at the given speed, during the given time.

I am further asked: "How is it possible to fix the limit of time?"

My answer is: By calculating, from theoretical or practical data, the distance (L) through which *any weight* of a given accumulator could, by a scientific use of the imagination, convey *itself only* under given conditions of traction efficiency. This distance (L), multiplied into (A), the weight of accumulator transported—which, in this hypothetical case, constitutes the total traction weight (W)—approximately, or within the limits of practice, expresses the maximum work that can be done by the given weight of accumulator. And, if W be one ton, L is evidently the theoretical maximum distance through which one ton could be conveyed—under the given conditions of practice—by the given accumulator. Further, if (S) be the speed of traction, the time $t = \frac{L}{S}$ will be the maximum period during which the accumulator can "run."

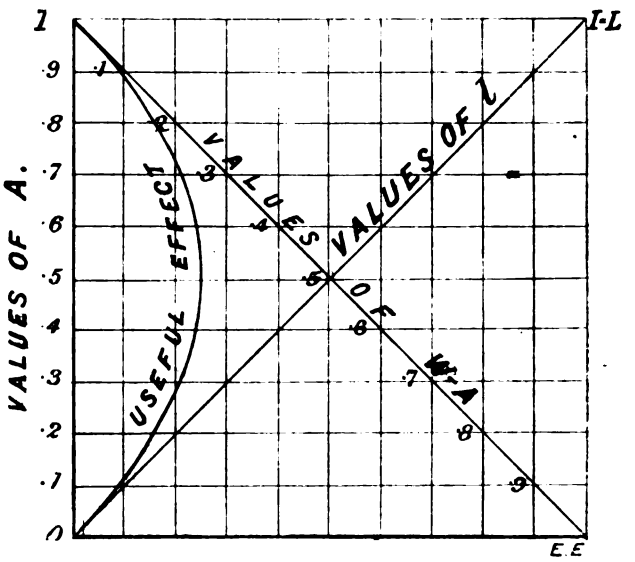
In this extreme case of maximum distance and maximum traction work obtainable per ton of traction weight, we have also the minimum of useful work, which is nil. What may be called in practice the *useful traction work* is the distance traversed (l) multiplied into the ratio of the aggregate weights of the vehicle, passengers, and luggage to the total traction weight (W). Or,

$$\text{Useful work} = \frac{W - A}{W} t,^*$$ for a given speed.

In the above case, $W - A = 0$. In the opposite extreme case $W - A = W$, and there can be no work done. Between the two extremes, W being constant, there is a point—a ratio $\frac{A}{W}$—at which the useful work will be a maximum. What is of practical interest is to determine this point, and to ascertain what ratio the maximum useful work bears to the theoretical maximum work.

I may as well state at once that this ratio is ·25, and that it obtains when $A = \frac{W}{2}$, and when the distance traversed is $l = \frac{L}{2}$.

This is, in a practical form, the law of maximum useful work applicable to accumulator traction.



The total work done ($l \times W$) varies, of course, in any case as A, or $\frac{l \times W}{A}$ is a constant. Divide one side of a square into tenths. Let these divisions represent the weights of accumulator, then, if the length of side represent the whole traction weight = 1 ton, each tenth will represent 2cwt. of accumulator.

Starting from the lower left-hand corner, divide a diagonal into tenths. Let this diagonal be taken as (L). A value deduced for (L) from the results of a recent experimental run with a well-known traction battery is L = 66·6 miles. Let the lengths on this diagonal (or, for miles, the length × 66·6, or any similar experimental constant) represent (l) the distance run.

Starting from the upper left-hand corner, divide the other diagonal into tenths, and let the whole diagonal be taken as W = 1 (ton). Then each division along this diagonal will represent 2cwt., and the number of divisions will give the value of (W – A).

Now, taking the values of (A), equal to the corresponding values of (l), as abscissæ, construct the curve shown in the diagram, taking as ordinates the corresponding values of (W – A) l—*i.e.*, of useful work. This curve will indicate the useful work for any value of (A) or of (l) or of W – A.

* The weight of the motor should also, strictly speaking, be subtracted from W. The latter, being taken as unity, may of course be cancelled in the denominator.

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1. Thus, when $A = \cdot1$ (of W),
$l = \cdot1$ (of L),
$W - A = \cdot9$ (of W),
and the ordinate of the curve $= l\,(W - A) =$ useful work $\Big\} = \cdot09$ (of L W).
Or, in the case of the accumulator referred to above, $66\cdot\dot{6} \times \cdot09 = 6$ ton-miles.

2. When $A = \cdot2$, $l\,(W - A) = \cdot16$ (of L W).
3. " $= \cdot3$, " $= \cdot21$ "
4. " $= \cdot4$, " $= \cdot24$ "
5. " $= 5$, " $= \cdot25$ "

Which is a maximum; since now the values decrease in the same order as they augmented.

It will be seen that the weight of accumulator (as might be foreseen) increases in higher ratio than does the useful work. This fact, however, is not in contradiction to the above law.

I have given $66\cdot\dot{6}$ miles as a value for L deduced from the results of an actual experimental run with an automotor carrying accumulators of a well-known type. At the rate of only seven miles an hour, this would give a run of but $9\frac{1}{2}$ hours if the accumulator (mounted on a carriage without weight, yet subject to the normal coefficient of resistance and losses of energy by conversion) had to transport its own weight alone. It is a "far cry" from this to the 18-hours' run required by my friend. But, in the trial referred to, the weight of accumulator per ton of traction weight was 9cwt., instead of 20cwt. As the total work (here expressed as ton-miles) necessarily varies as the weight of accumulator, the distance actually traversed would be $66\cdot\dot{6} \times \frac{9}{20} = 30$ miles; and, at the above-mentioned speed, the time would be only 4·3 hours. And the useful work would be $(W - A) \times 30 = 16\cdot5$ ton-miles—which is very nearly the maximum, viz.: $\frac{L}{4} = 16\cdot\dot{6}$.

The value (L), which will be found useful in simplifying various calculations and estimates, may be arrived at in several ways—some involving experimental data only, and others some such data in conjunction with theoretical assumptions or approximations. Thus, in the case of the experimental run to which I have referred; taking for convenience a total weight (W) of one ton, we have A = 9cwt. and $l = 30$ miles. It will be seen that

$$A : l :: W : L,$$

and that

$$L = l\,\frac{W}{A} = 66\cdot\dot{6}.$$

We may obtain an approximation to this value by a process of reasoning involving certain assumptions. Thus, the value of L must be dependent upon the specific capacity—*i.e.*, the capacity per pound of the accumulator. Now, in the case of the accumulator above referred to, the specific capacity, when a cell is discharged in five hours, is

$$\frac{\text{Watt-hours}}{\text{lb. gross weight}} = 8\cdot55.$$

Taking a ton of this accumulator, the storage in horse-power hours electrical is

$$\text{H.P.-h. } (e) = \frac{8\cdot55 \times 2{,}240}{746} = 26.$$

Allowing 64 per cent. efficiency in conversion, the horse-power hours utilised mechanically are—

$$\text{H.P.-h. } (m) = \cdot26 \times 64 = 16\cdot6.$$

Now, taking the well-known formula for traction power on a fairly level road—

$$\text{H.P.} = S.\,W.\,\frac{K}{375}$$

(K being the average resistance to motion or lb. required to pull one ton).

Whence

$$\text{H.P.-hours} = l.\,\frac{K}{375}$$

for a traction weight of one ton.

Now let us assume K = 91. (This is a high value, yet not so high as that noted in some other experimental trials.)

Then

$$l = \frac{16\cdot\dot{6} \times 375}{91} = 68 \text{ miles}$$

(instead of $66\cdot\dot{6}$).

Again, supposing we have carefully verified values for $\frac{\text{watt-hours}}{\text{lb.}}$ in the case of various accumulators, and a verified value for (L) in the case of one of them. Then calling the capacity of the latter (C), and that of any other (C_1), then the value of (L_1) in the case of this other accumulator will be:

$$L_1 = L\,\frac{C_1}{C}.$$

THE BALLISTIC GALVANOMETER IN THEORY AND PRACTICE.

BY ELLIS H. CRAPPER, A.I.E.E.

§ 1. *Introduction.*—It is a matter for congratulation that the experimental determination of the magnetic properties of iron and steel, intended for use in the construction of dynamo machinery and transformers, is being undertaken by the steelmakers themselves, and that the ballistic room is now recognised as a valuable addition to the chemical laboratory in steelworks. It is, in fact, very pleasing to know that experimental work with the ballistic galvanometer, until quite recently considered as belonging to the physicist and expert, is now considered essential to the production of good material, and it is with the hope that such work may develop that this series of articles has been prepared.

§ 2. *Ballistic Galvanometers.*—As is well known, a galvanometer is an instrument for measuring the strength of an electric current by comparing the magnetic field produced by the current with the earth's magnetic field; it usually consists of a magnetic needle, or system of needles, and a coil of wire, through which the current to be measured is sent. One is fixed and the other movable. With many types of galvanometers in use, measurements are made by means of the deflections produced when a current passes through the instrument, and for certain purposes a suspended and movable coil is used, whilst for others the coil is fixed and the magnetic needle is suspended and free to move. In all cases the position taken up by the movable part when deflected is that of the direction of the resultant of two forces—*i.e.*, the *controlling* force and the *deflecting* force. The controlling force may be the earth's magnetic field, a controlling magnet, the torsion of a wire or spring, whilst the deflecting force is proportional to, and is due to, the current passing through the coil. With many galvanometers currents are measured by the permanent deflections which are obtained when a steady current is sent through the galvanometer, but for currents which last but a very short time important modifications have to be introduced, which give rise to special methods and special forms of instruments, suitably designed for such measurements, and known as "ballistic galvanometers."

Definition.—The ballistic galvanometer is a special type of deflecting galvanometer, having a system of needles constituting the suspended and movable parts, so arranged that the damping or retardation due to the frictional forces is a minimum, in consequence of which the instrument is specially adapted for measuring impulses produced by very small quantities of electricity, for which reason it is named the ballistic galvanometer, from its analogy to a ballistic pendulum.

The passage of transient currents, such as are produced by induction, or when a condenser is discharged through the coils of a galvanometer, produce corresponding transitory magnetic fields, constituting the deflecting force, for which there is no permanent deflection of the suspended parts. In such cases the displacement of the needle is of the nature of a *throw* or *kick* due to the magnetic impulse imparted to the system of needles by the transient current. It is the *first throw* or *kick* of the galvanometer needle which is observed in making measurements with the ballistic galvanometer. We shall presently show that when the electricity traverses the coils of the galvanometer so

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quickly that the system of needles is not sensibly displaced during the passage of the transient current, the sine of half the angle of the first throw or kick of the needle is a measure of the total quantity of electricity which has passed through the coils. It is thus obvious that the motion of the needle should be so slow, or, in other words, the period of vibration so long, that the extent of the first swing may be accurately determined. This condition, and also the requisite minimum damping, are attained by making (1) the system of the suspended needle so symmetrical about the axis of rotation that the resistance to motion is small; (2) the moment of inertia of the needle fairly large; and (3) by suspending the needle by a long torsionless fibre of silk.

It will not be out of place here to remark that an erroneous idea prevails—*i.e.*, that a considerable moment of inertia is absolutely essential. What is really required is that the moment of inertia of the needle shall be large

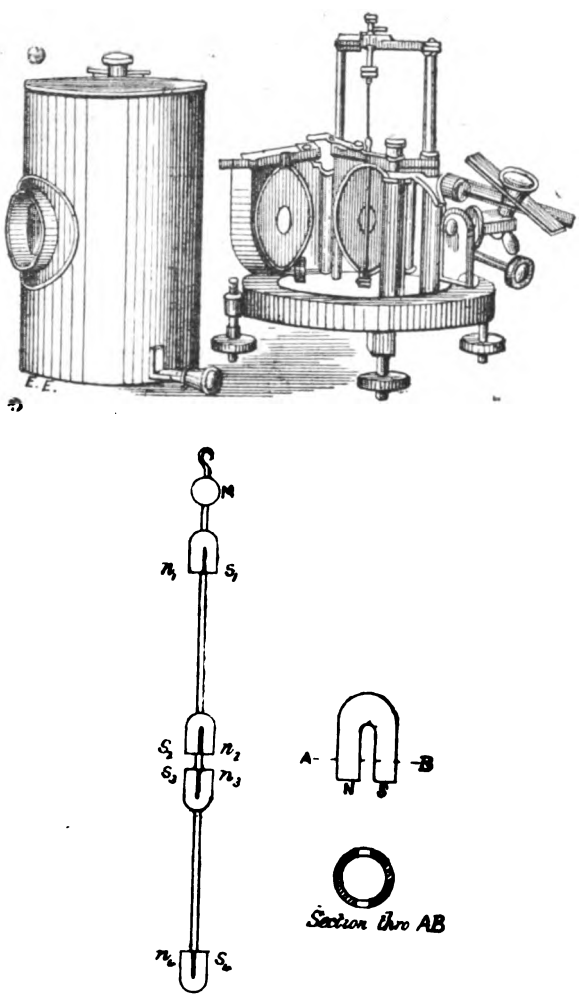

FIG. 1.

enough to produce a convenient period of swing and a small decrement of the vibration, both of which are produced by increasing the moment of inertia. For very accurate work the needles are made of magnetised spheres or cylinders of steel, giving very little air damping; the more common method, however, is to use bell-shaped horseshoe magnets with semi-cylindrical limbs, and these have proved themselves to be invaluable for ballistic galvanometer work where constancy is desirable. The general arrangement of the system of needles and the construction of the bell-shaped magnets are given in Fig. 1, from which it will be observed that four of these magnets are fixed, as shown, to a common axis, usually made of aluminium. M is a small concave mirror of definite focal length.

Although high-class instruments of the type shown are desirable, it must be observed that a good deal of valuable experimental work may be done with an ordinary mirror galvanometer, if the suspended needle be weighted and the vane removed.

§ 3. *Theory of the Ballistic Galvanometer.*—

Let M = magnetic moment of the needle = $m \times l$.
H = horizontal component of the controlling magnetic field at the needle.
T = period or time of one complete oscillation.
I = moment of inertia of the needle.
t = infinitely short time during which the current traverses the galvanometer coils. t is so small that the needle has not moved from its zero position, consequently the needle is in the strongest part of the field due to the current and receives the full effect of the impulse due to the current.
Q = total quantity of electricity passed through the galvanometer.
C = the transient current discharged through the instrument.
G = galvanometer constant = magnetic force at the centre of the galvanometer coils for unit absolute current passing through them.
n = number of turns of wire forming galvanometer coils.
r = mean radius of galvanometer coils.
ω = angular velocity of the oscillating needle as it passes its point of rest.
l = length of needle.

From first principles it is clear that the strength of the magnetic field at the centre of the coils due to unit absolute current passing through them

$$= \frac{2\pi n}{r} = G,$$

and the force exerted on the pole of the needle of m units strength when a current of C absolute units passes

$$= \frac{2\pi n C m}{r} \text{ dynes};$$

$\therefore$ deflecting moment or moment of couple, acting on needle l cms. in length

$$= C \times \frac{2\pi n}{r} \times m l = \frac{2\pi n M C}{r}$$
$$= G M C.$$

Now, since the current through the coils of a ballistic galvanometer is of the nature of a discharge and only lasts for the brief period of time t it is obvious that the total impulse given to the needle

$$= G M C t,$$

but
$$Q = C t,$$

$\therefore$ the total impulse $= G M Q$;

but this total impulse must equal the moment of momentum produced, which is equal to the moment of inertia, I, of the system multiplied by the angular velocity, ω.

$$\therefore I \omega = G M Q,$$

and
$$\omega = G M Q \div I \quad . \quad . \quad . \quad . \quad . \quad (1)$$

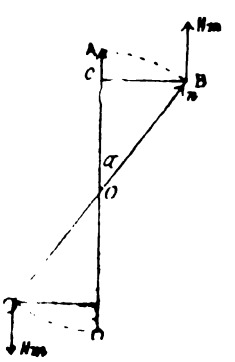

FIG. 2.

And let α be the angle through which the needle is deflected by the passage of the current in the time t, then from Fig. 2 it is evident that the work done, neglecting friction of air, against the force, H m, in moving the N pole, m, from A to B

$$= H m \times A C$$

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$\therefore$ work done in moving the needle through the angle α

$$= 2\,H\,m \times A\,C$$

since the S pole is also moved through the same distance.

$$\therefore \text{work done} = 2\,H m \times \left(\frac{l}{2} - O\,C\right) = 2\,H m \times \frac{l}{2}(1 - \cos\,\alpha)$$

$$= H\,M\,(1 - \cos\,\alpha) = 2\,H\,M \sin^2\frac{\alpha}{2}.$$

And the work done is the equivalent of the kinetic energy with which the needle moves when it has its greatest angular velocity, ω, and this is

$$= \tfrac{1}{2} I\,\omega^2$$

$$\therefore \tfrac{1}{2} I\,\omega^2 = 2\,H\,M \sin^2\frac{\alpha}{2};$$

$$\therefore \omega = 2\sqrt{\frac{H\,M}{I}} \sin\frac{\alpha}{2} \quad . \quad . \quad . \quad (2)$$

Now, from what has already been said, it is clear that the problem we are considering is the same as that of an instantaneous force acting on a pendulum the amplitude of whose vibration is small; consequently the oscillating needle of a ballistic galvanometer obeys the pendulum laws, and the time, T, of a complete oscillation is

$$T = 2\pi\sqrt{\frac{I}{H\,M}} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

From (1) and (2) we have

$$\frac{G\,M\,Q}{I} = 2\sqrt{\frac{H\,M}{I}} \sin\frac{\alpha}{2};$$

$$\text{and } Q = \frac{2}{G}\sqrt{\frac{H^2\,M\,I^2}{H\,M^2\,I}} \sin\frac{\alpha}{2} = \frac{2\,H}{G}\sqrt{\frac{I}{H\,M}} \sin\frac{\alpha}{2}$$

$$= \frac{H\,T}{G\,\pi} \sin\frac{\alpha}{2} \text{ (from (3))} \quad . \quad . \quad . \quad . \quad (4)$$

Now $\frac{1}{G}$ is constant for the galvanometer, and may be represented by the letter K, and equation (4) becomes

$$Q = \frac{K\,H\,T}{\pi} \sin\frac{\alpha}{2} \quad . \quad . \quad . \quad . \quad . \quad (5)$$

And if the angular displacement, α, be small, then $\frac{1}{2}\alpha$ may be substituted for $\sin\frac{\alpha}{2}$ without introducing any serious error, and we may write for the quantity of electricity passing,

$$Q = \frac{K\,H\,T\,\alpha}{2\,\pi} \quad . \quad . \quad . \quad . \quad . \quad (5a)$$

(To be continued.)

THE STROWGER AUTOMATIC TELEPHONE EXCHANGE.*

The exchange of the Augusta Telephone and Electric Company, of Augusta, Ga., is probably one of the greatest novelties existing in the way of telephone exchanges, and is said to be the largest automatic telephone exchange in the world.

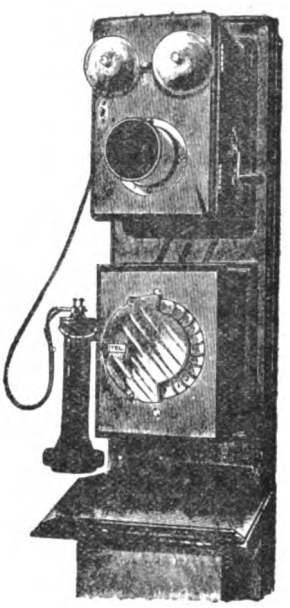
The offices of the company are on the fifth floor of the Jarvis-Conklin building, which is situated in the heart of the city. The construction of the lines was commenced February 15 last. Three hundred and fifty subscribers are now in operation, and contracts are in hand for 250 more, and the lines are being pushed towards the outlying portions of the city. Hard-drawn copper wire, No. 14 B. & S., is used throughout the system, every subscriber has a complete metallic circuit, and all instruments are equipped with long-distance transmitters.

A great deal of cable has been used in order to avoid chances for trouble, and to cut down the expense of making cuts while running wires for new subscribers. The cables are the dry-core paper cables with braid over lead covering, manufactured by the Standard Underground Cable Company. Trolley lines and lighting circuits have been avoided as much as possible in laying out the lines, and the longest circuits are practically free from induction and other disturbances both night and day.

* The *Electrical Engineer* (New York).

But the feature of the system which puts it in striking contrast with any system of the size is the switchboard. The telephone operator is done away with, and the connections are made by the machines and system of the Strowger Automatic Telephone Exchange of Chicago. These connecting machines or switches are operated by means of electromagnets which receive current from a storage battery at central through circuits manipulated by the subscribers at their telephones. One leg of the battery at central is a wire which extends over the entire system and taps into each subscriber's station. The other end of the battery connects through the electromagnets of the switches to the bare wires of the subscriber's metallic circuit. Thus both ends of the central battery are furnished at the telephone, and by making contacts between the common feeder wire and the terminals of the bare wires which are called the "units" and "tens" lines respectively, impulses are sent through the magnets of the machine at central.

These contacts are made and regulated by means of the numbered disc on the face of the telephone. This disc is pivoted at its centre, and to call a certain number the subscriber places his finger in the projections opposite the successive figures of the desired number, and turns the disc until his finger comes against the stop. That is, to call "386," the "3" would be pulled down to the stop and the disc allowed to return to its original position, then the "8" would be pulled down and the disc allowed to return. and, lastly, the "6" would be pulled down.



The Strowger Telephone Transmitter.

After each movement the disc is returned to normal position by means of a clock spring, and during the return movement it makes as many contacts as there are units in the number pulled down. That is, after the first movement in calling "386" the returning disc would make three contacts between the terminal of the unit line and the feeder terminal, and thus send three impulses over the unit line to central. On the second movement of the disc eight impulses would be sent over the tens line to central, and on the last movement six would be sent over the unit line again. This operation of making the connection requires on the average from three to four seconds, and having finished it, the subscriber rings his bell and waits for the party called to answer. If his bell does not ring he knows that the party he wants is "busy," and he calls again in a few minutes.

The machines at the central office consist essentially of two sets of electromagnets. One set is called the "unit" magnets and the other set is called the "tens" magnets, corresponding to the unit and tens lines just mentioned. Each set of magnets operates an armature which carries an arm with a pawl, which meshes with a ratchet hub on the shaft of the machine. One pawl moves the shaft in a longitudinal direction, and the other revolves it. This shaft carries a set of spring wipers, which make contact with the contact points shown at the bottom of the machine. These

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contact points are arranged in vertical and horizontal rows, so that each move of the shaft in a longitudinal direction carries the wipers up one row of contacts, and each movement of the shaft as it revolves carries the shaft around from one row to the next. So by properly regulating the impulses sent through the magnets by closing the circuits at the telephone, the wipers can set on any desired contact and thus connected to any desired "bank wire."

There are two sets of these machines or switches, one called the primary switch and the other the secondary. A subscriber operates the same primary switch no matter what number he calls, but the secondary switch he operates depends on the 100 he calls. He operates a certain secondary switch when he calls a number commencing with 100, another when he calls a number commencing with 200, and so on. The primary simply serves to select the secondary switch, so the primary is operated by the first set of impulses sent from the subscriber's station, and the secondary by the last two sets.

The wiper contacts on the primary switches are arranged in three vertical double rows, and the shaft carries three double wipers. The hidden ends of the contacts in one vertical row of one pair of rows are connected to the unit magnets in the respective secondary switches. The contacts of the other row of the same pair are soldered together and connected to the unit line. Hence, when the double wiper comes on any pair of these contacts it connects the unit line through to the unit magnet of the secondary switch. Similarly, a second pair of contact rows are used to make the connections from the tens line through to the tens magnets of the secondary switch, while the third pair of contact points are used in making the connections for the private attachment, which is explained later.

For example, if "386" is called, the first three impulses carry the wipers up opposite the third horizontal row of contacts. The first impulse of the "8" turns them in on the contacts, thus connecting the lines through to the 300 secondary switch, and at the same time cutting out the magnets of the primary switch. The remaining seven contacts of the "8" are thus made to send current to the secondary switch, whose shaft carries two wipers. These wipers are carried up opposite the seventh row on the upper and lower banks respectively. Then the six impulses turn them about to the sixth contact in the horizontal row. This places the upper wiper on contact "86" in the 300 bank and completes the connection. The hidden end of each contact in the section is connected to an individual line whose number commences with "3."

The lower wiper is called the private wiper. If a second subscriber calls the same number while the first subscriber is still talking, when his private wiper comes on the same contact as that of subscriber No. 1, a circuit is hereby closed through a third magnet on the switch, thus operating an armature, which opens the last subscriber's line and prevents him from cutting in on the conversation already in progress. After a subscriber is through talking he simply hangs up his receiver, and as the hook come down contacts are made between the battery feeder and the unit and tens lines in such a way that the magnets at central operating on their armatures release the shafts of each machine, and a spring returns each shaft to its normal position ready for another call.

A storage battery of 48 cells of 40 ampere-hour capacity operates the switches. The battery is recharged in the evening, but the recharging does not interfere with the operation of the exchange.

One man attends to everything about the central office during the day, and after 10 o'clock at night and on Sundays the exchange is locked up. All lines are tested every morning for breaks, crosses, and grounds by using a few cells of the central battery for a test battery. The tests only require a few moments, and do not annoy the subscribers in any way. All telephones are inspected on an average once a month.

The points about the system which are especially worthy of notice are: the great speed and simplicity with which connections are made, the small number of wrong connections, the opportunity to ring a subscriber's bell until he is compelled to answer the call, the absence of cross-talk and induction from the lines, the absolute privacy of each conversation and the chance to do business over the wires without interference from operators or other subscribers.

Such a system as that put in at Augusta is more costly than most of the opposition exchanges have been, but the officers of the company realise that to compete successfully first-class service must be given and that such service cannot be maintained at a small cost without using the best of material and good instruments. Good material and good workmanship are as quickly appreciated by both patrons and stockholders of a telephone system as in any other business enterprise. And a pleased patron is always a company's best advertisement—a very old but a very truthful saying. The exchange is under the able management of Mr. P. D. Langdon, with Mr. Lee Campbell, superintendent.

THE GRAND THEATRE, FULHAM.

This latest addition to the suburban theatres of London is to be opened on Monday next. We were this week invited to inspect the electric lighting arrangements, which have been put in under the design and superintendence of Messrs. Lucas and Pyke, consulting engineers, of 39, Victoria-street.

The theatre, which was designed by Mr. W. G. R. Sprague, is built of white Portland stone, in the classic style, and is surmounted by a very beautifully designed allegorical group, above which is placed an arc lamp of 5,000 nominal candle-power.

The theatre stands in a unique position, near the end of Putney Bridge, being entirely surrounded by a wide roadway. The front of the theatre, in High-street, Fulham, is a striking feature of a very effective scheme. It has a gracefully proportioned portico, semi-circular in shape, over which is a loggia to be used as a smoking lounge. The portico is lighted by three Jandus arc lamps. From the ground-level a flight of broad steps leads to the entrance vestibule, semi-circular in shape, constructed to complete the circle of which the portico forms one half. The inner vestibule has a fine domed ceiling supported by marble columns with bronze caps; leading from which is the grand crush-room, the ceiling of which is panelled out in a large oval centre, and the whole decorated in a most elaborate style. The dress circle is reached by two corridors from a marble staircase leading from the centre of this room, while entrances to the stalls are on either side. The auditorium is of fine proportions, capable of seating, we are told, 2,239 persons, but we understand that by a supreme effort the 2,240th person might manage to get a seat.

In addition to the complete isolation of the building affording convenience for the construction of a most perfect system of exit, every possible precaution has been taken against fire. The theatre is absolutely fireproof, and the fireproof curtain separating the auditorium from the stage can be lowered in four seconds. Iron doors are also provided in all the corridors.

The contractors for the electric lighting and heating work have been Messrs. Vaughan and Brown, who for many years have made a speciality of such outfits. The generating plant consists of a Crossley high-speed gas-engine, an Easton, Anderson, and Goolden dynamo, and a large set of E.P.S. accumulators. These are arranged so that the dynamo is at night time always independent of the accumulators, which are of sufficient power to light the whole theatre. In this way the engine and dynamo will, as a rule, furnish the power, but in case of breakdown or over-load, certain circuits can be at once switched over to the accumulators.

The engine-room occupies one corner of the basement, and, as is often the case in such plants, this corner was awarded to the engineering department because it was too irregular in shape for other purposes. Hence, although the plant is well arranged, no small amount of care and forethought had to be given to it by the consulting engineers.

The gas-engine (Fig. 1) is one of Crossley's 20-h.p. nominal high-speed engines of the type introduced about two years ago for electric lighting direct. Engines of this type are fitted with one heavy flywheel and outside bearing, the crankshaft is balanced, and the governor is now placed in direct communication with the crankshaft

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instead of the side shaft, as in the case of the ordinary gas-engines. This makes a much more satisfactory governing arrangement. The normal speed of this engine is 210 revolutions per minute, and the maximum horse-power indicated when running at this speed is about 72, while crank is also balanced, as can be seen, which tends to equalise the turning movement. When we visited the theatre it was broad daylight, and certain portions of the wiring not being finished, we could not have the lights put on to see if any fluctuations at all could be observed.

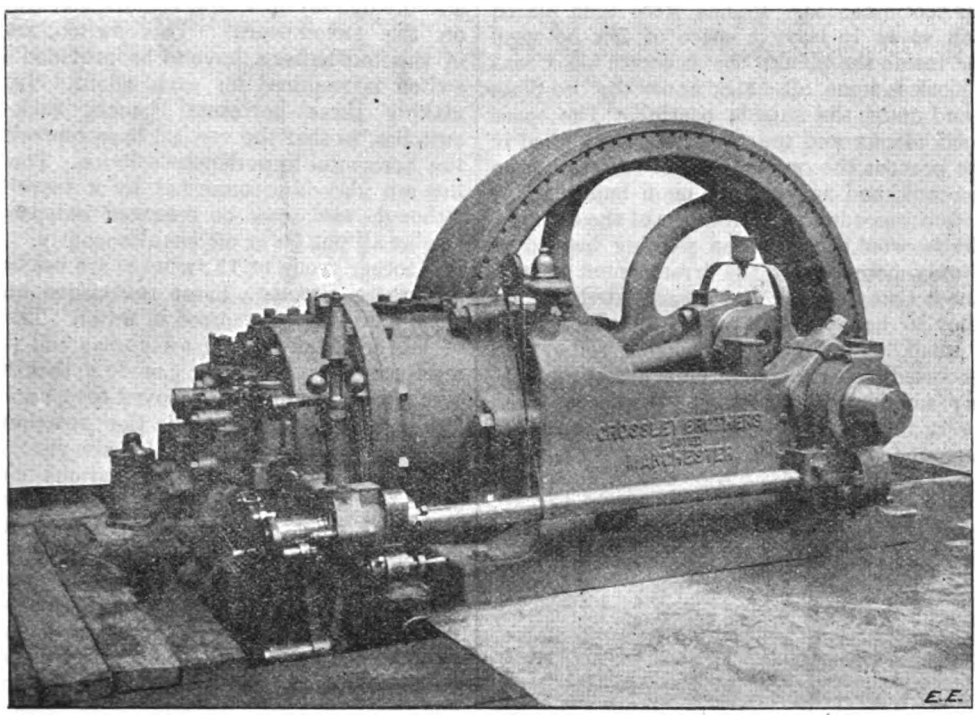

FIG. 1.—Crossley's High-Speed Gas-Engine of 20 nominal horse power.

some 59 b.h.p. can be obtained. The consumption of gas per brake horse-power at Fulham is yet to be tried, but with gas equal to that supplied in Manchester the makers expect this will be about 18·9 cubic feet. The lubrication of the large end of the connecting-rod

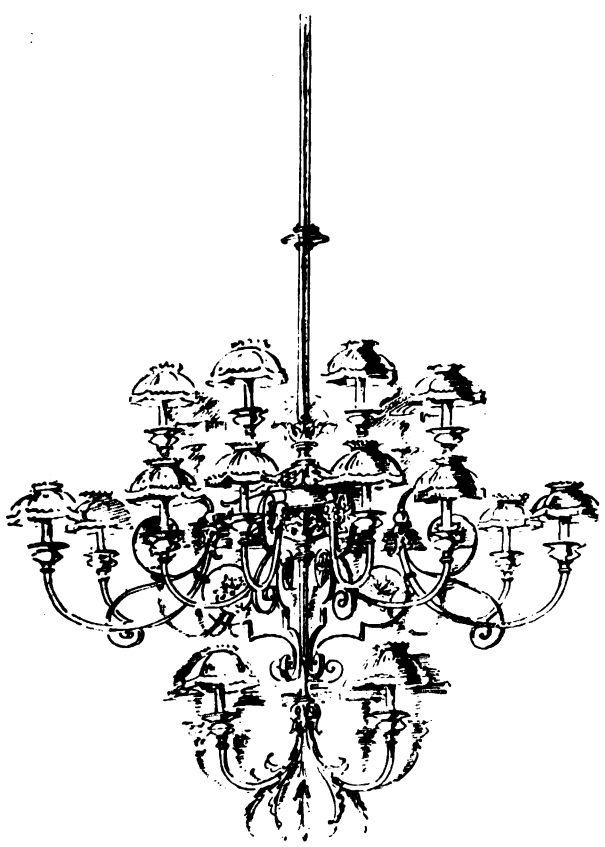

FIG. 2.—Thirty-Light Electrolier in the Crush-Room.

brasses is so arranged that the engine can be run long periods without stopping for oiling, which is a great advantage for electric lighting. The higher speed with this class of engine is obtained by increasing the diameter of the piston and decreasing the length of stroke. The

This engine drives, by means of a link belt, a four-pole dynamo, manufactured by Messrs. Easton, Anderson, and Goolden. This machine is capable of giving 410 amperes at 110 volts or 327 amperes at 140 volts when running at a speed of 850 revolutions per minute. It has a tooth-cored armature with embedded conductors. Two conductors are placed in each slot, and the end connections are made on the cylinder system by bending one conductor in each direction. Copper gauze brushes are used. The field is shunt wound, and is provided with a rheostat for raising the voltage for charging the cells.

The foundations of both engine and dynamo are special on account of the fact that the level of the lower part of the foundations is lower than the high-water mark of the River Thames. The subsoil being gravel, the water was found to give trouble when building. Then the following

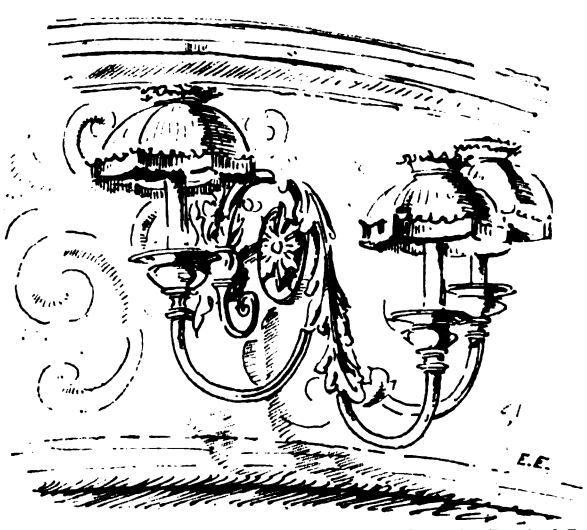

FIG. 3.—Three-Arm Bracket with Candle Lamps Used on the Front of Dress Circle and Gallery.

arrangements have been adopted, to give freedom from vibration, and at the same time to prevent the water flooding the foundations. The first step was to put in a thin layer of some 6in. of concrete. On this two layers of creosoted railway sleepers were placed, the

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sleepers in the upper layer being placed at right angles to those in the lower layer. On this a galvanised iron tank was placed of sufficient depth to bring the upper edge at least a foot above the high-water mark. Inside the tank, two more layers of sleepers were put before the concrete was recommenced. Planks were then placed around the tank so as to leave a space of 3in. between them and it, and inside the planks the concrete block was formed. This block is some 6ft. thick under the bed-plate of the engine and under the outside bearing. The space between the wood planks and the tank was then filled in with sawdust, to prevent the transmission of vibration from the block to the tank, and hence to the main building. A similar construction was adopted in the case of the dynamo, except that silicate wool was used as packing instead of sawdust. The only point about the arrangement of this part of the plant is that the tank has necessitated the use of a jockey pulley to help the belt over the edge. This pulley is made small, being, in fact, a wooden roller, and, as a result, its speed is excessive. This jockey pulley, however, is only temporary, and will be displaced when the proper one is ready. All the pipes are placed in trenches and surrounded with sand.

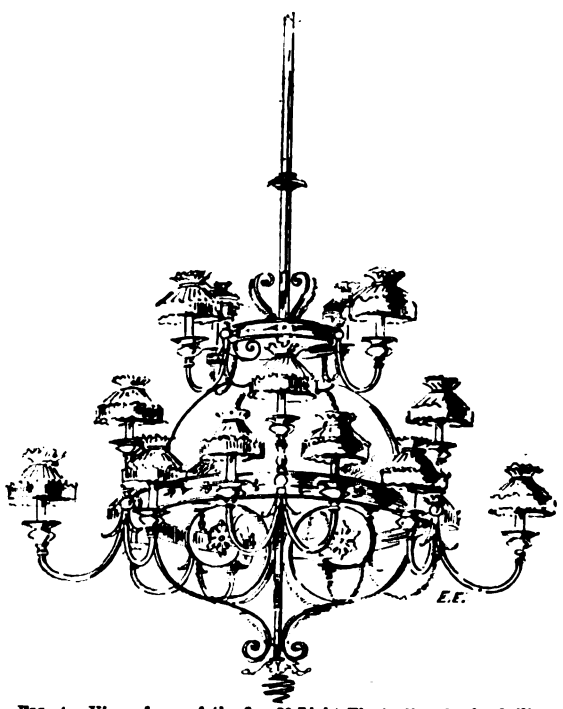

FIG. 4.—View of one of the five 20-Light Electroliers in the Ceiling.

The main switchboard consists of three marble panels, with suitable switches for dividing the whole light up into four circuits. One of these goes to the stage, two go to the auditorium, and one supplies the arc lamps outside. The two circuits in the auditorium are required by the London County Council, so that the lights in the exits and corridors, etc., cannot be put out by the stage switchboard attendant. These circuits are each provided with throw-over switches, so that they can be put either on to the dynamo direct or on to the accumulators. These, as mentioned above, are of the Electrical Power Storage Company's manufacture. They consist of two parallel sets of 43 K-33 type cells, in addition to which 10 central-station cells of double the K-33 capacity are used for the controlling and regulating end of the battery. This is done to avoid the use of two regulating cells being connected in parallel, in which case one faulty cell soon upsets its previously healthy companion.

Coming, now, to the wiring of the theatre, this has all been done on the draw-in system. Iron gas barrel is used for the conduits, and in certain places boxes are placed to give access to the cables. This system of boxes is not carried out to the branch circuits. The four main circuits from the generating switchboard are each carried in separate pipes. Siemens Bros.' cable is used, of the 1,000 megohm type. As is usual in theatres, the bulk of the lights are controlled from a switchboard on the stage. This has been designed by the consulting engineers to give special facilities for rapid stage effects. The stage lighting is done by four battens, each containing 90 lamps—30 of which are respectively coloured red, white, and blue; two proscenium battens with 30 lights each; and a row of footlights with 67 lamps. The latter are also divided up into three colours, and are grouped together on the switchboard. This switch, and one for each of the four battens, have to be provided in threes, as one switch is required for each colour. This is effected by making three horizontal panels, each containing five switches, so that the vertical lines represent circuits, while the horizontal lines denote colours. The five switches in line are also interconnected by a travelling bar, so that although each can be operated independently, they can also be all put on or off simultaneously.

Another group of 15 switches are used to put resistances into these circuits. These resistances are of the Lyons type, with cones immersed in water. They will be capable of fine adjustment to get daybreak and sunset effects; and arrangements are also to be made so that the various regulators can be grouped and moved together if need be. Over these switches are placed the switches controlling the lights in the auditorium, which are visible from the stage. Over these, again, come the various circuit fuses, and over all a row of small pilot lights to show the attendant what light he is giving to the various stage battens. Some 10 arc lamps of the Vaughan and Brown hand regulating projector type are provided. These will be used from the flies for scenic effects, etc. The lighting of the auditorium has been most tastefully arranged, and the illustrations we give show some types of the fittings used. Louis XIV. style of decoration is adopted throughout the house. The centre panel of the ceiling is dome shaped, with four medallions in mitres, lined with a row of single pendants, and filled in with painted subjects. These lights and the five electroliers in the ceiling are arranged to lower for cleaning purposes. The proscenium is very elaborately finished with open scroll-work and figures, candelabra fittings being used for these parts. The whole of the decoration is treated in delicate shades of cream and light terra-cotta, and all the ornamentation is richly gilded.

The total number of lights used is as follows: 743 16-c.p. lamps, 178 8-c.p., one 15-ampere arc, three Jandus lamps, and 10 stage projectors.

All concerned are to be congratulated on the finished appearance of the theatre, which we hope to see lighted up at an early date. Mr. Brough has acted as clerk of the works throughout.

THE ALTERNATING-CURRENT INDUCTION MOTOR.*

BY CHARLES PROTEUS STEINMETZ.

(Continued from page 202.)

At given impressed E.M.F., the exciting current, I_{00}, is inversely proportional to the mutual inductance of primary and secondary circuit. The short-circuited current, I_{10}, is inversely proportional to the sum of the self-inductance of primary and secondary circuit.

Thus the characteristic constant, $\delta = 2\ y\ z$, is approximately the ratio of total self-inductance to mutual inductance of the motor circuits—that is, the ratio of the flux interlinked with one circuit, primary or secondary only, to the flux interlinked with both circuits, primary and secondary. The effect of this quantity will be shown in the following in the discussion of individual motors.

To exhibit the effect of the variation of constants on the behaviour of the induction motor, a number of characteristic motors have been calculated in the above described manner, and the load curves of some of them are shown in Figs. 3 to 7, while an abstract of their constants is given in Table I.

These motors are calculated with the constants:

1. $Y = \cdot 01 + \cdot 1j$,
   $Z = \cdot 1 - \cdot 3j$; or
   $\delta = 6 \cdot 36$,
   $\beta = 10\ 0$,
   $\gamma = 31 \cdot 6$. Fig. 3.

* *Transactions* of the American Institute of Electrical Engineers.

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TABLE I.—Constants of Induction Motors. $E_0 = 110$. (The motors marked by × are typical motors.)

Number of motor.	Number of diagram.	$Y = g + jb$.	$Z = r - jx$.	$\delta = 2yz = y(z_0 + z_1)$.	$\beta = \frac{g}{y}$	$\gamma = \frac{r}{z} = \frac{r_0 + r_1}{z_0 + z_1}$	T_m = max. torque, synchr. kilowatt.	P_r = rated output, k.w. at $\frac{2}{3} T_m$	P_m = max. output in per cent. of P_r.	s = slip, at P_r.	Exciting current, per cent. of current at P_r.	Power factor at			Efficiency at			Apparent efficiency at		
												Full load.	½ load.	¼ load.	Full load.	½ load.	¼ load.	Full load	½ load.	¼ load.
—	—	·005 + ·05 j	·1 − ·3 j	3·18	10·0	31·6	9·00	5·65	1·33	6·3	8·7	96·6	95	91	85	93	93·5	82·2	88	85
—	—	·01 + ·1 j	·05 − ·3 j	6·12	10·0	16·4	8·90	5 75	1·42	3·2	16 7	88 7	88·7	77·8	92·4	93·5	90·8	82	83·1	70·5
× 1	3	·01 + ·1 j	·1 − ·3 j	6·36	10·0	31 6	8·25	5 15	1·36	6·3	17·4	89	88·5	74	86·5	91·2	88·2	77·4	81	65
× 2	4	·01 + ·1 j	·2 − ·3 j	7·26	10 0	55·4	7·10	4·20	1·25	11	19·5	91	88·4	71	76	86·5	85	69·2	76	60
—	—	·01 + ·1 j	·4 − ·3 j	10·04	10·0	80·0	5·30	2·90	1·12	6·18	25·0	93	83	57	66	85	90	61	70	51
—	—	·02 + ·2 j	·1 − ·3 j	12 70	10·0	31·6	7·90	4·95	1·35	6 3	32	83	74	55	84	87	80	70	64·5	44
—	—	·02 + ·2 j	·2 − ·3 j	14 52	10 0	55·4	6·80	4 00	1·26	11	36	85	72	50·5	75·5	80·6	74	64·3	58·2	37·5
× 4	6	·04 + ·4 j	·05 − ·3 j	24·44	10·0	16·4	7·90	5 10	1·42	3·2	51·4	69·4	55	37	86·4	83	73·5	60·5	45·5	27
× 5	7	·02 + ·4 j	·1 − ·3 j	25·35	5·0	31·6	7·60	4·75	1·35	6·3	52	71	54	36	82	82·3	75	58·2	44·5	26
—	-	·04 + ·4 j	·1 − ·3 j	25 40	10 0	31 6	7·30	4·55	1·35	6·3	53·5	71	54	36	79·7	79	69	56	42·5	25
× 3	5	·04 + ·4 j	·3 − ·3 j	34·20	10·0	70·7	5·50	3·10	1·13	16·5	62·5	75	53	37	60·6	61·3	47	45·3	32·5	17
		Single-	phase	motors :																
1_1	—	·03 + ·3 j	·1 − ·3 j ·033 − ·1 j	12·72	10	31·6	9·9	6·4	1·43	2·8	36	82	73	52 5	84·5	85	78	70	61·5	40·5
2_1	—	·03 + ·3 j	·2 − ·3 j ·067 − ·1 j	14·52	10	55·4	7·5	4 8	1·36	4·3	44 3	85	67·5	47	74·5	78	69	62	53	33·5
4_1	—	·12 + 1·2 j	·05 − ·3 j ·0167 − ·1 j	48·88	10	16·4	8·8	5·8	1·43	1·9	73	52	36	24·5	76	68	52	39·5	24·5	13
5_1	—	·06 + 1·2 j	·1 − ·3 j ·033 − ·1 j	50·7	5	31·6	7·75	5·0	1·41	3·4	78	53 5	35	24	69·5	62·5	47·5	37	22	11
3_1	–	·12 + 1·2 j	·3 − ·3 j ·1 − ·1 j	68·4	10	70·7	4·3	2·67	1·33	6·8	92	60·5	45·7	38·5	40	28·6	17	24·3	13·5	6·8

2. High-resistance motor.
$Y = ·01 + ·1\,j$,
$Z = 2 - ·3\,j$; or
$\delta = 7·26$,
$\beta = 10·0$,
$\gamma = 55·4$. Fig. 4.

3. High-resistance and high-admittance motor.
$Y = ·04 + ·4\,j$,
$Z = ·3 - ·3\,j$; or
$\delta = 34·20$,
$\beta = 10·0$,
$\gamma = 70·7$. Fig. 5.

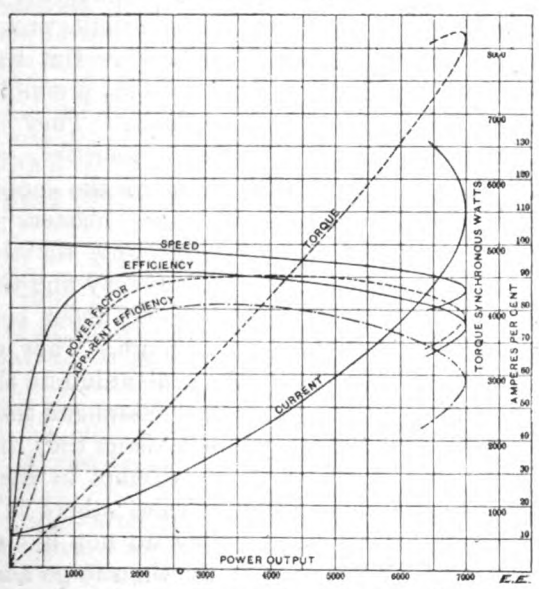

Fig. 3.—Induction Motor. Load Curves. $Z = ·1 - ·3\,j$. $Y = ·01 + ·1\,j$.

4. High-reactance motor.
$Y = ·04 + ·4\,j$,
$Z = ·05 - ·3\,j$; or
$\delta = 24·44$,
$\beta = 10·0$,
$\gamma = 16·4$. Fig. 6.

5. High-susceptance motor.
$Y = ·02 + 4\,j$,
$Z = ·1 - ·3\,j$; or
$\delta = 25·35$,
$\beta = 5·0$,
$\gamma = 31·6$. Fig. 7.

Number 1, with load curves shown in Fig. 3, refers to the best motor which can be built at frequencies of 40 to 60 cycles. As seen, the efficiency rises very rapidly at light loads, reaches a maximum of 91 per cent., and then slowly drops to 88 per cent. at full load. The power factor rises somewhat slower, but is already 74 per cent. at quarter load. The apparent efficiency is very high also, above 80 per cent., and rises at light loads quite rapidly. The exciting current is very small. The drop of speed, 6 per

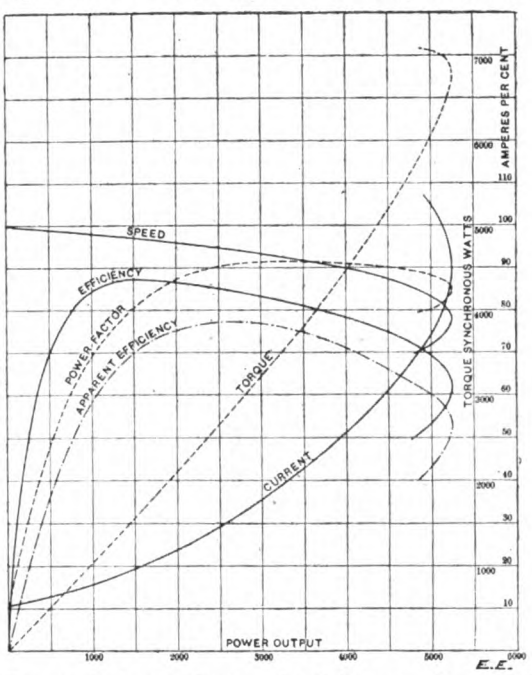

Fig. 4.—Induction Motor. Load Curves. $Z = ·2 - ·3\,j$. $Y = ·01 + ·1\,j$.

cent., at full load, could be made less by lessening the armature resistance. In very large motors as close a speed regulation as 1 to 1½ per cent. has been reached. Thus this motor is equally as satisfactory at light loads as at heavy loads.

Number 2 in Fig. 4 shows the typical high-resistance motor. It is characterised by poor speed regulation, a drop of 11 per cent. at full load, an efficiency curve reaching very high values at light load, but falling off with load, while the power factor rises slowly, but reaches very high values at heavy loads.

(To be continued.)

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E C Anonymous communications will not be noticed.*

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BOUND VOLUMES.

Vol. XIX. of new series of "The Electrical Engineer" can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.

THE STRIKE.

It is altogether outside our intention to enter into the question of the merits or demerits of the engineers' strike. To us there is no discussion possible. The men are utterly in the wrong, claiming for themselves what they deny to the masters. Our point will be seen directly, but first a little history. Take Crompton and Co., at Chelmsford, originally a non-union house, then by request admitting unionists, now putting forth a statement that, whatever the result of the present strike, the house will not in future recognise unionists, but will become again an absolutely non-unionist house. As a counterblast to this announcement, the Chelmsford Strike Committee issue the following:

"It seems fair to us that Crompton and Co. should be allowed the same right to combine as we claim for ourselves for mutual protection, but not to combine to take away the liberty of their workmen to provide for sickness, want of employment, and a pension in old age. Whatever may be the result of the quarrel Messrs. Crompton and Co. have forced upon us, we shall claim a perfect right to belong to any society we please which allows us, as the Amalgamated Society of Engineers does, local control of our own affairs. We have no quarrel with the firm other than with the unwarranted and cold-blooded manner in which they have treated us. We are fully determined not to be coerced into abject submission to slavery rules, and would warn the firm that the tyrannical manner in which they are now treating us has been defeated before in its object, and doubtless will again."

It has been said again and again that there is no lie so harmful as the half-truth. Neither Messrs. Crompton and Co. nor any other master ever interfered or wanted to interfere with a workmen providing for himself in the directions above stated. At any rate we never heard of any master interfering with his men when they desired to become members of a benefit society such as the Oddfellows, the Foresters, or a local society. These societies provide for sickness, and pension in old age. But these societies which foster and initiate strikes are not of the same kidney as the Oddfellows. They are put forward as being provident societies, and that is the lie they flaunt before the public. They are directly societies to coerce masters; to fight them one by one, or by groups, till their tactics are found out; and as soon as they find their real motives are discovered to cry out about being allowed to look after their own affairs. They can look after those affairs till the millennium if they chose, but when they neglect those affairs and themselves interfere with other people's affairs they must expect retaliation. There is no attempt to coerce into abject submission to slavery rules; there is no attempt to coerce at all. If they do not like the rules of any firm nothing is easier than to go away, and let men work who want to work, and are willing to abide by those rules. We should be the first to object to slavery, but if a man, having come to years of discretion, likes to go to Zanzibar (but slavery is abolished there, we believe) or to some place where slavery exists and become a slave, we should say he was a fool, but have no moral or legal right to prevent him. The strike committee or the lock-out committee, or whatever name they call themselves, know as well as we do that without coercion—they call it moral suasion—a goodly proportion of their members would not have left

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work. Our point, then, is that no attempt is being made to interfere with what we shall call the men's domestic affairs. They can join as many societies as they please for what purpose they please, except to interfere with other people's domestic affairs.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

SHOREDITCH DESTRUCTOR.

SIR,—Our attention has been called to your issue of the 6th inst, page 191, where in a reprint from the *Rochdale Observer* it is stated that "with the exception of Southampton, which was started about the same time, Rochdale was the first town in England to use household refuse as a substitute for ordinary fuel in the production of electricity." We beg to say that this is a mistake, as elec tricity was produced from the consumption of house refuse in Fryer's patent destructor at Nottingham upwards of 14 years ago. The works were constructed by this firm to the designs and under the superintendence of Mr. Arthur Brown, the city engineer.

It is also stated that at Shoreditch a certain amount of coal is used with the refuse to make it good fuel. In this matter the writer has also been misinformed. At ordinary times no coal is used at all at Shoreditch, the refuse being the sole fuel, but coal is used on Sundays and at other times when no refuse is available, but it is not at any time mixed with the refuse to make it good fuel. When coal is used it is burnt in separate furnaces, and not in the destructor furnaces where refuse is burnt.

Will you kindly give the same publicity to this correction as to the original statement, and oblige—Yours, etc.,

MANLOVE, ALLIOTT, AND CO., LIMITED.

August 13, 1897.

TWO GUINEAS FOR A LETTER.

[The following are types of letters we are continually receiving, and continually answering, on the question of how to train for the profession of electrical engineering. The subject is a burning one to many interested in the future of their boys, and we therefore offer a prize of two guineas for the best comprehensive letter on the subject. Perhaps two points of view should be treated in accordance with a varied assumption as to the financial status of the young man's friends. The letters must reach us not later than August 31.—ED. *E. E.*]

SIR,—May I trespass on your kindness to be furnished with answers to the following questions:

What is the best, and least expensive way of making a lad of sixteen an electrical engineer? What steps should be taken to place him as an apprentice? Would he receive pay for work done during his apprenticeship, and what is the customary duration of such an apprenticeship?—Yours, etc.,

CAENBY.

August 16, 1897.

SIR,—Would it be troubling you if I asked what subjects you would advise a young man to study for the post as an "assistant engineer-in-charge" at a lighting station—alternate or continuous current?—Yours, etc., R. G.

RECONSTRUCTION.

SIR,—Some misconception having been caused by a recent notice of a winding-up meeting of this company, we wish to explain that the meeting referred to is merely formal and has to do with the final winding-up of our old company. The present company was registered last year in order to facilitate the increase of capital to meet the requirements of our manufacturing business, the development of which has continued uninterruptedly for many years past. Although our principal business consists in the manufacture of dynamos and motors for the trade, we may mention that at the present time we have several other contracts in hand, including the supply of plant for the Norwich Electricity Company, Limited (extensions), the Northwich Electric Supply Company, Limited (new plant), and the Corporation of the city of Lincoln (new plant). We think this will suffice to show that the voluntary winding-up of our old company does not involve interruption to our business.—Yours, etc.,

LAURENCE, SCOTT, AND CO., LIMITED.

ELECTRICAL CABS.

The London Electrical Cab Company is to-day to be congratulated for several reasons. One of these is that the electrical cab No. 16,800 is owned by them, and that it is the first autocar of any type to be licensed by the Scotland-yard authorities. We understand that several oil-propelled vehicles have applied for licenses and have failed. The fact that the new cab was electric did not prevent close inspection, as every official who had any interest in the cab licensing department has had a hand in the inspection and trial of this new public convenience. It is also to the credit of the company that although the combination of vehicle and driver had to past muster, they have had no difficulty in training men (ordinary cabmen) in a week to drive their cabs. We think the company is also to be congratulated on the promptitude of their technical advisers and manager in getting the cabs on to the streets. Coming to the cabs themselves, we need hardly say that accumulators are used to drive them. It is in the arrangements for carrying these accumulators and in the details of the driving gear to suit accumulator traction, that the great departure has been made from previous attempts in this direction.

At first sight it might appear that the use of accumulators in connection with these vehicles would prove no more successful than the use of accumulators in the propelling of tramcars, which up to the present date can hardly be described as successful commercially, although their reliability leaves nothing to be desired. There is, however, a very great difference in the use of accumulators of these two types on vehicles. Perhaps this difference is due to the fact that the electrical cabs were built with the idea of accumulator traction, while with tramway work the idea has been to take an ordinary tramcar and to put in as many cells as will go under the seats. Owing to the small space thus available for the storage of the cells, the proportional weight of the cells to the total weight of the vehicle is comparatively small, say as, for example, in the case of the accumulator cars run by the Birmingham Central Tramway Company, the weight of the accumulators is 2¼ tons out of a total weight of about 13 tons, including passengers. In the case of an electrical cab, such as those now put into service by the London Electrical Cab Company, the accumulators weigh upwards of 14cwt. out of a total weight, including passengers, of, say, 30cwt. The beneficial effect of this difference cannot be over-estimated. The cells on an electrical tramcar running under the above conditions are being almost continuously discharged at a higher rate than that normal for the cells, and with a consequent rapid deterioration of the cells and a lowering of their capacity. The cells on the electrical cabs, on the other hand, are usually discharged at under the normal rate, and with the arrangements adopted, even in ascending moderate inclines, the normal discharge rate of the cells is not exceeded. It is only when ascending severe gradients such as those leading into Waterloo Station that this normal discharge rate of the cells is exceeded, and then only by a comparatively small amount.

Early experiments made by the company to determine the energy required to propel the road vehicle on solid rubber tyres disclosed the fact that the tractive effort on wooden pavements barely exceeds that of a tramcar running on rails, and that even on an ordinary macadamised road the energy taken is not much greater. When, however, the thick mud such as that met with only in the country is encountered, the tractive effort is very considerably increased. The company, therefore, whilst maintaining

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that it is perfectly practicable to run electrical vehicles in the streets of London or other well-paved and comparatively level towns with commercial success, do not suggest that the same necessarily holds good for vehicles to be used on country roads.

The completed cab, with that desirable addition, a licensed driver, is shown in Fig. 1. Accommodation for two is provided in the cab, which is elegantly fitted with all the usual conveniences. The front is of glass, which affords a pleasant view of the road ahead. The centre pane opens, so that the driver can be communicated with. This is a much more convenient method than hanging out of the window and poking the driver with an umbrella "à la Growler."

The battery used on each of the vehicles consists of a set of 40 cells of the Electrical Power Storage Company's traction type, having a capacity of 170 ampere-hours when discharged at a rate of 30 amperes. These cells are all mounted in one tray, which is slung under the bottom of the cab by four suspension links supported by springs under compression, and the ordinary carriage springs also separate the cells from the vibration to which the carriage wheels are exposed. It will also be noted that another pair of long bars from

FIG. 1.—One of the Electrical Cab Company's Vehicles.

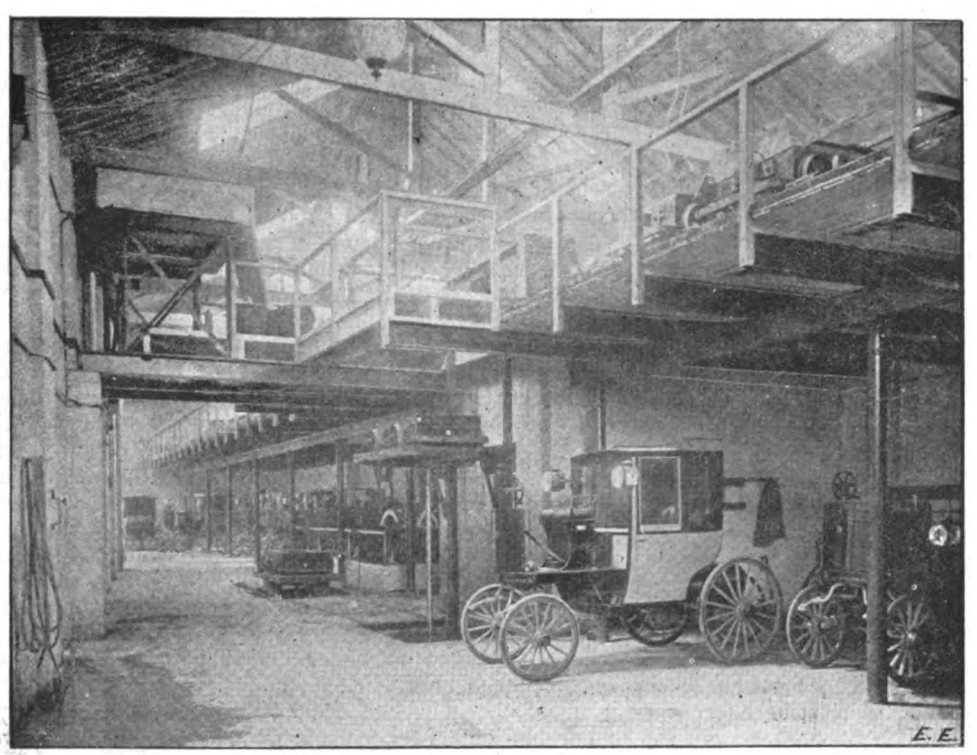

FIG. 2.—View of the Juxon-street Works, showing the Two Hydraulic Lifts.

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the front of the cab prevents the tray from swinging to any extent on the links. One of the causes of expenditure in the maintenance of traction cells is due to the damage done by the pulling about they are usually subjected to in taking them in and out of the vehicles. These cabs have, therefore, been designed so as to entirely prevent any such damage occurring. The cabs are placed over an hydraulic table (Fig. 2), on to which the tray of cells is wheeled on the light skeleton iron trolley, seen in Fig. 3. The table is then raised until the tray comes into the position in which it can be attached to the suspending links and made fast. The hydraulic table with the trolley is then lowered,

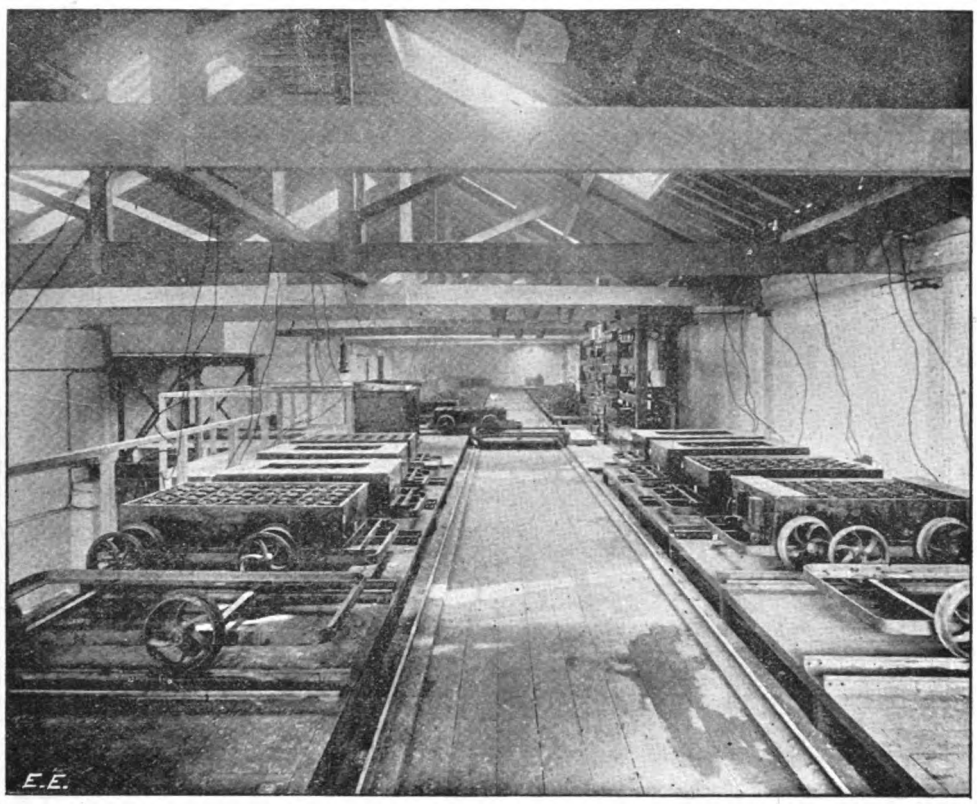

FIG. 3.—The Charging Gallery.

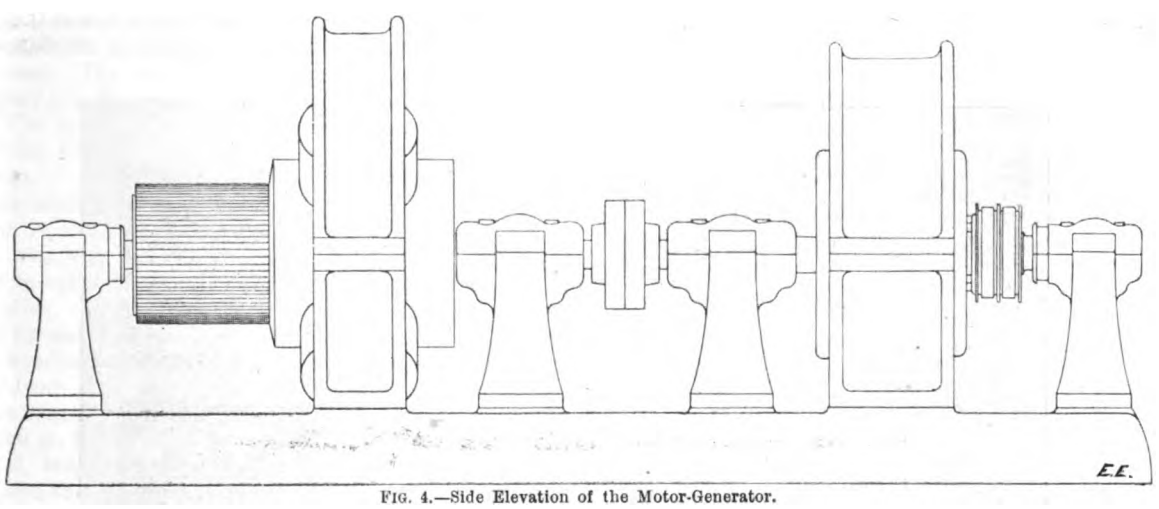

FIG. 4.—Side Elevation of the Motor-Generator.

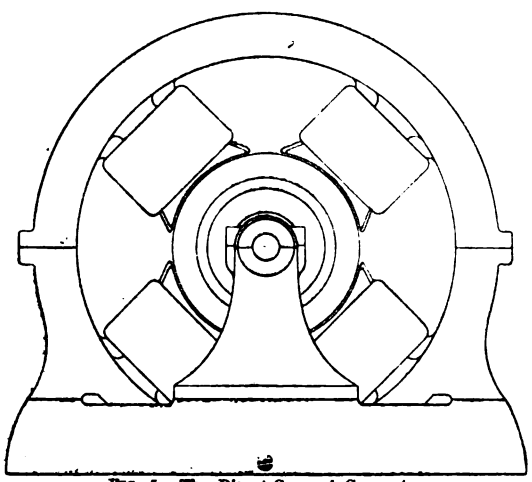

FIG. 5.—The Direct-Current Generator.

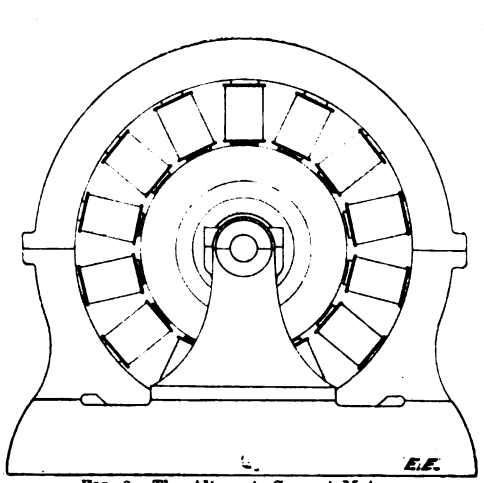

FIG. 6.—The Alternate-Current Motor

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and the two electrical connections being made the cab is left free to propel itself away. When the cells are to be changed, the cab is propelled over the hydraulic table and the reverse operation takes place.

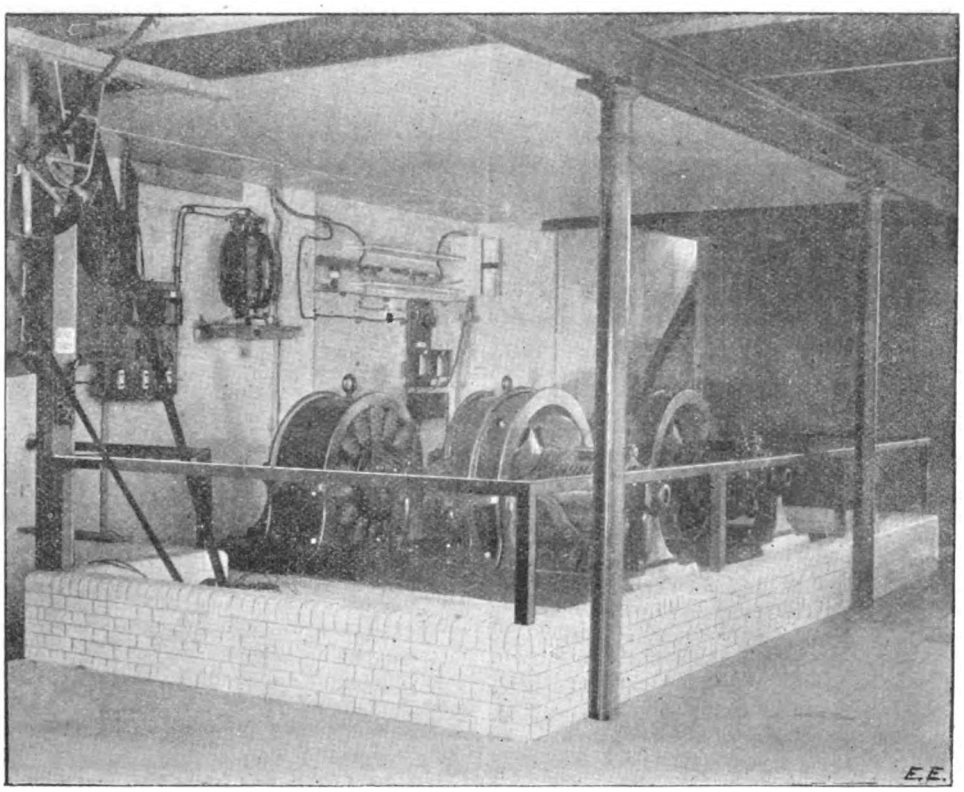

FIG. 7.—A General View of the Electrical Plant at Juxon-street.

The charging arrangements for the cells are very complete, special care having been devoted to their design by Messrs. Kincaid, Waller, and Manville. A battery having been detached from the cab in the manner described, it is run on rails over the hydraulic lift, which can be seen in Fig. 2, by which it is elevated into the charging gallery above, illustrated in Fig. 3. The battery with its trolley is taken on a second trolley along the rails traversing the gallery into one of the charging berths, where it is connected up to the two conductors carrying the low-tension supply. One of these conductors passes directly back to the charging switchboard through a regulating resistance and ammeter, the other conductor being attached to a common return. Each battery is, therefore, separately connected to the charging switchboard, and the charging current regulated by its own regulating resistance switch.

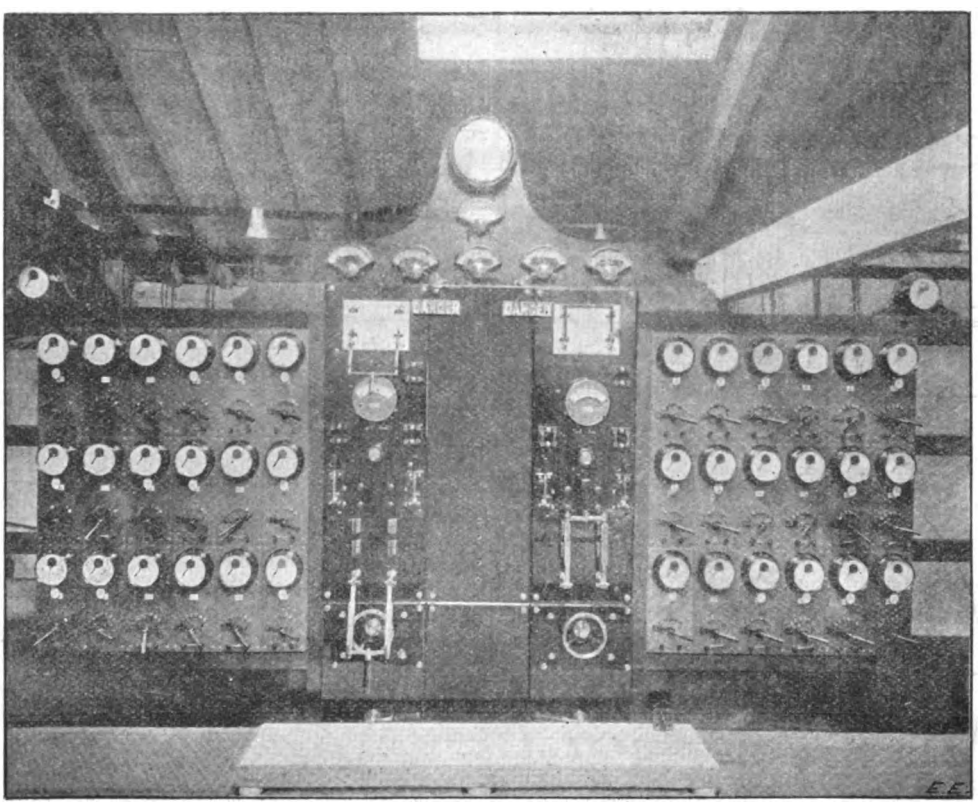

FIG. 8.—The Switchboards.

The slate slabs on which these switches are mounted are also used for registering the time at which each battery is put on to the charging circuit, and the rate at which it is being charged.

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So it will be seen that the individual cells are never handled or removed from the tray carrying them. This tends to minimise the cost of renewals and repairs. The charges on the account renewals and repairs, however, are not borne by the Cab Company, as the Electrical Power Storage Company have entered into a maintenance contract at 10 per cent. per annum of the first cost of the batteries. This means an annual charge per cab of about £10 per annum, allowing two sets of cells per cab.

The electrical mechanical equipment on each cab consists of a 3-h.p. Johnson-Lundell motor with a double-wound armature and double-wound fields; the series-parallel controller by which the connections between the windings of the armature and fields are manipulated, and countershaft to which the motor is geared, and which in its turn drives the two driving wheels of the cab through endless chains. As the two rear cab wheels are driven by the one motor, it is essential to adopt a differential gear of the "Jack-in-the-box" type to connect the two halves of the countershaft together. The gear between the motor and countershaft consists of a leather pinion gearing into a steel wheel. This gear has been ingeniously arranged within the gear wheel driven by the motor pinion, and forms a very compact arrangement. The chains connecting the countershaft with the driving wheels are of Hans Renold's latest laminated type, dispensing entirely with the usual sprocket arrangement. They run on the pinion and chain wheel with the same side play as a belt, thus wearing the chain evenly. The gear, which has a total reduction ratio of 25 to 1, was supplied by Mr. E. Oppermann, of Clerkenwell.

The double-wound motor and series-parallel controller is, in our opinion, the most important arrangement on this cab for ensuring the greatest possible economy in the consumption of current at whatever speed the cab may be running. The motor itself is a four-pole one of the enclosed type of field. The two poles which are wound are the horizontal ones. The armature has two direct windings, with two commutators placed one at either end. Thus it really acts as though two motors were supplied for matters of control, whereas the single field magnet and armature core give compactness. The two lines of carbon brushes used on each commutator are, of course, placed at right angles to each other. The ball bearings of the motor are provided so as to minimise friction, and so require little attention for lubrication.

The controller is arranged in a similar way to the controller on electric tramcars. The first step in starting connects the two armature windings and the two field windings in series with a small starting resistance on to the batteries. This is not a running speed, but is only intended to start the motor into motion. On the second step the windings are still in series, but the resistance cut out, and from this point onwards no resistance is used. With this arrangement the cab runs at a speed of about three miles an hour. The third step places the armatures in parallel, but leaves the fields in series, and with this arrangement the cab runs at about seven miles an hour. The fourth step places the field windings in parallel, and the cab runs at nine miles an hour. It will thus be seen that three normal running speeds allow of the full energy of the current being utilised in the motor without any absorption in resistance, and the cab can thus "crawl," using only about the exact number of watts per car mile required for propulsion. In the reverse direction from the top position, the series-parallel controller on the first step short-circuits the motor through the starting resistance, thereby gently braking the cab. On the second step backwards the motor is completely short-circuited, bringing the cab to a dead stop, and the third step backwards reverses the connections between the armatures and fields, all being in series, to enable the cab to be moved at the slowest speed backwards. The whole of these movements are produced by the use of one lever, seen at the side of the driver's box (Fig. 1). The circuit from the accumulators to the controller and motor passes through an ingenious switch arrangement attached to the foot brake, which can also be used for bringing the cab to a stop. This switch is arranged to break the circuit when the foot brake is applied, and to break it rapidly, so that there is no injurious arcing at its contacts. It is therefore impossible in the use of either the electric or the foot brake for a careless driver to apply the brake whilst the current is still passing through the motor in the forward direction. The foot brake has another advantage in the crowded London streets, for when moving in a block the driver can set his controller handle to slow ahead, and then start and stop the cab time after time as the traffic slowly moves on by simply putting on and taking off his foot brake, which will then make and brake the circuit. Another good point is the provision of a key switch. The key of this will be taken by the driver should he leave the cab, and the act of removing it cuts off the current entirely, so that no one can run off with the cab.

It was originally estimated that two sets of cells would be required to enable the cab to do an ordinary day's work in the streets of London, it being considered that one set would propel it about 35 miles. The economy of the motor and controller arrangements, however, is so considerable that it is found the cabs will do with the cells in the present condition at least 50 miles with one set of cells. The economy in the use of current thus experienced will make the running of the cabs cheaper than was originally expected. The company, recognising that when its service becomes considerable it will require charging stations in several parts of London, determined not to generate their own current for charging, but to purchase it as a day load from supply companies. In their first charging station at Juxon-street, Lambeth, the current is received from the London Electric Supply Corporation at 2,400 volts alternating, with a periodicity of 83 per second. To convert this into a continuous current, two alternating motor-generators (Figs. 4, 5, and 6) have been provided and installed by the British Thomson-Houston Company, Limited. They consist of two dynamos mounted upon a common bed-plate, their respective armature shafts being connected by a suitable coupling. The motor (Fig. 6) is a synchronous motor with 14 poles, at 83 cycles per second; it runs at 712 revolutions per minute, and is capable of taking some 110 h.p. from the high-voltage mains.

The direct-current generator (Fig. 5) has four poles and four sets of carbon brushes on the commutator. It has a capacity of 750 amperes at 100 volts. The fields of both motor and generator are separately excited from the 100-volt battery mains. The field frames of both dynamos are of cast steel, and the armatures of the standard iron-clad construction of the British Thomson-Houston Company. The general arrangement of this plant is shown in Fig. 7. The efficiency guaranteed for this motor-generator was 86 per cent., but we hear that 88 per cent. is nearer the true figure. In starting the motor-generator, the generator is first used as a motor, taking current from the 100-volt mains of the storage battery. When it has attained correct speed, to bring the motor into synchronism with the 2,400-volt mains, the motor switches are closed, and the direct-current dynamo becomes a generator and ready to charge the batteries. The switchboard for effecting this, and for regulating the charge to the cab batteries, is illustrated in Fig. 8. The two central panels are for the high-voltage circuits.

The general design of the cab is the outcome of past experience largely on the part of Mr. Walter C. Bersey, the manager of the company. This gentleman has been chiefly responsible for the details of the present cab, and has been ably assisted in the matter by the Hon. Reginald Brougham, one of the directors of the company. The consulting engineers, Messrs. Kincaid, Waller, and Manville, also brought their traction experience to bear. The result is an exemplification of the old adage, that "Two heads are better than one." We do not suppose that the present type of cab is perfect, but it is far away the best design we have seen in this direction. The batteries are suitably proportioned as regards weight and capacity to the rest of the vehicle. The weight of the accumulator is low down, so that the cab is very unlikely to upset, and, above all, the driving gear is designed to suit the accumulator and to economise power.

Through the courtesy of the manager, Mr. Bersey, we had a drive in one of the cabs recently, and, barring the

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ironical enquiries of the street urchin as to the resting place of the driver's whip, found everything perfectly satisfactory. The ease of steering was most remarkable.

It is as yet too soon to get any reliable figures as to the cost of running these cabs, which, under the Asquith award, will be able to earn 12s. 4½d. per day, but if some 50 miles can be traversed for 170 ampere-hours at 80 volts, it would look as though about 275 watts would take the cab over an average mile. Allowing for the energy lost in charging and the motor-generator, even on an extravagant basis the quantity of electrical energy paid for should not then exceed 500 watts. As current is being supplied at 1½d. per unit, this gives only ¾d. per car mile, or about 3s. per day. The accumulator upkeep for two sets of accumulators at £10 per annum would come to about 8d. a working day, which leaves a liberal margin for capital charges.

THE OPENING CEREMONY.

To Juxon-street, Lambeth, were the orders to a cabby in Fleet-street. Over Westminster Bridge the cabby asked a policeman where the street was to be found, and was courteously told the way. Other cabbies were driving in that direction—in fact, a large gathering of financiers, scientific men, and journalists found their way to the London Electrical Cab Company's premises on Thursday about 2 p.m. The incentive was to be at the practical inauguration of the company's work. Motor cabs are now to be hired like other cabs in London streets, and in this respect we play second fiddle to Paris, New York, Chicago, and other go-ahead towns, where motor carriages are not so few and far between.

The visitors, upon arrival at the yard, were presented with an illustrated pamphlet describing the cabs and the manner of working, together with a card showing the list of fares. They then perambulated the building, saw the cabs—many entered the cabs to try and find out if they were comfortable, examined the charging and switching arrangements, or talked to friends till the opening ceremony took place. We say ceremony, but there was not much of that—just a table and a few chairs upon a small platform—where, soon after the appointed time, the chairman called order, and after a few remarks about the company, its progress and position, introduced Mr. W. H. Preece, C.B., F.R.S., to address the company.

Mr. Preece is always a welcome speaker. He speaks with much deliberation, and his periods are rounded and sonorous; and on this occasion he surpassed himself, not only with what he said, but how he said it. The chairman had spoken, but no one heard a word—if they were not directly under him—while, on the contrary, no one lost a word of what Mr. Preece had to say. He told us how great was his gratification at being present at this inaugural ceremony, and that, owing to a concatenation of circumstances, he had been present at the inauguration of all the great practical applications of electricity. It was 46 or 47 years since he was apprenticed to a telegraph engineer, and since that time he had had a hand in improved train signalling, telegraphic apparatus, he brought over the first telephone, ran into a stall at Vienna when on Prof. Ayrton's electrically-driven bicycle, and so on. Generally he was an enthusiastic believer in electricity, and was gratified to be there to inaugurate the acme of electrical work in its application to the traction of carriages. He laughingly described the horse as a bad piece of mechanical apparatus on four legs, which if one leg went wrong the other three followed, and as having a senseless head, pointing this later statement with an anecdote telling that a horse ran away the other day, and was so senseless as to run into a post office to take rest. Fancy, taking rest at a post office at the present time! Then the horse wanted accommodation, food, and a man to look after it, and himself also. This was all to introduce the value of electric energy in traction work, and the speaker proceeded to describe the vehicles that were in the works, into which we need not enter here, for we give an illustrated description above. He concluded by wishing success and prosperity to the company.

The Chairman thanked Mr. Preece for his kind wishes, and hoped the company would merit the success he referred to, and asked the Earl of Crawford and Balcarres to say a few words.

Lord Crawford briefly referred to the words of Mr. Preece; and the latter having thanked the chairman and Lord Crawford for kind words, a party of the company proceeded to sample the working of the cabs.

REVIEWS.

Euclid. Books I.-IV. By Rupert Deakin, M.A. London: W. B. Clive, University Correspondent, College Press. 2s. 6d.

The value of any text-book of this kind is almost as much a matter of type, arrangement in printing and diagrams, as in the words used. There can be little difference as regards the latter in any book on "Euclid." There is, however, greater scope for remarks and in the exercises than in the propositions themselves, and here it is that the more modern authors have produced works far in advance of their predecessors. Euclid is a book on logic of immense practical importance, for the varied problems arising in practice require a knowledge of these fundamental problems and theorems for their solution. Hence the exercises which assist the pupil to apply his knowledge are just those which are of the nature of labour-saving in after-life. Mr. Deakin gives a very large number of exercises, many excellent of their kind, but, of course, as is necessary in any work of the kind, many suited to examination purposes. On the whole, we should say this book is in all ways excellent of its kind.

Formulaire de l'Electricien. By E. Hospitalier. 1897. Paris: Masson et Cie.

Better late than never. By this we mean it is better to be late in noticing the fifteenth issue of this well-known book than not to mention it at all. The work has been kept well up to date; the various additions and alterations have improved it; but perhaps the most valuable of the new features is the technical vocabulary in French, English, and German by M. Levylier. Although in practical science words become more or less cosmopolitan, there are words indigenous to each language, the translation of which is not always easy to persons even well acquainted with the ordinary language. Technical terms are a little out of the ordinary, hence the great value of this vocabulary. We can only say that we have during the past few years often had occasion to consult the editions current of this work, and always with a satisfactory result.

LAMINATED POLE-TIPS.

The heating of field-magnet poles when toothed armatures are used is a well-known phenomenon, and one which we think is well understood. That the one edge of the pole gets hotter than the rest is also well known, and is due to the effect of the armature cross-turns strengthening the magnetic field at that place.

It is usual, however, to so proportion the size of teeth to the air-gap that the heating effect is negligible. In some large machines, where broad slots are required, the fields have been laminated with the same object. Mr. S. W. Rushmore, of Jersey City, has recently introduced a method of laminating the corners of pole-pieces only. The laminations are dovetailed into the solid metal forming the magnet limb in a way which must add considerably to the cost of labour on the dynamo. Still, the inventor claims that the device saves money, and also is as efficacious as the method of entirely laminating the poles. We hardly agree with him in this latter respect, as eddies will be set up in the central parts of the polar surfaces which are solid.

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MULTIPHASE SIGNALLING GEAR.

BY C. ARLDT.

We are now able to give an abstract of the above paper, read by the author at the Eisenach meeting of the Verband Deutscher Elektrotechniker:

The convenient and instantaneous action of electricity, which allows of its employment in many ways, even over great distances, soon causes the same to be employed for the transmission of signals by the change of position in an indicator needle. Such indicators consist of a transmitter and a receiver, which are connected by an electric wire, the length and distance between the two being of no importance. Any change of position of the lever on the transmitter is reproduced immediately and exactly synchronously by the hand of the receiver.

Many of these indicators are in use on board of vessels,

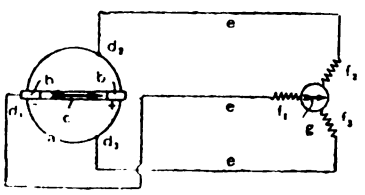

FIG. 1.

between the bridge and the engine-room, the boiler-room, etc. In this case they indicate commands referring to navigation, pressure of steam, or the quantity of drinking water in store, or the number of turns of the screw, etc.; also at various other places, notably waterworks, the same apparatus is used, the lever of the transmitter being then connected with a chain and a cogwheel with a float in the reservoir. It thus automatically records the water-level in any given number of receivers.

Prof. L. Weber, in Kiel, was the originator of instruments for this purpose described by the author, which have been perfected and patented by the Allgemeine Elektricitäts-Gesellschaft of Berlin. In the indicators manufactured by the latter firm the multiphase-current principle is used. The action of the currents peculiar to this type of apparatus

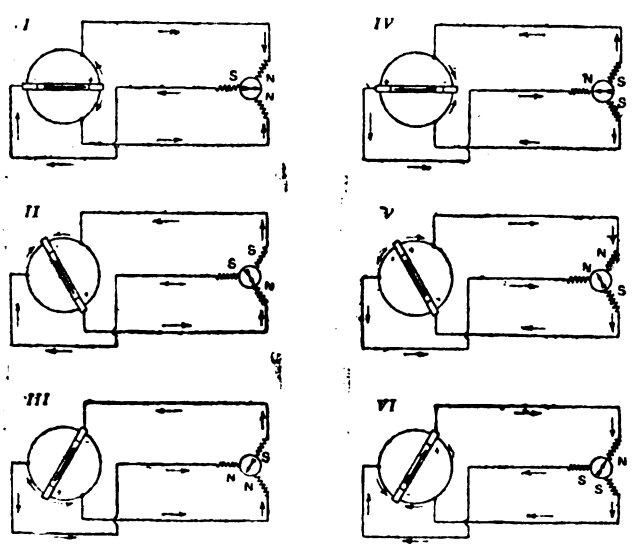

FIG. 2.

causes synchronism between the lever of the transmitter and the direction of the magnetic field in the receiver. A needle in the receiver is then used to indicate the direction of the field.

The transmitter (Fig. 1) consists of a closed resistance coil, *a*, to which the current is conducted by the lever, *c*, which has two contacts, one at either end of the lever. This current is taken off the resistance at *d* 1, *d* 2, and *d* 3, points placed at 120deg. round the circle, and is carried by the three wires to the receiver. The receiver consists of a system of three (or of any greater number divisible by three) magnetic coils, *f* 1, *f* 2, *f* 3, in the magnetic field of which a magnet, *g*, shaped as shown, turns freely. A current, transmitted to the transmitter through the two loop contacts, *b*, which are in a position diametrically opposite to each other, divides itself in the resistance coil, along the wires, *e*, to the receiver, and in the coils *f* 1, *f* 2, *f* 3, in such a way that a magnetic field is created, the position of which corresponds with that of the lever of the transmitter.

If the lever of the transmitter has, for instance, the position as shown in Fig. 2 I., then the current is divided so that the two outer coils of the receiver cause north poles inwards, while the middle coil caused an inwardly directed south pole—*i.e.*, the components of the three coils give a magnetic field the direction of which corresponds with that of the lever of the transmitter. If we change the latter 60deg. (see Fig. 2 II.) the distribution of the current is

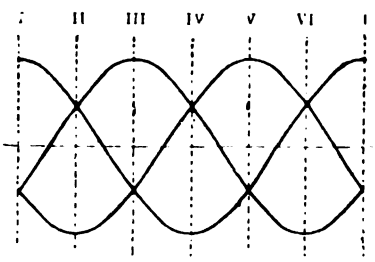

FIG. 3.

changed in such a manner that the lower and the middle coil retains the same polarity, although in altered strength, while the upper has changed its polarity and sets up a south pole on the inside. The components of the three coils cause a magnetic field turned 60deg. from its original position, which is exactly the same as the position of the lever of the transmitter.

In the same way the diagrams numbered III., IV., V., and VI. (Fig. 2) show a synchronous motion of the magnetic field in the receiver and the lever of the transmitter. If we move it from position VI. another 60deg. we obtain again position I., so that the magnetic field in the receiver has made a complete revolution simultaneously with the lever of the transmitter. The separate currents in the coils of the receiver vary nearly in a sinusoidal form, while they are displaced from each other at the same time by 120deg.

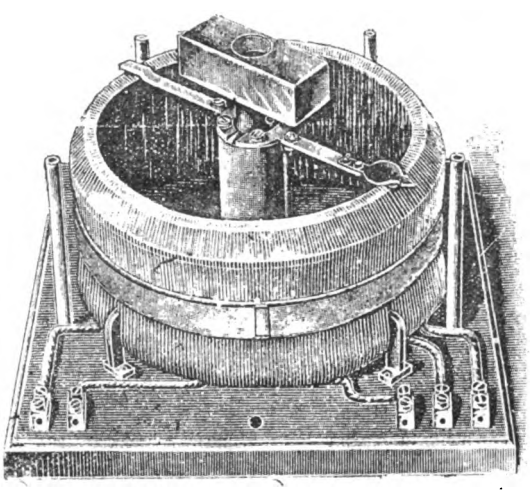

FIG. 4.

Fig. 3 shows these currents, especially as far as cases I.-VI., treated in Fig. 2, are concerned.

If we change the pressure of the applied current, a change takes place in the strength of the single currents in the receiver, but not a change in the relation of these currents to each other, therefore the condition of the three single components out of which the magnetic field is formed remains the same in every position, independent of the pressure—*i.e.*, the direction of the magnetic field remains the same, while the strength only is affected by the action of the pressure. Therefore the indicators are absolutely independent of any changes in the pressure of the current supplied. The connection from transmitter to receiver is formed by three wires (Fig. 1), no matter how many

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different signals are intended to be transmitted. It is possible to arrange it at once that a change from degree to degree is indicated, thus providing for 360 various signals.

Since the magnetic field is formed instantaneously in a direction according to the position of the lever of the transmitter, the pointer of the receiver takes immediately its proper position; and it is not necessary to set the instrument before using it, as every position of the lever corresponds only with one and the same in the recorder needle.

Fig. 4 shows the interior arrangement of the apparatus, the face removed. This shows how the lever slides over the resistance coils. The two terminals upon the left receive the current from the battery or dynamo, while the wires leading to the receiver are attached to the three terminals upon the right.

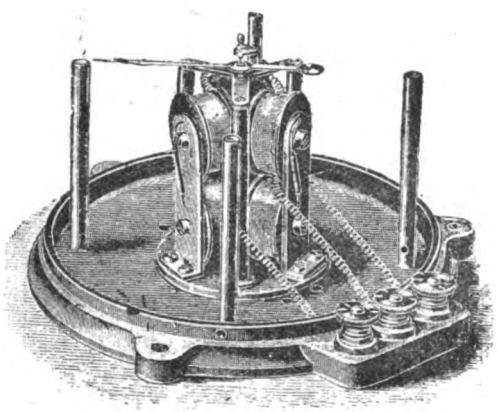

FIG 5.

The inner arrangement of a receiver with three pairs of coils is shown in Fig. 5. The magnet, with the pointer, moves between the latter. The arrangement of the coils may be changed so that, for instance, in some apparatus there is a constant fixed magnet in whose field the movable coils turn, which then carry the pointer. This apparatus has great advantages over those formerly used, the which solenoids are arranged as in voltmeters, in that these latter only work properly under an absolutely constant pressure. This condition is impossible on board a ship unless a separate source of electricity is provided for the instrument.

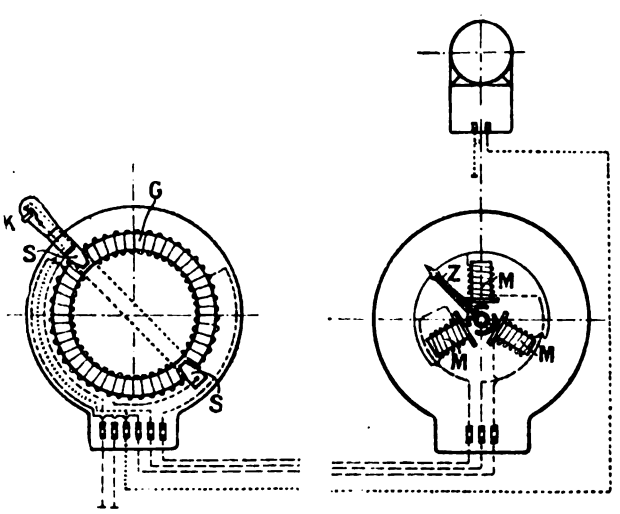

FIG 6.—Diagrammatic Connections of the Apparatus. G, Resistance Coil in Transmitter; S, Contacts on Sending Lever; M, Magnetic Coils in Receiver; Z, Indicating Needle; K, Contact in Sending Lever to Ring the Signalling Bell.

Other step by step indicating gear was held by this author to be faulty, owing to the difficulty of ensuring synchronism before commencing to signal. A double instrument placed vertically with two dials can be arranged, so that after the transmitted order has been executed the answer to that effect is returned from the engine or steering room. In the former the lever is moved by the engineer, while in the latter the movement of the rudder itself directs the transmitter for the answer. When such reply instruments are in use, the same movement and installation can be used to signal the same commands, also to various other single instruments. A bell may also be attached to call attention to the signals being given.

The advantages of this instrument are:

1. These indicators are independent of variations of the pressure of the current from the source of power.

2. They have for each position of the lever of the transmitter only one position of the needle of the receiver, the latter following immediately every movement of the former.

3. Only three wires are necessary between the transmitter and receiver, irrespective of the number of signals to be transmitted.

4. They are always ready for use without previous adjusting or synchronising.

ELECTRIC METERING FROM THE STATION STANDPOINT.*

BY CARYL D. HASKINS.

(Concluded from page 214.)

In closing, some brief consideration at least is due to the new fields into which meters are reaching, and to the help special metering features may perhaps give indirectly, as well as directly, to the amplifying of the business of electric light and power companies and to their more economic operation.

There has recently been much interesting discussion regarding the question of the flattening of the peak of the load either by the systematic modification of rates under special time contracts, governing the hours of burning, which does not concern the immediate subject-matter of this paper, or by an actual modification in one of several forms in the meter itself, which should practically make the meter automatically control the modification of the rates in such a way as to gain the same end with certainty, as is aimed at in the special contract system.

Whilst personally I have grave doubts regarding the actual feasibility of this plan commercially, in view of other and perhaps simpler methods by which it can be accomplished, I still have much respect for all of the various methods which have been proposed, and do not question that there will be at least many cases where they can be advantageously applied. Questions relating to the peak of the load, however, are subject to such great variations locally that a rule which would apply in New York might very readily fail in a system adopted in a smaller town.

It is quite obvious that the best double-rate meter will be that which tends to flatten the load curve of the station, not by oppressing or discouraging the user of light, who must have his light at the period of the peak, so much as by encouraging the use of light at other periods. We do not want to provide means for cutting off the peak so much as we want means for raising the rest of the curve to the same height as the peak. In my personal opinion, it is in this respect that perhaps the most ingenious of all these double-rate meters falls short. I refer to that form of two-rate meter which proportionately increases its rate of record at such time as the local load which it is measuring is highest. This discourages the use of light at the period of the local peak, and if the local peak and the station peak are coincident, it absolutely fulfils its purpose. But if they are not it fails, because instead of discouraging the use of a large amount of light at the time of the local peak, it should actually encourage it. Encouragement of local peaks, which are not coincident with the station peak, is beneficial to the central station in the highest degree, for it tends, as I have pointed out it should, to raise the general load curve towards the station peak magnitude.

If two-rate meters are to be used, therefore, I believe that their increased proportional speed should be dependent purely upon the occurrence of the station peak, and should bear no relation whatever to the occurring of the local peak. Such an arrangement can be secured in a number of ways, all of them simple and all of them effective.

* Paper read at the fourteenth general meeting of the American Institute of Electrical Engineers, Eliot, Me., July 27, 1897.

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One other feature of metering, which has recently come into existence in Europe, is about to make its appearance commercially in this country. It brings with it much of promise for the increase of profitable business for central stations. I refer to the prepayment meter system. The drop-a-nickel-in-the-slot and get-your-money's-worth meter. In gas practice this system has proved an unqualified success. I am informed that the London Gaslight Company added 6,000 new customers of a profitable kind over and above their average annual growth in a single year; and other companies have had similar experience.

There is in every large city a considerable area into which illuminating companies have been unable to go by reason of the untrustworthy character of the people who would there be their customers. In other words, because the people in these districts are a floating population without credit, coming to-day and going to-morrow, and yet ready and willing to buy electric light at high rates. The prepayment meter throws open this new field and makes it immediately available; and here I predict for it wide usefulness.

THE BRITISH ASSOCIATION.

Address to the Mathematical and Physical Section.

BY PROF. A. R. FORSYTH, M.A, SC.D., F.R.S., PRESIDENT OF THE SECTION.

One of the most important events of the past year connected with the affairs of this section has been the reception by the Prime Minister, Lord Salisbury, of a deputation to represent the need for the establishment of a national physical laboratory to carry out investigations of certain definite types. Such institutions exist in France and Germany, and have proved of the highest usefulness in a field of work that includes the wide range from pure research to the most direct applications of science to industry. The desire for such an institution in England has long been felt, and as far back as 1891 Prof. Oliver Lodge, when presiding over our section at the Cardiff meeting, argued in its favour. It has frequently been discussed since that date, particularly in 1895, when Sir Douglas Galton dealt with it so ably in his presidential address at Ipswich, and also in a communication to our section. The subject was then formally referred to a committee of physicists, who, at last year's meeting in Liverpool, presented a report containing a working scheme for developing the Kew Observatory into an institution of the desired character. The recommendations of the report were approved by a unanimous vote of this section, and were subsequently adopted by the association. Thereupon a joint committee, representing the various scientific bodies throughout the United Kingdom interested in the matter, was constituted to further the plan: in particular, to urge upon the Government the establishment of such a laboratory, and, if possible, to obtain from them the funds which are a preliminary necessity for that purpose. It was a deputation from this joint committee which, headed by Lord Lister, waited upon the Prime Minister on February 16 last. His reply to the deputation was manifestly sympathetic with the request; there is consequently reasonable ground for supposing that the Government will take the matter into their favourable consideration.

After having said, by way of preface, thus much upon the chief event of the past year arising partly from our direct action, I wish to turn to the main line of my address, and to ask, for a brief time, your attention and your consideration for the subject of pure mathematics. If, remembering the brilliant address made at the Montreal meeting, you regret that Lord Kelvin is not again now occupying this position; or if, remembering the interest aroused by Prof. J. J. Thomson's address last year, you regret that the fascinating tale then opened is not being resumed by someone with imagination enough and knowledge enough to continue it, I can, not unselfishly, share your regret.

It appears, however, from the practice of the council and the General Committee, to be their policy that mathematicians belonging to the extreme right (if the phrase may be used) shall from time to time be nominated to the presidency of the section. It is, I think, the case that this section has always had assigned to it the subjects of mathematics and physics. In their development, pure mathematics has continued to be associated with applied mathematics, and applied mathematics with physics. So far as I know, there is no substantial reason why any change should be made, and so far as I have been able to observe, there is a strong consensus of opinion that no change by way of separation need be tried. Wide as is the range of our discussions, distracting as is the occasional variety in the matter of the papers we receive, the complexity of our section, if in any respect a disadvantage, does not appreciably discount the advantages it otherwise secures. Specialisation in all our subjects has become almost a necessity for progress, but excessive obedience need not be paid to that necessity. On the one hand there will be danger of imperfect appreciation if a subject is so completely restricted to a few specialists that it is ignored by all but them; and, on the other hand, there will be danger of unsound growth if subject and thinkers alike become isolated, and cease to take an active interest in the methods, the processes, and the results other than those which directly concern them. Accordingly, I think that our group of sciences, which form a continuous range, are better united than divided.

Aristotle declared that it is unbecoming to praise the gods. Observing his canon, I shall say nothing as to the wisdom and the justice of our executive in sometimes selecting a pure mathematician to preside over this section. I shall only appeal to your indulgence in accepting the opportunity they have thus given me of speaking more specially about my own subject.

I make this appeal the more earnestly, for two particular reasons. One of these is based upon the conflicting views, popularly held and sometimes summarily expressed, about the subject and those who are addicted to it. It is true that the day has gone by when it is necessary to give serious consideration to attacks upon mathematical studies, and particularly upon analysis, such as were made by the metaphysician Hamilton: attacks no longer thought worthy of any answer. Feelings of hostility, if ever they were widely held, have given way to other feelings, which in the mildest form suggest toleration and acquiescence, and in the most extreme form suggest solemn respect and distant wonder. By common consent, we are allowed without reproach to pursue our aims, though those aims sometimes attract but little sympathy. It is not so long since, during one of the meetings of the association, one of the leading English newspapers briefly described a sitting of this section in the words, "Saturday morning was devoted to pure mathematics, and so there was nothing of any general interest": still, such toleration is better than undisguised and ill-informed hostility. But the attitude of respect, I might almost say of reverence, is even more trying: we mathematicians are supposed to be of a very different mould, to live far up the heights above the driving gales of controversy, breathing a rarer intellectual atmosphere, serene in impenetrable calm. It is difficult for us to maintain the gravity of demeanour proper to such superior persons; and perhaps it is best to confess at once that we are of the earth, earthy, that we have our differences of opinion and of judgment, and that we can even commit the Machiavelian crime of making blunders.

The other of my reasons for claiming your indulgence is of a graver character, and consists in the difficulty of framing general explanations about the subject. The fact is that mathematics do not lend themselves readily to general exposition. Clifford, it is true, could lecture and enchant his audience; and yet even his lectures ranged about the threshold of the temple of mathematical knowledge and made no attempt to reveal the shrines in the sanctuary. The explanation of this initial difficulty is, however, at hand. Our vocabulary is highly technical, perhaps as technical as is that of moral philosophers: and yet even the technicality of a vocabulary can be circumvented by prolixity of statement. But the ideas and the subject-matter in any branch of our study, when even only moderately developed, are so abstract as to demand an almost intolerable prolixity of statement if an attempt is made to popularise them. Moreover, of the many results obtained, there are few that appeal to an unprofessional sympathy. Adams could discover a new planet by subjecting observations made of the known planets to the most profound calculations, and the world, not over curious about the process, could appreciate the significant result. But such instances are rare; for the most part, our particular results must remain somewhat intangible, somewhat incomprehensible, to those who dwell resolutely and completely outside the range of mathematical knowledge.

What, then, am I to do? It would be pleasant to me, though it might not prove satisfying to you, to discourse of the present state of one branch or of several branches of mathematics, and particularly to indicate what seem to be lines of possible and probable growth in the future. Instead of pursuing this course, I shall keep my remarks of a general character as far as possible, and shall attempt, not merely to describe briefly some of the relations of pure mathematics to other branches of science, but also to make a bold claim that the unrestricted cultivation of pure mathematics is desirable in itself and for its own sake. Some—I should like to believe many—who are here will concede this claim to the fullest extent and without reservation; but I doubt whether this is so in general. And yet the claim is one which needs to be made before an English-speaking audience. For it is a curious fact that, although the United Kingdom has possessed some of the very greatest of pure mathematicians in the second half of this century, the subject has there received but a scant share of attention as compared with that which it

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has found in France, in Germany, in Italy, in Sweden and Norway, or in the United States. I am not oblivious of the magnificent contributions to other parts of our science made alike by British leaders and British followers; their fame is known to the world. But apathy rather than attention has been the characteristic feature of our attitude towards pure mathematics; and it seems to me a misfortune, alike for the intellectual activity of the nation and for the progress of the subject, that English thought has had relatively so small an influence upon its vast modern developments.

Now it is not enough for my purpose to be told that the British Association includes all science in its scope, and consequently includes pure mathematics. A statement thus made might be framed in a spirit of mere sufferance; what I wish to secure is a recognition of the subject as one which, being full of life and overflowing with a power of growth, is worthy of the most absorbing devotion. The most cursory examination of the opinions of scientific men leads at once to the conclusion that there are two views of the subject, both accurate so far as they go, both inadequate whether alone or combined, which to some extent explain, if they do not justify, what may be called the English attitude in the past. Let me deal with these in succession.

One of these estimates has been framed by what is called the practical man; he regards the subject as a machine which is to provide him with tables, as far as tables can be calculated; and with the simplest formulæ and the most direct rules, whenever tables cannot be calculated. Results, not methods, are his want; it is sufficient for him that an authoritative statement as to a result shall be made; all else is ignored. And for what is beyond, in the shape of work that does nothing to meet his special wants, or of the processes that have led to the results he uses, he cares little or nothing. In fact, he would regard mathematics as a collection of formulæ and an aggregate of processes to grind out numerical results; whatever else there is in it may be vain and is useless. In his view it is to be the drudge of the practical sciences.

Now, it is undoubtedly an advantage in any case that labour should be saved and time economised; and where this can be done, either by means of calculations made once for all or by processes that lead to results admitting simple formulation, any mathematician will be glad, particularly if his own work should lead to some such issue. But he should not be expected to consider that his science has thus fulfilled its highest purpose; and perhaps he is not unreasonable if, when he says that such results are but a very small part, and not the most interesting part, of his science, he should claim a higher regard for the whole of it. Indeed, I rather suspect that some change is coming; the practical man himself is changing. The developments in the training for a profession—for example, that of an engineer—and the demands that arise in the practice of the profession, are such as to force gradually a complete change of view. When I look into the text-books that he uses, it seems to me a necessity that an engineer should now possess a mathematical skill and knowledge in some directions which, not so very long since, could not freely be found among the professional mathematicians themselves. And as this change is gradually effected, perhaps the practical man will gradually change his estimate of the scope of mathematical science.

I pass from the practical men to some of the natural philosophers. Many of them, though certainly far from all of them, expound what they consider proper and economical limits to the development of pure mathematics. Their wisdom gives varied reasons; it speaks in tones of varied appreciation; but there can be doubt as to its significance and its meaning. Their aim is to make pure mathematics, not, indeed, the drudge, but the handmaid of the sciences. The demand requires examination, and deserves respectful consideration. There is no question of giving or withholding help in furthering, in every possible fashion and with every possible facility, the progress of natural philosophy; there is no room for difference upon that matter. The difference arises when the opinion is expressed or the advice is tendered that the activity of mathematicians and all their investigations should be consciously limited, and directed solely and supremely, to the assistance and the furtherance of natural philosophy.

One group of physicists, adopting a distinctly aggressive attitude in imposing limits so as to secure prudence in the pursuit of pure mathematics, regard the subject as useful solely for arriving at results connected with one or other of the branches of natural philosophy; they entertain an honest dislike, not merely to investigations that do not lead to such results, but to the desirability of carrying out such investigations; and some of them have used highly flavoured rhetoric in expressing their dislike. It would be easy—but unconvincing—to suggest that, with due modifications in statement, they might find themselves faced with the necessity of defending some of their own researches against attacks as honestly delivered by men absorbed in purely practical work. But such a suggestion is no reply, for it does not in the least touch the question at issue, and I prefer to meet their contention with a direct negative.

By way of illustration, let me take a special instance; it is not selected as being easier to confute than any other, but because it was put in the forefront by one of the vigorous advocates of the contention under discussion—a man of the highest scientific distinction in his day. He wrote: "Measured [by the utility of the power they give] partial differential equations are very useful, and therefore stand very high [in the range of pure mathematics] as far as the second order. They apply to that point in the most important way to the great problems of nature, and are worthy of the most careful study. Beyond that order they apply to nothing." This last statement, it may be remarked, is inaccurate; for partial differential equations, of an order higher than the second, occur—to give merely a few examples—in investigations as to the action of magnetism on polarised light, in researches on the vibrations of thick plates or of curved bars, in the discussion of such hydrodynamical questions as the motion of a cylinder in fluid or the damping of air waves owing to viscosity.

Putting this aside, what is more important is the consideration of the partial differential equations of the second order that are found actually to occur in the investigations. Each case as it arises is discussed solely in connection with its particular problem; one or two methods are given, more or less in the form of rules; if these methods fail, the attempt at solution subsides. The result is a collection of isolated processes. about as unsatisfactory a collection as is the chapter labelled "Theory of Numbers" in many text-books on algebra, when it is supposed to represent that great branch of knowledge. Moreover, this method suffers from the additional disadvantage of suggesting little or no information about equations of higher orders.

But when the equations are considered, not each by itself but as ranged under a whole system, then the investigation of the full theory places these processes in their proper position, gives them a meaning which superficially they do not exhibit, and indicates the way in which each solution satisfies the general conditions of existence of a solution. For the full theory of partial differential equations of the second order in, say, two independent variables establishes the conditions of existence of a solution, the limitations upon the conditions which make that solution unique, the range of variation within which that solution exists, the modes of obtaining expressions for it when it can be expressed in a finite form, and an expression for the solution when it cannot be expressed in a finite form. Of course, the actual derivation of the solution of particular equations is dependent upon analytical skill, as is always the case in any piece of calculating work; but the general theory indicates the possibilities and the limitations which determine the kind of solution to be expected. But not only does the general theory effect much by way of co-ordinating isolated processes—and, in doing so, lead to new results—but it gives important indications for dealing with equations of higher orders, and it establishes certain theorems about them merely by simple generalisations.

In fact, the special case quoted is one more instance, added to the many instances that have occurred in the past, in which the utilitarian bias in the progress of knowledge is neither the best stimulus, nor in the long run the most effective guide towards securing results. In may be—it frequently is—at first the only guide possible, and for a time it continues the best guide, but it does not remain so for ever. It would be superfluous, after Caley's address in 1883, to show how branches of mathematical physics, thus begun and developed, have added to knowledge in their own direction. They have suggested, they have even created, most fascinating branches of pure mathematics, which, when developed, have sometimes proved of reciprocal advantage to the source from which they sprang. But for proper and useful development they must be free from the restrictions which the sterner group of natural philosophers would lay upon them.

Now I come to another group of natural philosophers who will unreservedly grant my contention thus far; who will yield a ready interest to our aims and our ideas, but who consider that the possibility of applying our results in the domain of physical science should regulate, or at least guide, advance in our work. Some of these entertain this view because they think that possibility of early application is, in the last resource, the real test of useful development; some, because they fear that the profusion of papers annually published and the bewildering specialisation in each branch, are without purpose, and may ultimately lead to isolation or separation of whole sections of mathematics from the general progress of science.

The danger arising from excess of activity seems to me unreal; at any rate, there are not signs of it at home at the present day, and I would gladly see more workers at pure mathematics, though not of course at the expense of attention paid to any other branch. But for results that are trivial, for investigations that have no place in organic growth and development, or in illustration and elucidation, surely the natural end is that they soon subside into mere tricks of "curious pleasure or ingenious pain." However numerous they may be, they do

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not possess intrinsic influence sufficient to cause evil consequences, and any attempt at repression will, if successful, inevitably and unwisely repress much more.

More attention must be paid to the suggestion that mathematicians should be guided in their investigations by the possibility of practical issues. That they are so guided to a great extent is manifest from many of the papers written in that spirit; that they cannot accept practical issues as the sole guide would seem sufficiently justified by the consideration that practical issues widen from year to year and cannot be foreseen in the absence of a divining spirit. Moreover, if such a principle were adopted, many an investigation undertaken at the time for its intrinsic interest would be cast on one side unconsidered, because it does not satisfy an external test that really has nothing to do with the case, and may change its form of application from time to time.

To emphasise this opinion that mathematicians would be unwise to accept practical issues as the sole guide or the chief guide in the current of their investigations, it may be sufficient to recall a few instances from history in which the purely mathematical discovery preceded the practical application and was not an elucidation or an explanation of observed phenomena. The fundamental properties of conic sections were known to the Greeks in the fourth and the third centuries before the Christian era, but they remained unused for a couple of thousand years until Kepler and Newton found in them the solution of the universe. Need I do more than mention the discovery of the planet Neptune by Adams and Leverrier, in which the intricate analysis used had not been elaborated for such particular applications? Again, it was by the use of refined analytical and geometrical reasoning upon the properties of the wave-surface that Sir W. R. Hamilton inferred the existence of conical refraction which, down to the time when he made his inference, had been "unsupported by any facts observed, and was even opposed to all the analogies derived from experience."

It may be said that these are time-honoured illustrations, and that objections are not entertained as regards the past, but fears are entertained as regards the present and the future. Very well, let me take one more instance, by choosing a subject in which the purely mathematical interest is deemed supreme, the theory of functions of a complex variable. That at least is a theory in pure mathematics, initiated in that region and developed in that region; it is built up in scores of papers, and its plan certainly has not been, and is not now, dominated or guided by considerations of applicability to natural phenomena. Yet what has turned out to be its relation to practical issues? The investigations of Lagrange and others upon the construction of maps appear as a portion of the general property of conformal representation, which is merely the general geometrical method of regarding functional relations in that theory. Again, the interesting and important investigations upon discontinuous two-dimensional fluid motion in hydrodynamics, made in the last 20 years, can all be, and now are all, I believe, deduced from similar considerations by interpreting functional relations between complex variables. In the dynamics of a rotating heavy body, the only substantial extension of our knowledge made since the time of Lagrange has accrued from associating the general properties of functions with the discussion of the equations of motion. Further, under the title of conjugate functions, the theory has been applied to various questions in electrostatics, particularly in connection with condensers and electrometers. And, lastly, in the domain of physical astronomy, some of the most conspicuous advances made in the last few years have been achieved by introducing into the discussion the ideas, the principles, the methods, and the results of the theory of functions. It is unnecessary to speak in detail of this last matter, for I can refer you to Dr. G. W. Hill's interesting "Presidential Address to the American Mathematical Society" in 1895; but without doubt the refined and extremely difficult work of Poincaré and others in physical astronomy has been possible only by the use of the most elaborate developments of some pure mathematical subjects, developments which were made without a thought of such applications.

Now it is true that much of the theory of functions is as yet devoid of explicit application to definite physical subjects; it may be that these latest applications exhaust the possibilities in that direction for any immediate future; and it is also true that whole regions of other theories remain similarly unapplied. Opinion and divination as to the future would be as vain as they are unnecessary, but my contention does not need to be supported by speculative hopes or uninformed prophecy.

If in the range of human endeavour after sound knowledge there is one subject that needs to be practical, it surely is medicine. Yet in the field of medicine it has been found that branches, such as biology and pathology, must be studied for themselves, and be developed by themselves with the single aim of increasing knowledge, and it is then that they can be best applied to the conduct of living processes. So also in the pursuit of mathematics, the path of practical utility is too narrow and irregular, not always leading far. The witness of history shows that in the field of natural philosophy mathematics will furnish more effective assistance if, in its systematic development, its course can freely pass beyond the ever-shifting domain of use and application.

What I have said thus far has dealt with considerations arising from the outside. I have tried to show that in order to secure the greatest benefit for those practical or pure sciences which use mathematical results or methods, a deeper source of possible advantage can be obtained by developing the subject independently than by keeping the attention fixed chiefly upon the applications that may be made. Even if no more were said, it might be conceded that the unrestricted study of mathematics would thereby be justified. But there is another side to this discussion, and it is my wish now to speak very briefly from the point of view of the subject itself, regarded as a branch of knowledge worthy of attention in and for itself, steadily growing, and full of increasing vitality. Unless some account be taken of this position, an adequate estimate of the subject cannot be framed; in fact, nearly the greater part of it will thus be omitted from consideration. For it is not too much to say that, while many of the most important developments have not been brought into practical application, yet they are as truly real contributions to human knowledge as are the disinterested developments of any other of the branches included in the scope of pure science.

It will readily be conceded for the present purpose that knowledge is good in and by itself, and that the pursuit of pure knowledge is an occupation worthy of the greatest efforts which the human intellect can make. A refusal to concede so much would, in effect, be a condemnation of one of the cherished ideals of our race. But the mere pursuit or the mere assiduous accumulation of knowledge is not the chief object; the chief object is to possess it sifted and rationalised; in fact, organised into truth. To achieve this end, instruments are requisite that may deal with the respective well-defined groups of knowledge, and for one particular group we use the various sciences. There is no doubt that, in this sense, mathematics is a great instrument; there remains for consideration the decision as to its range and function—are they such as to constitute it an independent science, or do they assign it a position in some other science?

I do not know of any canonical aggregate of tests which a subject should satisfy before it is entitled to a separate establishment; but, in the absence of a recognised aggregate, some important tests can be assigned which are necessary, and may, perhaps, be sufficient. A subject must be concerned with a range of ideas forming a class distinct from all other classes; it must deal with them in such a way that new ideas of the same kind can be associated and assimilated; and it should derive a growing vigour from a growing increase of its range. For its progress, it must possess methods as varied as its range, acquiring and constructing new processes in its growth; and new methods on any grand scale should supersede the older ones, so that increase of ideas and introduction of new principles should lead both to simplification and to increase of working power within the subject. As a sign of its vitality, it must ever be adding to knowledge and producing new results, even though within its own range it propound some questions that have no answer and other questions that for a time defy solution; and results already achieved should be an intrinsic stimulus to further development in the extension of knowledge. Lastly, at least among this list, let me quote Sylvester's words: "It must unceasingly call forth the faculties of observation and comparison; one of its principal methods must be induction; it must have frequent recourse to experimental trial and verification, and it must afford a boundless scope for the highest efforts of imagination and invention." I do not add as a test that it must immediately be capable of practical application to something outside its own range, though, of course, its processes may be also transferable to other subjects, or in part derivable from them.

All these tests are satisfied by pure mathematics; it can be claimed without hesitation or exaggeration that they are satisfied with ample generosity. A complete proof of this declaration would force me to trespass long upon your time, and so I propose to illustrate it by reference to only two or three branches.

First, I would refer to the general theory of invariants and covariants. The fundamental object of that theory is the investigation and the classification of all dependent functions which conserve their form unaltered in spite of certain general transformations effected in the functions upon which they depend. Originally it began as the observation of a mere analytical property of a particular expression, interesting enough in itself, but absolutely isolated. This then suggested the inverse question: What is the general law of existence of such functions if they exist as more than mere casual and isolated occurrences? and how can they all be determined? The answer to these questions led to the construction of the algebraical theory of invariants for linear transformations, and subsequently to the establishment of covariantive forms in all their classes. Next came the question of determining what is practically the range of their existence—that is, is there a complete finite system of such functions in each particular case? and, if there is, how is it composed when in a form that ought

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to admit of no further reduction? These questions, indeed, are not yet fully answered.

While all this development of the theory of invariants was made upon these lines, without thought of application to other subjects, it was soon clear that it would modify them greatly. It has invaded the domain of geometry, and has almost recreated the analytical theory: but it has done more than this, for the investigations of Cayley have required a full reconsideration of the very foundations of geometry. It has exercised a profound influence upon the theory of algebraical equations; it has made its way into the theory of differential equations; and the generalisation of its ideas is opening out new regions of the most advanced and profound functional analysis. And so far from its course being completed, its questions fully answered, or its interest extinct, there is no reason to suppose that a term can be assigned to its growth and its influence.

As one reference has already been made to the theory of functions of a complex variable, in regard to some of the ways in which it is providing new methods in applied mathematics, I shall deal with it quite briefly now. The theory was, in effect, founded by Cauchy; but, outside his own investigations, it at first made slow and hesitating progress. At the present day, its fundamental ideas may be said almost to govern most departments of the analysis of continuous quantity. On many of them, it has shed a completely new light; it has educed relations between them before unknown. It may be doubtful whether any subject is at the present day so richly endowed with variety of method and fertility of resource; its activity is prodigious, and no less remarkable than its activity is its freshness. All this development and increase of knowledge are due to the fact that we face at once the difficulty which even the schoolboy meets in dealing with quadratic equations, when he obtains "impossible" roots; instead of taking the wily x as our subject of our operation, we take the still wilier $x + y\sqrt{-1}$ for that purpose, and the result is a transfiguration of analysis.

In passing, let me mention one other contribution which this theory has made to knowledge lying somewhat outside our track. During the rigorous revision to which the foundations of the theory have been subjected in its re-establishment by Weierstrass, new ideas as regards number and continuity have been introduced. With him, and with others influenced by him, there has thence sprung a new theory of higher arithmetic; and with its growth, much has concurrently been effected in the elucidation of the general notions of number and quantity. I have already pointed out that the foundations of geometry have had to be reconsidered on account of results finding their origin in the theory of invariants and covariants. It thus appears to be the fact that, as with Plato, or Descartes, or Leibnitz, or Kant, the activity of pure mathematics is again lending some assistance to the better comprehension of those notions of time, space, number, quantity, which underlie a philosophical conception of the universe.

The theory of groups furnishes another illustration in the same direction. It was begun as a theory to develop the general laws that govern operations of substitution and transformation of elements in expressions that involve a number of quantities: it soon revolutionised the theory of equations. Wider ideas successively introduced have led to successive extensions of the original foundation, and now it deals with groups of operations of all kinds, finite and infinite, discrete and continuous, with far-reaching and fruitful applications over practically the whole of our domain.

So one subject after another might be considered, all leading to the same conclusion. I might cite the theory of numbers, which has attracted so many of the keenest intellects among men, and has grown to be one of the most beautiful and wonderful theories among the many in the wide range of pure mathematics; or without entering upon the question whether geometry is a pure or an applied science, I might review its growth alike in its projective, its descriptive, its analytical, and its numerative divisions; or I might trace the influence of the idea of continuity in binding together subjects so diverse as arithmetic, geometry, and functionality. What has been said already may, however, suffice to give some slight indication of the vast and ever-widening extent of pure mathematics. No less than in any other science knowledge gathers force as it grows, and each new step once attained becomes the starting point for steady advance in further exploration. Mathematics is one of the oldest of the sciences; it is also one of the most active, for its strength is the vigour of perpetual youth.

In conclusion, a few words are due to the personal losses caused since our last meeting. It is but little more than two years since Cayley passed away; his life had been full of work, unhasting and unresting in the almost placid course of his great mental strength. While Cayley was yet alive, one name used to be coupled with his when reference was made to English pure mathematics; the two great men were regarded as England's not unworthy contribution to the exploration of the most abstract of the sciences. These fellow-workers, diverse in temperament, in genius, in method, were bound by a friendship that was ended only by death. And now Sylvester too has gone, full of years and honours; though he lived long, he lived young, and he was happily active until practically the very end. Overflowing with an exuberant vitality alike in thought and work, he preserved through life the somewhat rare faculty of instilling his enthusiasm into others. Among his many great qualities, not the least forcible were his vivid imagination, his eager spirit, and his abundant eloquence. When he spoke and wrote of his investigations, or of the subject to which the greater part of his thinking life had been devoted, he did it with the fascination of conviction; and at times—for instance, in his presidential address to this section at Exeter in 1869—he became so possessed with his sense of the high mission of mathematics, that his utterances had the lofty note of the prophet and the seer.

One other name must be singled out as claiming the passing tribute of our homage; for, in February last, the illustrious and venerable Weierstrass died. He was unconnected with our association; but science is wider than our body, and we can recognise and salute a master of marvellous influence and unchallenged eminence.

Thus, even to mention no others, pure mathematics has in a brief period lost three of the very greatest of its pioneers and constructors who have ever lived. We know their genius; and the world of thought, though poorer by their loss, is richer by their work.

> Tho' much is taken, much abides, and tho'
> We are not now that strength which in old days
> Moved earth and heaven; that which we are, we are:
> One equal temper of heroic hearts,
> Made weak by time and fate, but strong in will
> To strive, to seek, to find, and not to yield.

Knowledge cannot halt though her heroes fall: the example of their life-long devotion to her progress, and the memory of their achievements, can inspire us, and, if need be, can stimulate us in realising the purpose for which we are banded together as an association—the advancement of science.

CONTRACTS FOR ELECTRICAL SUPPLIES

CONTRACTS OPEN.

Switzerland.—Tenders are invited at Lausanne for a concession for erection and lease of electric works. Applications to be made to the Municipality before September 25.

Belfast.—We beg to remind our readers that tenders will close on August 23 for the supply of two dynamos, one commutator, 100 arc lamps, 100 isolators etc. Tenders to be addressed to the Secretary of the Harbour Commissioners.

Jassy (Roumania).—Contracts will close on September 18 at 4 p.m. for the electric lighting of the town of Jassy. Specifications, plans, and all particulars may be obtained at Paris, 80 rue de Varenne, at the Bureau des renseignements commerciaux.

Sydney (New South Wales).—Tenders are required by October 18, at noon, at the General Post Office, for supplies to the Telegraph, Telephone, and Post Office Departments, including iron, copper, and insulated wire, insulators, nails, screws, nuts bolts, electric batteries with all accessories and chemicals, diaphragms, arc lamps, incandescent lights, 11,000ft. carbon for arc lamps, and various other appliances.

Sale by Tender.—The receiver for the debenture-holders of the Electrical Manufacturers, Limited (in liquidation), 223, Upper Thames-street, E.C., is prepared to receive tenders for the purchase of the stock in-trade and furniture of the company. Particulars and conditions of sale and forms of tender can be obtained by application at 223 Upper Thames-street, E.C., and the goods will be on view there from 10 a.m to 6 p.m. each day (Saturdays, 10 a.m. to 1 p.m.). Tenders will be received by the Receiver up to and inclusive of September 3

Burnley.—Tenders are advertised by the Corporation for a lightning conductor in connection with the chimney at the Health Depôt. Specification and form of tender may be obtained on application to Mr. G. H. Pickles, A.M I.C.E. borough surveyor. All tenders, which must be made out on the form supplied, and endorsed "Tender for Lightning Conductor," and addressed to the Chairman of the Health Committee, shall be delivered at the office of Mr. W. T. Fullalove, town clerk, Town Hall, Burnley, not later than noon on August 21.

Derby.—The Corporation are prepared to receive tenders for the supply of one alternating-current dynamo and engine and for the supply to the present engine of one continuous-current dynamo. Specifications etc. form of tender may be had on deposit of £1. 1s. (which will be returned on receipt of a bona fide tender) from Mr. J. E. Stewart, engineer. Electric Lighting Station, Derby, on and after 7th inst. Tenders, endorsed "Electric Lighting, Tender for Dynamo, etc.," to be sent to Mr. H. F. Gadsby, town clerk by 12 noon on 30th inst.

Ludlow.—The Corporation offers a prize of £20 for the best and most economical scheme of electric lighting for the borough. The scheme must deal exhaustively with the whole matter, and give definite information of the cost of steam and water power for the purpose of comparison with the total cost of the undertaking and working expenses. Schemes to be delivered at the offices of Mr. John Herbert Williams, town clerk, Ludlow, marked "Scheme for Electric Lighting," before 4 p.m. on October 1. Should the

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Corporation employ the engineer whose scheme is awarded the prize to carry the work out, then the £20 will merge in the commission to which he would then be entitled to.

Sunderland.—The Corporation invite tenders for a steam feed pump. Specifications and forms of tender can be obtained from Mr. John F. C. Snell, borough electrical engineer, Dunning-street, at his office, on payment of a deposit of £1. 1s., which will be returned on receipt of a bona fide tender. The persons or firms whose tenders are accepted will be expected to pay the rate of wages to workmen engaged in carrying out the work which is payable by the particular trade affected by the contract in the district where the work is executed. Tenders, endorsed "Tender for Feed Pump," and addressed to the Chairman of the Highways Committee, Town Hall, Sunderland, must be sent to Mr. Fras. M. Bowey, town clerk, by noon on 27th inst.

Barking Town.—The Barking Town Urban District Council are prepared to receive tenders for the supply and erection of the following plant: Section A.—Generating plant, boilers and fittings, economiser, feed pump, injector, etc.; steam dynamos, condensers, oil filter, fittings, etc.; steam, exhaust, feed, blow-off, and sundry pipes; valves, water tank, etc. Section B.—Storage batteries. Section C.—Switchboard and all connections. Section D.—Overhead travelling crane. Section E.—Conduits and mains for private supply. Section F.—Mains for public lighting, and adaptation of existing lamps. Section G.—Arc lamps and posts. Tenderers are at liberty to tender for any section or sections, or for the whole of the sections, but not for part of a section. Successful tenderers will be required to enter into a contract to pay the trades union rate of wages and to observe the trades union hours of labour. The ground plan of plant, diagram of switchboard, plan of streets, etc., and specifications, with forms of tender, may be obtained at the offices of Mr. W. C. C. Hawtayne, the consulting engineer to the Urban District Council, Mansion House-chambers, 20, Bucklersbury, E.C., on and after August 21, 1897, on payment of £2. 2s., which sum will be returned on receipt of a bona fide tender. Tenders, sealed and marked "Tender for Electric Lighting," addressed to the Chairman of the Urban District Council, Council Offices, Barking, must be sent in by noon on September 21.

Madras.—Tenders are invited for the utilisation of water flowing from the Periyár Lake for purposes other than irrigation and not incompatible with the use of the water for drinking. The irrigating season extends over nine to ten months, during which time the discharge is likely to be from 1,100 to about 500 cubic feet a second, according to the demands for irrigation and the available quantity in the lake. Subject to the risk of interruption by accident or drought, supply can be given throughout the irrigation season. No supply can be guaranteed at other times, but, so long as water is available, the Government will be prepared to issue it in such daily quantities as may seem to it advisable with reference to the time which is likely to elapse before the supply is replenished by the setting in of the rains. The fall from the tunnel to the foot of the hills is approximately 900ft., and the distance measured along the course of the stream about 6,800ft. One cubic foot per second falling 900ft. is estimated to produce over 60 effective horse-power. Intending lessees should state the quantity of water required in cubic feet per second and the annual rent offered for each cubic foot per second. No rent will be charged for the first year from the date of the concession; for the second year the charge will be one-fifth, and an additional charge of one-fifth will be made every year until the full rent is reached. The whole or part of the concession may be surrendered on a year's notice being given. Lessees will construct at their own expense, on plans to be approved by Government, all the weirs and other works required to divert the water from the river below the tunnel. For further information, application may be made to the Chief Engineer for Irrigation, Madras, by whom tenders will be received up to October 31, 1897.

Port Elizabeth (Cape Colony).—The Town Council of Port Elizabeth (Cape Colony) invite tenders for lighting the streets and municipal buildings of Port Elizabeth by electricity, in consideration of the grant of a concession for the exclusive right of supplying electric current through the streets and roads of the town, to private houses, stores, etc., for terms of 5, 15, 20, 25, or 30 years respectively. There are approximately about 54 miles of streets in the town, as follows: main thoroughfare, 5 miles 1,196 yards; principal streets, 16 miles 1,433 yards; minor streets, 32 miles. The streets of the town are at present lighted by 380 gas lamps of reputed 16-c p. The municipal buildings consist of town hall municipal offices, morning market, feather market, wool market, and museum. The main streets are to be lighted by arc lamps, and the side streets and municipal buildings by incandescent lamps. Tenderers must state at what sum per annum they are prepared to adequately light the streets and municipal buildings for the various periods mentioned above, if they are granted a concession for any one of the periods referred to. The concession will provide, inter alia, that the particular system and plant to be adopted by the concessionaires shall be subject to the approval of Council; the charge for supplying current to private houses shall not exceed 1s. 9d. per London Board of Trade unit; and that the Council will have the option of taking over the whole undertaking, etc., at a valuation to be made in case of difference by two arbitrators or their umpire at the end of the period of the concession at the then value of the plant and mains. Tenders, endorsed "Port Elizabeth Electric Lighting," should be delivered to the agents of the Municipality, Messrs. Davis and Soper, 54, St. Mary-axe, London, E.C. (from whom further information may be obtained), on or before September 21.

BUSINESS NOTES.

Oswestry.—An enquiry has been held on behalf of the Light Railway Commissioners.

Newport.—The County Council have resolved to apply for sanction to borrow an additional £5,000 for the supply of electric machinery.

Newcastle.—Various improvements to the town hall will be carried out. The estimates, as passed, contain an item of £1,460 for electric lighting.

Llanfair.—An enquiry, which lasted two days, has been held into two light railway lines projected for the districts. The Commissioners reserved their decision.

C. Loggon and Co., Limited.—We have received an illustrated catalogue of electric bells, telephones, and electric light supplies, which this firm manufacture and import.

Leeds.—The question of lighting has been considered, and it was decided to recommend the Council to have an electrical installation, and to instruct the city engineer to prepare a scheme.

Le Ca bone (late Lacombe and Co.).—We are informed that the above firm have been appointed sole agents for the United Kingdom and Colonies for Mons. L. Boudreaux's foliated rolled metal dynamo brushes.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended August 15 amounted to £1,516, as compared with £1,375 in the corresponding week of the previous year, being an increase of £141.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended August 13 were £2,706. 15s. 10d., compared with £2,376. 17s. 7d for the corresponding period of last year, being an increase of £329. 18s. 3d.

Edinburgh.—We are informed that a monster electric lamp is about to be put up to light the area in front of the McEwan Hall. It will cost £1,500. The lantern alone measures 12ft. in height, and will contain six Jandus lights, each giving 800 c.p.

Warrington.—A special meeting of the Council has been summoned for September 7 to consider the advisability of applying to the Board of Trade for a provisional order empowering the Council to supply electricity for lighting, etc., within the district

Peterborough.—In consequence of the enquiry held on behalf of the Light Railways Commissioners, and referred to in our last issue, the line proposed between Peakirk and Cowland has been recommended for the Board's approval. The estimate is £34 751.

Sweden.—It is stated that De Laval, the inventor of the turbine of that name, who is a Swede, and M. Gin, the French engineer, have obtained sole control of the Kraengede Waterfalls, in Jueurtland (Sweden). These falls have an estimated water power of 160,000 h.p.

Broadstairs.—At the last meeting of the Broadstairs and St. Peter's Urban District Council a letter was read from the Council's solicitor, stating that the promoters of the light railway accepted the terms of the Council, and asked that no further delay be caused by the Council.

Gillingham.—During the discussion of a project of electric tramways it was stated that, although the scheme would cost £80,000 to £100,000, ample funds would be forthcoming. The Local Board had previously given their support to a proposal for trams, but it was not then proceeded with.

City and South London Railway.—The returns for the week ended August 15 were £837, compared with £1,110 for the corresponding period of last year, being a decrease of £273. The total receipts for the half-year 1897 amounted to £6,293, compared with £6,529 for the corresponding period last year, being a decrease of £236.

Ashton.—The Town Council have received notice of an application by the promoters of the Oldham, Ashton, Hyde, and District Electric Tramways to the Board of Trade to prolong the time limited for the commencement of the works authorised by the order of 1896 until October 7, 1897. They decided to offer no objection to the proposal.

Dungarvan.—The Guardians of Lismore Union have adopted a resolution urging her Majesty's Treasury to impose a further condition on the Lismore Railway Company—viz., that they give running powers over the county railway to any company who might construct a line from Rosslare to Waterford and from Fermoy to Cork.

Glasgow.—The Electricity Committee of Glasgow Corporation, referred to in our last issue, have decided to recommend the purchase of a large plot of ground in the north-western district near Phœnix Park, and another in the southern district near Eglinton Toll, to meet probable future developments in the electric lighting system of the city.

Neath.—At the meeting of the Rural Council objections were made to the present charge of £4 per annum for each light at present demanded by the Corporation, and it was said that if the authorities do not reduce the charge for what might be termed an obsolete mode of lighting, the Skewen district might take steps to light by electricity.

Brierley Hill.—The South Staffordshire Blast Furnace Power Syndicate have given notice of their intention to apply to the Board of Trade for a provisional order under the Electric Lighting Acts to enable them to supply electricity for public and private purposes within the Brierley Hill district. The Council adopted a resolution to oppose the granting of such a provisional order.

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Gildersome.—In consequence of the Council's charges for electric light having been found higher than those in the surrounding districts, the price per unit has been reduced from 7d. to 6d. for the first 1½ hours, and to 3½d. for the rest. The new extensions have been decided upon, and a resolution also come to to ask the Local Government Board's permission to a loan of £3,000 for that purpose.

Newington.—We understand that specifications are being prepared for a generating station and plant, in order that the Vestry, immediately after the recess, may have the scheme before them with a view to putting into immediate force the Newington electric lighting provisional order, which has passed through both Houses of Parliament and received the Royal assent without amendment.

California.—A long-distance electricity-transmitting installation is about to be laid down in California, where power is to be taken from a stream that flows through Santa Ana Canyon, and conveyed thence a distance of 80 miles. The pressure of the current is to be 33,000 volts. The fall of water utilised is 750ft. vertically in a course of 2,200ft., and four turbines will gather the energy developed.

Algiers.—We understand that tenders will shortly be called for the erection of an electric tramway from the Hospital du Dey to Bouzarea. The fares are intended to be fixed at 1d. per kilometre, or 7d. for the second and 5d. for the third class passengers, 4d. per ton per kilometre for goods, 1s. 4d. per ton from Algiers to Bouzarea, while at present the ton costs 4s. Fuller particulars may be obtained at the Prefect's or at the Chamber of Commerce, Algiers.

Coventry.—The Electric Lighting Committee of the City Council have presented a report recommending the extension of works and mains and the lighting of a number of streets with arc lamps at a cost of £37,900. The Council resolved, after an animated discussion, that the report be referred back to the committee, in order that a modified scheme might be presented. Both the amount of the expenditure and the appointment of an expert at £1,200 were objected to.

Positions Abroad.—The college at Neustadt, in Mecklenburg, is advertising for two teachers. They must be possessed of a thorough education. One is required to teach the construction of electrical machines and the design of light and power installations; the second is for general electrical engineering, physics, chemistry, and is to be chief of the laboratory. Candidates are required to forward to the manager, Mr. Bellot, testimonials, curriculum vitæ, and should state salary expected.

Greenock.—Committees appointed by the respective Councils of Greenock, Gourock, and Port Glasgow to consider the question of electric lighting for these districts have met and agreed to recommend that a joint committee be appointed to obtain full information on the subject, and that power be granted them to visit installations in the country. The report also recommended that an engineer be appointed to visit the three burghs and advise as to the best means of utilising motive power, etc.

Johannesburg Tramways.—The *Financial News* comments upon the fact that immediately following the refusal of the authorities to ratify the Lombaard electric tramway concession, the Johannesburg City and Suburban Tramway Company has petitioned the Government to be allowed to extend its system to the suburbs covered by the proposals of the defeated Lombaard Syndicate. It is stated that the extensions for which permission is now sought are urgently required, and it seems probable that the necessary sanction will be obtained.

Appointment Vacant.—The Corporation of Darwen are prepared to receive applications for the post of borough electrical engineer. The person appointed will be required to devote the whole of his time to the office. The Corporation have recently received parliamentary powers to supply electricity within the borough, and are about to give effect to the Board of Trade provisional order; applicants must therefore have had practical experience in designing and carrying out electrical installations. Salary, £200 per annum. Applications, stating age and experience, accompanied by not more than three copies of recent testimonials, to be sent to Mr. Chas. Costeker, town clerk, marked "Electrical Engineer," before September 6. Canvassing will disqualify.

North Staffordshire Tramways.—The chairman of directors (Mr. W. J. Carruthers-Wain, A.I.C.E.), in moving the adoption of the report at the ordinary general meeting of the shareholders of the North Staffordshire Tramways, Limited, made an important statement. He said that the agreement entered into between the authorities and the directors of a company with a view of purchasing contained a clause making the deal conditional upon the company's changing the present mode of traction from steam to electricity. Furthermore, the electrical equipment had practically been supplied, the buildings were in process of erection, and all the poles had been placed. A more frequent service on the line would necessarily follow. This report was adopted *nem. con*

Wakefield.—As mentioned in our last issue, the electric lighting of the city is being sadly delayed by the strike of engineers in Leeds, where the engines are in course of construction, but the Electric Lighting Committee of the City Council have received a promise that the first portion of the plant will be delivered at an early date; and as the engine-shed and other buildings at Calder Vale are nearing completion, there need only be a delay of a few days after the receipt of the plant in the turning on of the new illuminant. The chimney stack has attained a height of about 140ft., only leaving 40ft. more to be built. The sub-electric station at the top of Westgate is also practically completed with the exception of the roof, so that had it not been for the dispute in the engineering trade, all might have been in readiness for lighting up in the course of another week or 10 days.

Ship-Lighting.—The Northern Electrical and Ventilating Company, of 6A, Stanley-street, Liverpool, have just completed an electric light installation on board the Prince of Naples's steam yacht "Iela," so named after the beautiful Princess of Naples, who attracted so much attention at the recent Jubilee celebrations. The Prince and his party, who have now started on a trip round the world, have informed the firm that they are much pleased with the manner in which the work has been carried out. They were particularly interested in the deep-sea lamp. The installation consists of combined engine and dynamo and a complete set of accumulators for saloons and state-rooms, which rooms have special arrangements for lowering and raising the lights as required. The whole of the work has been carried out under the personal supervision of Mr. C. P. L. Titherley, the company's engineer.

Thetford.—The valuable freehold electric light and power station, with the complete plant, apparatus, mains, etc. (in liquidation), were offered for sale at the Anchor Hotel on Tuesday by Messrs. Oldman and Sons, instructed by Mr. Lovewell Blake, the liquidator. The premises are freehold and very compact, and contain thereon all the modern apparatus apparently in excellent condition for generating both light and power. The overhead mains are supported in various parts of the town by 33 wood and one iron poles, and contain about 5,000 yards of copper wire, and there are 19 meters. The sale did not attract a large attendance. The bids started at £800, and the property was bought at £1,375 by Mr. Scott (Laurence, Paris, and Scott, of Norwich). In addition to this, that firm purchased the office furniture and stores to be taken at valuation (about £50). Compared with the recent offer of the gas company to sell their plant to the Urban District Council for £5,500, the above purchaser is considered to have made a good bargain, as the electric works are of recent erection and, so far as we are informed, in excellent condition. There is plenty of scope for further extension in the town.

Shepton Mallet.—The Anglo-Bavarian Brewery at Shepton Mallet, requiring to utilise the water from wells at a distance of a mile from the brewery, put down large cast-iron mains, and by means of a 60-h.p. engine and dynamo generated a powerful current of electricity, and conveyed the same by overhead wires to a motor placed near the outlet from the wells. This motor, when set in action, pumps a huge volume of water, forcing the same through the iron mains, and raises the water to a height of 160ft., or over; and so important has this supply become that the company have recently constructed a special dynamo-room and erected another 60 h.p. engine to prevent any possibility of a breakdown in the arrangements. This has now been in successful work for some time. Another dynamo, fixed in the same room, supplies the current for the electric lighting of the brewery buildings. The electric pumps have also been adapted as a powerful adjunct to the well-known fire appliances at the brewery, as in connection with another large pump a dozen fire nozzles of 1in. diameter can be fully supplied and directed 100ft. high to almost any part of the brewery or adjacent houses or buildings.

Bristol.—At the half-yearly meeting of the Bristol Tramway and Carriage Company, Limited, the chairman, Alderman C. H. Low, in moving the adoption of the report, stated that the company's Bill had received the Royal assent, and they were pushing forward vigorously with the extension to Staple Hill. Reference had been made from time to time of their progress in the application to the Light Railway Commissioners for the line to Hanham. It was satisfactory to find that the whole of the local authorities were in perfect accord with the company in desiring that this work should be carried out under the provisions of the Light Railway Act, but they would have seen that the Corporation of Bristol were seeking to be heard in opposition, and should they be successful in materially altering the order, it would have to be withdrawn, and St. George and Hanham would reap the firstfruits of their amalgamation with the city. He need hardly say that, backed as they were by the unanimous approval of the people of the district, they would be able to present such a strong case to the Railway Commissioners that he could not believe the opposition of the Corporation of Bristol would much avail. The delay which had taken place up to the present was due to the Corporation of Bristol in attempting to force them to become customers of their electric light department, whilst they were willing and able to provide their own current and do their own business, and so be able to render a good account of themselves in the public service.

The additions to the electric power building are progressing. The ground which has taken so long to thus prepare is now ready. Owing to the marshy character of the site the ground has had to be extensively piled, the last pile having been driven with due ceremony. The building will be erected as quickly as possible. The ponderous foundation-stones to carry the new chimney stack have been laid, and the seatings for four new boilers are ready for their reception. There is every reason to believe that the new wing will be completed and equipped with the necessary plant in good time to meet the increased demand for electricity which is expected during the winter. The committee are about to extend the electric main along the Broad Plain and Stapleton-road.

London Electric Railways.—The City and South London Railway, which passes through the centre of Southwark, and also largely provides travelling facilities for Newington and Walworth, is an accomplished success. The ease with which one can descend, by means of the lifts, to the railway platforms, and again ascend to *terra firma*, afford special attraction, whilst the freedom from noxious and nauseous vapours in the tunnel contrasts most

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favourably with the underground railways on the northern side of the river. An extension has been commenced, which is to bring the line to The Angel, Islington, and the underground station connected with the new line is being rapidly constructed. The line at this point will pass southward, and form a junction with the Borough Station at the corner of Marshalsea-road. At Denman-street a subway will also be constructed, by which ready access will be obtainable to the London, Brighton, and South Coast Railway terminus. Going northward, the line will pass under the River Thames east of London Bridge and below the company's present station near the Monument, thence under King William-street to Lombard street, where another station will be formed under the church of St. Mary Woolnoth, and thence to Moorgate street and Islington *vid* City-road. The work on the Central London Railway from the City to the West is progressing rapidly, and the Waterloo and City Railway from Waterloo Station to the Bank is to be handed over before the end of the year. At Waterloo Station the departure platform will be 36ft. from the surface, and at the Mansion House the rails will be 65ft. beneath the surface of the ground. The line passes diagonally under the Thames at a gradient of 1 in 60 from Waterloo, rising by 1 in 88 towards the City. The northern or up tunnel has now been completed throughout, including the station and siding tunnels at the Mansion House. The City Station tunnel for the south or down line of rails has still to be executed, but the shield is in position, and driving will be commenced this week, and by the date of the general meeting the work will be fairly in hand, and will, we expect, be finished by the middle of September. The first instalment of the permanent-way materials has been delivered to the contractors, and road-laying has been commenced. The manufacture of boilers, engines, dynamos, and other electrical work was commenced early in the year, and has now far advanced, the first engine and dynamo being ready for testing. Arrangements have been made for the electrical contractors to follow on the permanent way at once with the conductor rails and cables. The cables themselves are finished and ready for laying, and the work generally is well forward, both as to the machinery for the power-house and the remainder of the electrical equipment.

Weaverham.—At the last meeting of the Parish Council Mr. Hough (chairman of the Acton Parish Council) and Mr. Fleming attended to invite the co-operation of the Weaverham Parish Council with the Acton Parish Council in the propasal to utilise the water power at Dutton sluices for electric lighting purposes. Mr. Hough explained that at the Dutton sluices there was a lot of water running to waste which might otherwise be put to good use by being utilised for the production of electric light. A deputation was appointed some time ago to wait upon the trustees of the Weaver, to see if they could obtain from them the use of the water. The trustees, however, after having the plans submitted to them, declined to receive the deputation. A parish meeting was called, at which it was decided to adopt the electric lighting if the water power could be obtained. Acton being only a small parish, they desired that Weaverham should join with them. Photographs of the Dutton sluices were shown by Mr. Fleming, who said it was proposed to erect a turbine where there was a narrow neck of land, and where the river was 8½ft. higher on one side than on the other, and the water passing through the turbine would take the power out. A dynamo would be used, and the power would be taken by means of a cable underneath the river and through the village, supplying buildings and the streets with electric light. Water power was the cheapest power for electrical purposes that could be obtained, and it was estimated by the speaker that the cost of a 50-h.p. turbine would be £210, the dynamo £500, and the erection £500. The sum of £1,000 would cover the cost of taking the electricity from the river to Weaverham Church, whilst another £1,000 would be required to carry the wires to houses and shops. There would be a further £1,000 for other items, and the total capital required would be nearly £4,000. If the sanction of the Local Government Board and the County Council of Cheshire was obtained, they could borrow the money at 3½ per cent., to be repaid in 50 years, and that would require 2 per cent. as a sinking fund, making a total of 5½ per cent., or £220 a year. A man, salaried at £80 a year, would be needed to look after the dynamo; £50 would be expended in sundry stores; £50 expenses of collecting the rate; and £100 would probably have to be paid as a royalty to the Weaver trustees. He thus estimated that an annual cost of £500 would be necessary. There were 250 houses in the districts of Acton and Weaverham, and supposing 100 of these burned a barrel of oil a year, that was 30s. each, which alone would bring in a yearly income of £150. The shops would probably raise another £100, the churches and chapels £50, and the railway station, streets, large house, etc., at £8 a year each, would make a total of £515. That simply dealt with the question of lighting, but there was the far more valuable one of power, and this he (the speaker) had come to demonstrate that evening. A great amount of labour would be saved in the district if electrical power could be used. He was ready to give £200 to back up his opinions. No definite decision was arrived at.

Sheffield.—As reported in our last issue, the Tramways Committee of the Sheffield City Council, having obtained the necessary parliamentary sanction, propose as rapidly as possible to convert the existing lines into the electric overhead system, and to commence several of the more important extensions. The committee's report has been fully discussd and adopted. An important amendment—viz., the paving of the line with wood instead of granite—was carried. Single *versus* double lines also created considerable discussion; the latter point was deferred. The following is a list of the proposed extensions which are to be proceeded with as rapidly as possible: (1) A connecting tramway between the Moorhead and Lady's Bridge (2) The conversion of all the existing lines into the electrical overhead system. (3) The construction of the following tramways: from the present tramway on South-street, Moor, along Ecclesall road, as far as Rustlings-road; from the present tramway near the Wicker Arches to Firth Park; from the proposed central terminus in Fitzalan-square, *vid* High-street, West-street, Hounsfield road, Crookes Valley-road, to the end of South-road, Walkley; from the proposed central terminus to Deep Pits, Intake *vid* Commercial-street, Sheaf-street, Duke-street, and Intake-road; from the proposed central terminus to Hallamgate-road, Crookes, *vid* High-street, West-street, Hounsfield road, Western Bank, Whitham-road, and Crookes-road. The committee also recommended that the assistance of an electrical expert be obtained to go through and advise on tenders. We quote from the *Sheffield and Rotherham Independent* as below: "Alderman W. E Clegg, in moving the minutes of the Tramways Committee, made an important speech, casting a retrospective glance over the first 12 months during which the Corporation have worked the tramway system. Touching upon the proposed extensions, it would, he said, be in the recollection of the Council that, as the result of the arbitration proceedings between themselves and the old tramway company, the Council had to pay them £30,750 for their undertaking. It was further necessary to borrow that money, and, therefore, for a Local Government Board enquiry to take place in order that the Council might obtain consent to do so. The result of the enquiry was that the Board gave them permission to borrow the money payable within a period of 17 years. The opinion of the city accountant was that that term was, under all the circumstances, a fairly satisfactory one. Touching upon the report of the Traction Sub-committee, which had been adopted by the Tramways Committee, he pointed out its importance, and summarised its most important points. In the first place, it was proposed to repave the existing tracks and to electrically bond the rails, the work to be done by the Corporation without outside assistance. The committee were further to proceed with all possible speed to undertake the section from Nether Edge to Tinsley, and to make communication between the Moorhead and Waingate. The details of the extensions in the centre of the city were fully set forth in the report. It was intended to ask four firms to send in in detail their tenders as to the equipment of the line from Nether Edge to Tinsley, and when they had obtained them to appoint and get the opinion of an electrical expert as to their suitablility and as to which they should adopt. The committee's recommendations as to the equipment of the extensions were of a very important character, because it meant that they were as soon as possible to extend the overhead trolley system throughout the whole of the proposed extensions."

PROVISIONAL PATENTS, 1897.

AUGUST 9.

18433. Improvements in insulating the contacts of incandescent electric lamps. William Durant and Thomas William Baron Durant, Burlington-arcade, Barnsley.

18438. Improved coil for electric instruments. William Thomson (Baron Kelvin of Largs), 154, St. Vincent-street, Glasgow.

18450. Improvements in cut-outs for electric lighting and other uses. Alfred Watson, 24, Temple-row, Birmingham.

18457. Improvements in electricity meters. George Hookham, 18, Southampton-buildings, Chancery-lane, London.

18464. An insulating incandescent electric lampholder. William James Bishop, 88, George-street, Croydon.

18466. Improvements in printing telegraph apparatus. Alfred Julius Boult, 111, Hatton-garden, London. The Printing Telegraph News Company, United States. (Complete specification.)

AUGUST 10.

18510. Improvements in electrical current distributing fuse and switch boards. Alfred Watson, 24, Temple-row, Birmingham.

18548. Improvements in the construction of electrical motors and generators. Sidney Howe Short, 45, Southampton-buildings, Chancery lane, London. (Complete specification.)

18552. Improvements in electric controllers for railway vehicles. Samuel Harris, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

18556. Improvements in and relating to lightning arresters. The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. (Edward M. Hewlett, United States.) (Complete specification.)

18560. Improvements in or relating to cut-outs for electric installations. Josef Hartig, 111, Hatton-garden, London.

18564. Improvements in secondary batteries Ernest John Clubbe, Alfred William Southey, and the Electric Motive Power Company, Limited, 15, Elm street, Gray's-inn-road, London.

18566. Improvements in and connected with secondary batteries. Ernest John Clubbe, Alfred William Southey, and the Electric Motive Power Company, Limited, 16, Elm-street, Gray's-inn-road, London.

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18567. Improvements in and relating to e'ectric traction. Ernest John Clubbe, Alfred William Southey and the Electric Motive Power Company, Limited, 16, Elm-street, Gray's-inn-road, London.

18568. Improvements in recording telegraphic receivers. Henry William Handcock and Alfred Herbert Dykes, 5, Victoria-street, Westminster, London.

18574. Improvements in or re'ating to non-synchronous induction motors. George William Money, 322, High Holborn, London.

AUGUST 11.

18589. Improvements in earthenware, stoneware, and other conduits for electric light and other cables. Russell Forrester Ferguson, 32, Marjorie-grove, Clapham Common, London.

18616. Improvements in or connected with electrolytes for primary electric batteries. Richard Hurley, Henry Cooney, Joseph Glover, and George Plummer Campbell, 15, Water street, Liverpool.

18628. Improvements in portable electric primary batteries. Charles Hamilton Cole, 321, High Holborn, London. (Complete specification.)

18635. Improvements in or relating to primary batteries. Guido Pagni Torelli, 31, Southampton-buildings, Chancery-lane, London.

18644. Improvements relating to electric telegraphy. Oliver Joseph Lodge and Alexander Muirhead, 323, High Holborn, London.

18651. Improvements in the manufacture of paper applicable for electric insulation and other purposes. Robert Atherton, 6, Lord-street, Liverpool.

18657. Improvements in hand electrical firing apparatus applicable for firing ordnance, grenades, mining charges, and the like Charles Ambrose McEvoy, 24, Southampton-buildings, Chancery-lane, London.

18658. Improvements in po ous diaphragms and vessels for cells and accumulators. Albert Nodon, 24, Southampton-buildings, Chancery-lane, London.

AUGUST 12

18662. Improvements in or relating to electric lamps. John Henry Cox, 3, Crawfurd-street, Greenock.

18666. A new material for the manufacture of electric conduits. Charles Hannay and Patrick John Thom, 115, St. Vincent-street, Glasgow.

18671. Improvements in and relating to the perforation of transmitting ribbons for telegraphy. Thomas Mark Hewitson, Malvern-road, Acocks Green, Worcestershire.

18701. An improved electric arc lamp for projection and other purposes George Davenport, 19, John-street, Strand, London.

18717. Improvements in and relating to controllers for electric motors. Sidney Howe Short, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

18718. Improvements in and relating to electric railways and tramways. Sidney Howe Short, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

18719. Improvements in supports for the current collectors of electric railways and tramways with overhead conductors. Siemens Bros. and Co., Limited, 28, Southampton-buildings, Chancery-lane, London. (Siemens and Halske, Germany.)

18730. Improvements in and relating to motor vehicles for electric railways and tramways Sidney Howe Short, 45, Southampton-buildings Chancery-lane, London. (Complete specification.)

AUGUST 13.

17866. The Flosin light for horse trams, electric trams, 'buses, and motorcars. Albert E. Flood and George J. Sinclair, 12, Westland-row, Dublin.

18769. Improvements in electrical measuring instruments. George Keith Buller Elphinstone and Arthur Cecil Heap, 101, St. Martin's-lane, London.

18776. Improvement in automatic or electric signals for railways. Wladyslaw Piskorski, 49, Black Lion-lane, Hammersmith, London.

18796. Improvements in and connected with secondary or storage batteries. William Moore McDougall, 45, Southampton-buildings, Chancery-lane, London.

18801. Improvements in elect ic switches. Edward William Lloyd and Leonard Newitt, 24, Southampton-buildings, Chancery-lane, London.

AUGUST 14.

18835. Improvements in electrolytic cells. Sebastian Ziani de Ferranti, Hollinwood, near Oldham.

18865. A safety device for use in connection with carriages propelled by electricity. The Honourable Reginald Thomas Dudley Brougham and Walter Charles Bersey, 24, Southampton-buildings, Chancery-lane, London.

18871. Improvements in electromagnetic contact systems. William Grunow, jun., Joseph Aloysius McElroy, and James Henry McElroy, 40, Chancery-lane, London. (Complete specification.)

18884. Improvements in and relating to the manufacture of plates for electric accumulators. Conrad Zimmer, Lincoln-chambers, 75, Chancery-lane, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1896.

13405. Dynamo-electric machines. Mordey.

16597. Primary batteries. Heurtey and Germain.

18187. Electric cab'e or conductor for electric fire or other alarm systems. Tisdale and Gould.

18319. Electric hand-lamp for general or special purposes. Westmancott.

18912. Te'ephone systems. Freudenberg. (Date applied for under International Convention, August 7, 1896.)

18951. Electrical accumu'ators. Conder and Michelot.

19501. Electric light conduits. Drake and Gorham.

19693. Electrical switch for certain useful purposes. Bersey, Moy, and Moy, Limited.

20330. Phonographs. The Edison-Bell Phonograph Corporation, Limited, and Greenhill.

21027. E ectrolytic apparatus. Wise. (Aluminium Industrie Aktien Gesellschaft.)

21218. Means or apparatus for producing radiation by elec tricity. Stearn and Topham.

21509. Electrolyser or electrolytic apparatus. Rhodin.

21539. Telephones. Boult. (Bair and Ream.)

1897.

10444. Portab'e electric batteries. Moffatt.

12134 Hanging of electroliers and other electrical fittings. Claremont and Royce.

12327. Device for use in connection with storage batteries. Walter.

13972. Controllers for e'ectric motor circuits and blow-out magnets for use with same. The British Thomson-Houston Company, Limited. (Potter and Case.)

14475. Systems of distribution of electricity. The British Houston Company, Limited. (Rice.)

14478. Electric meter apparatus Oxley.

14882. Means for producing theatrical effects. Walters.

15013. Negative electrode for zinc accumulators. Pitt. (Léger, Bomel, and Société Bisson, Bergès, et Cie.).

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	9¼-9¾
Brush Company, Ordinary	3	3-1⅛
—— Non. Cum., 6 per cent. Pref.	2	1¼-1½
—— 4½ per cent. Debenture Stock	100	105-109
—— 4½ per cent. 2nd Debenture Stock	100	93-97
Callender's Cable Company, Debentures	100	108-113
—— Ordinary	5	6¼-7¼
Central London Railway, Ordinary	10	9¾-10¼
——	6	5¾-6¼
Charing Cross and Strand	5	12½-13⅝
Chelsea Electricity Company	5	9¾-10¼
—— 4½ per cent. Debentures	100	110-113
City of London, Ordinary	10	23½-24½
—— 6 per cent. Cumulative Pref.	10	16¾-17¼
—— 5 per cent. Debenture Stock	100	130-135
City and South London Railway, Consolidated Ordinary	100	65-67
—— 4 per cent. Debenture Stock	100	139-141
—— 5 per cent. Pref. Shares	10	15½-15¾
County of London and Brush Provincial Co., Ordinary	10	12¾-13¼
—— 6 per cent. Cum. Pref.	10	15-15¼
—— 4½ per cent. 2nd Debenture Stock	10	15-15¼
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1½ 2
—— 5 per cent. Debentures	—	89-94
Edison and Swan United Ordinary	3	2½-2¾
—— 5 per cent. Debentures	5	4¼-4¾
Electric Construction, Limited	2	1¾-2
—— 7 per cent. Cumulative Pref.	2	2¾-3¼
Elmore's Copper Depositing	1	¾-1
Elmore's Wire Company	2	¾-1
W. T. Henley's Telegraph Works, Ordinary	10	18½-19¼
—— 7 per cent. Preference	10	18½-19¼
—— 4½ per cent. Debentures	100	108-113
House-to-House Company, Ordinary	5	9-9¼
—— 7 per cent. Preference	5	10¼-10¾
India Rubber and Gutta Percha Works	10	20½-21½
—— 4½ per cent. Debentures	100	105-108
Kensington and Knightsbridge Ordinary	5	13-13½
—— 6 per cent. Pref.	5	8-8½
London Electric Supply	5	1¾-2
Metropolitan Electric Supply	10	16¼-17½
—— 4½ per cent. First Mortgage Debenture Stock	100	118-122
National Telephone, Ordinary	5	6½-6¾
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	15-17
—— 5 per cent. Non. Cum. Third Pref.	5	6-6½
—— 3½ per cent. Deb. Stock	100	106-110
Notting Hill Company	10	15-16
Oriental, Limited, £1 shares	1	1¼-2
—— £5 Shares	5	8½-8¾
—— £4½ shares	4½	7¼-7¾
Oriental Telephone and Electric Company	1	¾-1
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	102-104
St. James's and Pall Mall, Ordinary	5	17-18
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	87-40
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	8	10¾-11¼
Westminster Electric Supply, Ordinary	5	14¾-15¼
Yorkshire House-to-House	5	8-8½

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NOTES.

Electric Lighting in Rangoon.—The municipal engineer has drawn up an elaborate report on the probable cost of introducing the electric light in Rangoon. Roughly speaking, a fresh debt of five lakhs would, he thinks, be necessary for the purpose.

Watts-His-Name.—A correspondent writes: "If the foreign engineer of whom I heard the following story is a fair sample of the talent in his country, there must be some queer installations abroad. A firm sent a case of goods accompanied by a letter describing the contents as 200 lamps of 16 c.p., 3·5 watts. To their amazement and amusement they received the following reply: 'We have received the 200 lamps in good condition, but not the 35 watts; please explain the cause of this omission, and send the 35 watts without delay.'"

The Laundry and Engineering Exhibition.—The fifth Laundry and Engineering Exhibition at the Agricultural Hall, Islington, was opened to the public on Monday last. The number of exhibitors remains about the same as last year, but their exhibits were in a most unfinished state when we inspected them on that day. The motorcars, of which some 30 have entered, were represented by six only, of which three were electrical cabs. We also noticed a placard to the effect that the flatirons on view in the stand below were heated by electricity. There was a fine display of sawdust to be seen on the stand and a few loose wires, but the irons were evidently coming up by the other 24 motorcars. We hope to be more instructed by our next visit.

A Floating Hotel.—Owing to the difficulty experienced in filling the places of the men on strike by non-unionist hands, in consequence of their having to "run the gauntlet" of the pickets when going to and fro from their work, Messrs. Yarrow and Co. have chartered the Royal Mail steamer "Southampton," which vessel is now moored opposite their yard at Poplar. She has lately been taken off the passenger service between Southampton and the Channel Islands, and is well fitted up for the accommodation of 150 passengers, and upon this vessel the new hands will be comfortably quartered and free from the annoyance of the pickets. It appears there are plenty of non-unionist men only too willing to secure employment, provided they can have the protection they are justified in expecting.

Behr Lightning Express at Tervueren.—Our readers will be interested to read the account of the above electric line in the article on the Brussels Exhibition. We hear from Mr. Behr that this railway is now running successfully. Yesterday week, Count Adrien d'Oultremont, Commissioner-General of the Government, and his family, had a very successful run on this line, and the count expressed himself very pleased with the same. The speed at one time on the most difficult part of the line, at which a sharp curve over a very bad embankment has to be negotiated, was, according to Count d'Oultremont's timing, over 75 miles per hour. We note from Mr. Scott's article that troubles due to the centrifugal force on the curves, which we predicted would be found, have given considerable trouble. Of course, this is not a fault in the system so much as a fault arising from trying to get excessive speed on an unsuitable track.

New Inventions.—We read in a daily paper that among recent inventions is an electric attachment to street-door boxes, whereby a letter dropped into the box causes a bell to ring in the kitchen, or any desired place in the house. The value of this while the London postman's double knock keeps up its accustomed strength is not very great. It reminds us, however, of a useful device we saw recently in Berlin. Mr. Gisbert Kapp was responsible for the design of this particular device, but we understand that they are not uncommon in Berlin. The private houses there are usually railed in by a strong fence, and all comers have to ring at the gate for admission. Then under the old arrangements, the servant had to leave the house and walk to the gate to open it. In this case, an electric release in the lock of the gate was provided, so by pressing a push placed near a window from which the gate is visible, the gate is released and flies open. This saves a great deal of trouble, and in winter is specially appreciated.

Universal Stop for Machine Tools.—Mr. E. G. Herbert has sent us details of a device he has got out for stopping automatically a self-acting lathe when the length of cut required has been taken off. The apparatus can be applied to any self-acting machine tool. It consists of an electrical relay, which, when a current passes through it, releases a weighted lever, which throws the belt on to the loose pulley. The contact for closing the relay consists of a stand not unlike a marking-off instrument. The pointer is insulated from the machine bed, and the instrument is so placed that when the feed gear has moved the tool over the travel required it makes contact with either the saddle or the tool-box. The idea is good, and if the shops were not so in the hands of trade unionism, might be applied with advantage in allowing one man to work several self-acting tools. With our present system of labour supply, however, Mr. Herbert will find that the men will not allow such a device to be used for labour saving.

Instruments for Determining Frequency.—Messrs. G. S. Moler and Frederick Bedell have read a paper on the above subject before the American Association for the Advancement of Science at Detroit. Two instruments were described in it and shown to the members present. The first one consists of a small synchronous motor brought to speed by a crank handle connected with the motor by a suitable train of gears and phase indicating gear. The apparatus contains an electrically operated speed counter so arranged that its reading gives the exact value of the frequency of the alternating current with which the synchronous motor is supplied. The whole apparatus does not weigh over 9lb. The reading is correct to within ·05 of an alternation. The second instrument consists of a sonometer or monochord. The alternating current flows through a piano wire mounted upon a sounding-board. The wire passes between the poles of a permanent magnet. By means of a sliding bridge the period of the wire may be made equal to that of the alternating current. This is indicated by the vibration of the wire. A scale is arranged so that the position of the bridge indicates the frequency directly. This latter method was, we believe, fully developed by Prof. Ayrton at the Central Institution in 1889.

"The Lancet."—With the decline of the summer we regularly receive the students' number of the *Lancet*. This year's production is in no way inferior to its predecessors, and gives most complete information of various places of study and examinations, with lists of fees, etc. The address to students is worthy of close attention. Thus it reminds the young man that, having chosen his medical school, he will have before him five years of hard work before the goal of qualification can be reached. "*Nil sine magno vita labore dedit mortalibus.*" If the five years are well spent, the training which the student has undergone will have fitted him to practise his profession with benefit to his patients and with credit to himself. If the five years are ill-spent, he may utterly fail in obtaining any qualification, and may have to fill the very undesirable *rôle* of an

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unqualified assistant. Translating this to our electrical profession, we find that parents expect by a premium and three years' lolling round works to convert their sons into men fitted to carry out electrical works with benefit to their employers or clients and with credit to themselves. After all a little knowledge is a dangerous thing.

Chesterfield and Midland Counties Institution of Engineers.—The annual general meeting of the members of the above institution will be held in the Stephenson Memorial Hall, Chesterfield, on Saturday, 28th inst., at 3 p.m., for the election of the council and officers for the ensuing year, and also of new members in the institution. The general report of the council and their finance report, with abstract of the audited accounts of the past year, will also be read and discussed if necessary. From the report we gather the institution now has a total membership of 353, a net increase of four over last year. The following papers will be read, or taken as read, at the meeting on Saturday: "Walker's Patent Hollow Needle for Firing High Explosives," by Mr. J. Mein, and "Electric Blasting," by Mr. W. Maurice. The following papers interesting to our readers which have been read at previous meetings will be again open for discussion: "Secondary Haulage," by Mr. W. Galloway; "Improved Apparatus for Drawing Timber in Mines," by Mr. E. B. Wain; "Electric Haulage at Pleasley Colliery," by Jno. Piggford; and "Notes on Auxiliary Haulage at Netherseal Colliery," by Mr. G. J. Binns. Members who cannot be present are invited to contribute to the discussions by letter.

Alternate Currents for Traction.—We have in our present issue two notices of traction schemes in which alternate currents will be used. The first is for the projected Jungfrau line. In this case, the multiphase motors will be used in their simplicity. They possess good starting torque, and on the up grade a uniform speed is desirable. The other article gives more details of the proposed Déri system, which at first sight appears to be very complicated. We understand, however, that it is to be tried, and the results of this trial will, we trust, soon be made public. The use of accumulators is not a bad feature in such a case, as, like in the case of the Hanover system, they are not used to store any large amount of energy. When starting they can, by parallel grouping, be arranged to work very economically by the avoidance of all resistances. It is always the starting torques that rule the current capacity of the motors, as hence there may be reason for the inventor's belief that neither the direct or alternate current motor will need to be of the full capacity in the present case. We cannot quite follow his reasoning, however, as far as the direct-current motor is concerned. The uniformity of speed on some railway lines may not be objectionable, but the fact that the trains cannot be accelerated to regain their scheduled places should delays occur is the greatest objection to the use of such alternating-current motors for traction purposes.

Submarine Exploration.—An Italian engineer is constructing a vessel for exploring the sea bottom, which is different in principle and construction to the usual type of submarine boat. This vessel, the designer of which has the name of Signor Piatti del Pazzo, is spherical in shape, and is ribbed to give it strength to withstand great pressure. It is hoped that by using it somewhat as a captive balloon is used to be able to descend to a depth of 1,500ft. below the water-level. As at this depth a pressure of about 750lb. per square inch has to be withstood, the need of the ribbed construction of the metal shell will be understood. The vessel will be equipped with levers, grapnels, and other tools, which can be worked from the interior. Although it will be lowered to the bottom by a chain, it will not be altogether inert, as it has three screw propellers on different sides, which enable it to move about at the end of its cable and to turn on itself. Stout windows or portholes will permit the operator to see what is around him. The screws and implements are to be worked by electricity supplied from accumulators, which also illuminate the interior. The divers can all speak with the ship or shore above by telephone. The electricity required might be supplied from the ship or shore itself, and in either case powerful submarine searchlights to illuminate the bottom can be worked from above. Should the chain part, the new "diving bell" can rise to the surface of itself. The device has been constructed by M. Delisle, but, of course, its efficacy can only be demonstrated by actual trials.

Submarine Vessels.—Our note on the exploration of the sea bottom reminds us that one of our most prominent central-station engineers passed several years in the construction and management of submarine vessels. We refer to Mr. P. W. D'Alton, the engineer to the London Electric Supply Corporation. We must confess to having spent a most pleasant hour in hearing his experiences on such boats, and were glad that the real subject of the interview did not necessitate us putting his experiences to practical proof. The boats in question were worked, when below the surface, on the thermal storage principle since taken in hand by Mr. Druitt Halpin. A large cylindrical vessel was filled with water, and the boiler used to propel the boat in the ordinary way passed steam into this. After a day or two, the water having been heated up to the correct temperature, the vessel was ready for an extended voyage under the surface. However, the various experts from other countries preferred to test the boat by a prolonged stay under water, where it could be watched. On one occasion, when off Italy, the boat went down in the bay, and after the recognised six hours prepared to ascend. It was then found that something was wrong, and that the expulsion of the requisite amount of water ballast did not have the desired effect. The engineer naturally could not get out to see what was the matter, but, after trying the effect of more buoyancy, put the engines full speed astern. This loosened the boat from the mudbank she had sunk into whilst resting, and the extra buoyancy took effect. When the vessel reached the surface a short aerial flight was attempted, and the rebound on to the water upset the crew very considerably. Still, the broken ribs were mended, and we are glad to chronicle the fact that Mr. D'Alton was not chewed up by his own engines, as nearly happened. We have not space for the rest of the anecdotes, but can well understand that the man whose nerves stood such work is invaluable in central-station running.

Fire Reports.—The Electrical Bureau of the National Board of Fire Underwriters of New York issue quarterly reports of fires which may be traced to electricity. We have before us the report dated July 10, 1897, which is interesting reading. The following extracts show the business-like way the report is got up. The various cases are numbered thus—1,737 reads: "A temporary connector formed of brass strips mounted on a wooden board was short-circuited by a brass candlestick dropping across the strips. The board was ignited by the arc, and the fire communicated to the adjacent combustible material. Loss, £2,555." Our comment to this would be the same as in the case of the Jubilee decorations in St. James's-street—Where were your fuses? "1,741. Hot metal from an arc lamp, unprotected by either arresters or globe nets, dropped on to dry goods underneath. Fire communicated to building, entailing a loss of £15,000."

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"1,747. During a heavy snowstorm a telephone wire broke and fell across a trolley wire. The telephone burned out, causing quite a loss." Comments as to whether earthed guard wires over the trolley wires, as ordered by our Board of Trade, are not advisable? Many more fires are detailed in which fuses must have been either absent or plugged with heavy copper wire which would not fuse. Other cases, as below, are interesting from the general point of view rather that from the fire office risks. Thus 1761 says a 11,000-volt circuit was supported on heavy triple petticoat glazed porcelain insulators. Several of these insulators had been punctured by the current, and in one instance this puncturing caused a short-circuit along the wet cross-arm, the pole being entirely burnt off and the cross-arm reduced to a small piece of charcoal. We give as a last example No. 1,767. A Bernstein series incandescent lamp in a show window became short-circuited and the arc ignited the cord, which set fire to the inflammable material in the window. In all some 142 cases are listed for the three months, which is a startling reminder to us that we do such work better on this side. It must, however, be remembered that lightning figures as the destructive agent in several of the cases given.

Dynamo Design.—The editor of our New York namesake has, at the request of Mr. Albert W. Smith, forwarded to us an advance proof of the latter gentleman's article on "Some New Principles in Dynamo Design." We wish, therefore, that we could, after this courteous treatment, concur with the title of the article which we reproduce. Our objections can be classed under three heads: What principles there are in the idea are not new; the new principles are most unprincipled; and lastly, the whole cannot be classed as "dynamo design." We should rather say it was a way not to design dynamos. In the first place, the split field-magnet winding does not, as arranged in the illustration, reduce the distortion of the magnetic field due to the armature cross ampere-turn any more than the usual method of halving the pole-piece in the Manchester type of field does. The statement that this reduction is abnormal is not correct, neither does this reduction of cross-induction (by, say, one half) warrant a shorter air-gap and much higher field. The author argues that "the magnetism generated by any given turn or section of a field coil must pass through that turn or section, though it need not necessarily pass through all of the turns or sections of the coil, but may leak out through the side of the coil adjacent to its own turn or section; it follows, therefore, that the magnetism generated by a field coil cannot be shifted forward further than the width of the coil." This is a shifting from "may" to "must" with a vengeance, and we fancy that some such argument will be required to be enforced by an iron hand, if the machine designed on the author's lines is not to have a very large leakage coefficient. The magnetic lines of force have a way of taking the path of least resistance, which does not always lead them only where they are wanted. The rest of the article treats of auxiliary poles to prevent sparking, such as were devised and tried by Mr. James Swinburne some eight or ten years ago. The difficulty of making such a construction useful in practice lies in the fact that it does not at all follow that the auxiliary pole will have its effect proportional to that of the commutating section, as the current is varied. We wish the author had tried his ideas before propounding them as facts in the technical Press.

The Chicago Elevated Railway.—It seems that Mr. Frank J. Sprague had obtained some months ago the contract for the electrical equipment of this line. He has decided to take a leaf out of our English practice as exemplified by the Liverpool Overhead Railway, and put motors on each of the cars of the train. As a six-car train has already been tried, we gather that considerably longer trains will be used in Chicago than at Liverpool. The *Electrical World* contains some details of this new train. For the purpose of trial, six standard 42ft. elevated railroad cars were taken from the rolling-stock of the "Alley" railroad system. The cars were each equipped with a single McGuire truck at one end, the old truck being retained at the other. Two "G. E. 57" motors were fitted to the new truck, one to each axle. These motors are rated normally at 50 h.p., with a capacity of twice this amount when necessary. In general design they are iron-clad four-pole machines, similar in design to the other G. E. motors, and are single reduction geared to the axles. The controlling arrangements are new. Instead of the usual double-direct hand-operated controllers, each car platform is equipped with a small operating switch enclosed in a circular box mounted on an upright pipe. The motors on each car are controlled from either end of the car by a single controller, which is in turn governed through the medium of these operating switches. Series-parallel control is used, but this gear on each car is controlled from the front car by means of a small motor, which keeps all the controllers at the same contact automatically. Also, should the current fail or the motorman leave his post, the handles all return at once to the off position. The air-brakes on the cars are also interconnected, which allows of them all being used simultaneously. Should any of the driving motors become disabled they are automatically cut out, that particular car being then pulled along by the others. Such control of a number of cars composing a train, therefore, makes each absolutely independent. Each car starts and accelerates itself, and a careful examination of the draw-bars between the cars of the test train showed that this is borne out in practice, as no strains were shown on the connecting couplings when the train was in motion. The chief point we are doubtful of is the automatic control, but it is difficult to ascertain the reliability of this without an extended trial in ordinary working conditions.

Accumulator Traction.—The arrangements of the Englewood and Chicago line, which is worked by accumulators, is fully described in the *Western Electrician*. This description is interesting reading, and we note that in many points the charging arrangements are similar to those described in our last issue as being adopted by the Electrical Cab Company, of London. Thus the accumulators are all placed in a tray under the car, and an elevator is used to lift and lower the tray when discharged, and to put the new set in place. The trays each contain 72 cells in 12 rows of six each. Each cell contains nine plates, the negatives being of the Chloride type, while the positives are either of the Tudor or Manchester type. Each plate is $14\frac{3}{8}$in. long and $7\frac{3}{4}$in. wide. The negatives are $\frac{1}{4}$in. thick and the positives $\frac{5}{16}$in. The containing vessels are made of hard rubber, with the following outside dimensions: $8\frac{1}{2}$in. by $5\frac{1}{4}$in. by $17\frac{3}{4}$in. deep. The plates of each cell weigh 75lb., while the weight of acid and containing vessel bring the total weight up to 100lb. The trays complete, with 75 cells, weigh 7,800lb., say, $3\frac{1}{2}$ tons. The ampere-hour capacity is not given, but 400 amperes is mentioned as their maximum rate of discharge. One tray enables the car to make a round trip of 24 miles, after which the cells are recharged. This can be done in 40 minutes, but a longer period of charge gives better efficiency. Owing to this quick charging, two sets of batteries are not required for each car, but a 50 per cent. increase only on the number actually in use is needed. The first cars have now been running for six months, and

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have run over a distance of 6,000 miles without repair. In charging, three different voltages are used, and the tray of cells commencing to charge at 160 volts is switched over first to 172 volts and then to 176 volts as the cells become charged. The normal charging rate is about 150 amperes. The controllers on the car have five points, and allow of the following combinations: (1) the batteries are grouped in four parallel circuits, and give about 36 volts; (2) the batteries are two parallel circuits giving 72 volts; (3) the batteries in series with resistance; (4) the batteries supply the motor direct; and (5) the same with the field of the motor shunted. In the power-house we note that Willans engines are employed. There are some 20 cars now running on 23 miles of track; and we await the financial returns of the company with interest.

The Fluid Theory of Electricity.—The recent failure of electric lighting in Edinburgh is yet to be fully explained, and also the extent to which the gas, which caused the first explosion, was responsible for the other after-effects is yet to be ascertained. The unfortunate occurrence has, however, not been without resultant good, as it has enabled the Edinburgh Gas Commissioners to add some interesting contributions to the fluid theory of electricity. Their explanation of the facts, as voiced in the *Journal of Gas Lighting*, are as follows: "The primary cause of the accident is a defective electrical cable allowing the electrical energy to gain access to a ¾in. brass gas-main tap, which was situated beneath the pavement in the vicinity of the defective cable. The electrical fluid attacked the brass tap, first permitting the escape of coal gas, but ultimately sealing up the iron pipe, by the fusion of the metals composing the brass tap, and the running of the liquid into the bore of the pipe. The electrical energy was also sufficient to fuse and slag the earth and stone in the immediate vicinity, and it was also the electric fluid that caused the cast-iron cover to become red hot. The loud hissing noise of the flames doubtless arose from the fusion of the metals, copper and zinc, and the absolute destruction of the latter, combined with the burning gas, and the explosions in the junction boxes would arise from the ingress of the escaping coal gas into the electrical conduits. Or it is also possible that the gas may have been generated from the destruction of the insulating material on the electric cables, this gas igniting where the fire originally broke out." This graphic description of the desperate underground fight of the two rival illuminants gives us great hopes that the "electrical fluid" will always remain victorious. We note that the "fluid" in question first turned on a gas-tap and then plugged up an iron pipe, showing that it would stand no opposition. Seriously, we are glad to note that the editor of the above journal has realised that the one-time frequent explosions in electrical conduits are generally preventable. He says that since the advice was given to fill up electric light manholes with an inert substance and to make the covers airtight, explosions have been almost unknown. It is significant of the excellence of the advice to say that on this occasion, while paving stones were displaced, the cemented manhole covers remained undisturbed. We may add that if gas-pipes could be kept tight, even the above precautions would be unnecessary.

A Proposed Alaska-Russian Telegraph Line.—Mr. Reginald A. Fessenden, in the *Electrical World*, discloses a project for connecting the States with Europe. The proposal is not new, but the writer advances new arguments in its favour. One great reason is very amusing. The writer says: "It must not be forgotten that at present almost the entire cable traffic with the East emanates from England and other European countries. But with Lord Salisbury's policy we may expect that, when the present temporary inflation is over, that England will take a much less prominent part in the world's commerce than formerly. As Rome held the ends of the chain of commerce which bound together the lands of the Mediterranean, as England has until now been predominant on the Atlantic, so the commerce of the Pacific belongs to the Americans. And as a first means to the securing of this, we must have a direct means of telegraphic communication." We suppose that the author believes what he has written, but our experience is that a message sent over even a direct telegraph line cannot command commerce, which, like a magnetic flux, takes the path of least resistance. The proposed telegraph line cannot be said to do that, and we hardly fancy that the cable across Behring Straits would rest long in peace. The author has apparently wrote out his ideas at a great rate, judging by the diversity of the end from the beginning of the article. Thus, he holds that high speed of signalling is to be the great gain, as the one land line should do as much work as 20 submarine cables. He admits at first that considerable new work would have to be done in the line of satisfactory relays for the five or six relay stations that would have to be established. Afterwards, he says that the electro-chemical recorder does not lend itself to relaying, but, on the other hand, with high voltages, which might be used with our improved methods of line construction, and borate of lead-glazed insulators, it would possibly not need more than one relay. If the article had extended over another column, we fancy that minus three relays would be wanted. Then, too, we are told that if the ice in the Behring Straits did give trouble, we could work that part of the line without wires. The essential want of the whole scheme is, however, financial, and until the fact that high speed could be maintained, in spite of a fair number of relays, and that the climate will not cause regular breakdown, we are afraid this new scheme for re-establishing commerce will languish.

Series Motors.—*L'Electricien* has just been publishing a series of articles on the historically Genoa transmission plant. We must confess to having always regarded the arrangements in use on this installation for working with constant current at high potentials as being instances of how impracticable the system is. Still, the last article of the series on the motors used is interesting as containing details we do not remember to have seen published before. The motors are always worked in series, and hence the E.M.F. varies with the power they have to develop. They are all of the Thury type, and those from 5 h.p. to 18 h.p. are bipolar. They are regulated for speed by shunting more or less of the current passing round the field magnets, which are always wound in series. All motors over 18 h.p. are made with six poles. Some of the larger motors are regulated by having a differentially wound field. The relative number of forward and back field-magnet turns can then be varied without altering the value of the current in the wire. These regulators are arranged to act automatically, being controlled by centrifugal governors. With this series system the insulation in the consumer's premises needs special care, as the pressure in some motors even reaches 1,250 volts. The following are particulars of a 60-h.p. motor used in this installation: normal output, 47 amperes at 1,070 volts, or 50 kw.; speed, 475 revolutions per minute; weight, 7,700lb.; diameter of armature, 23in.; length of armature, 28½in.; resistance of armature, 5 ohm at 50deg. C.; total number of turns, 136. The average strength of field in the air-gap is 4,500 C.S.S. lines per square centimetre. The field takes some 1,100 watts at full load for excitation. The other losses are

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as follows: armature copper, 1,100 watts: hysteresis and Foucault currents, 2,500 watts. This gives an apparent efficiency of 91·4 per cent. with 50 kw. output, but nothing is said as to frictional losses. The author agrees with the other experts who have visited the Genoa plant that the series system has not only fulfilled the desired conditions, but has given better results than were expected from the point of view of good regulation of the motors. The system of constant current at high pressures permits, in his opinion, of the distribution of electrical energy to great distances without the losses attending the use of transformers. The losses of the motors are only borne by the central station whilst the motors are actually working in the circuits. We hope some day to have a chance of seeing for ourselves this interesting plant, and of judging whether the dangers and want of flexibility of the system are more apparent than real.

Electric Lighting Progress.—Our contemporary, the *Journal of Gas Lighting*, devotes a column of its current issue to a fruitless endeavour to explain away the signs of progress of municipal lighting. Its text is the fact that during the past year 55 new provisional orders have been applied for, out of which 42 were applications on behalf of local authorities and the remaining 13 from companies. The journal adds that if London applications were taken out, only seven instances remain where private capital was involved. The inference drawn is that private capital could not be obtained for other schemes, whereas in a large number of cases the local authorities have been spurred on to action to keep companies from acquiring rights in their districts for the supply of that profitable commodity—electricity. The article as a whole is of the Red Riding Hood order, the principal actors being the wicked electrical tout and the innocent local magnates. The writer considers that the trouble of comparing the Board of Trade returns prevents the true state of the electric lighting undertaking being known. We gather from his remarks that one clerk at, say, £100 a year would prevent the dreadful practices he describes. He says, under the editorial "we," that he is "sometimes applied to by readers for information concerning these undertakings of the kind supplied by the Board of Trade returns relating to gas supply, and is obliged to reply that no such particulars are issued. This is to be regretted in the interests of ratepayers and others, who are consequently liable to be cajoled by electrical touts, and persuaded that electric lighting is a better paying business than is actually the case in the vast majority of instances. All electric light undertakings carried on under statutory powers are bound to file their annual accounts with the Board of Trade; and these are individually accessible by anybody who can show a reasonable claim to inspect them. There is not in existence, however, any general official statistical compilation exhibiting the financial and commercial side of British electric light undertakings, which is a circumstance greatly in favour of the machinations of the touting electricians already alluded to." He adds: "It seems a strange thing that members of local authorities, with all the technical and general Press before them, should yet be so completely ignorant, as they very often are, of the facts of municipal electric lighting enterprise." This is the key to the whole argument. The local authorities are not ignorant, but, reading the technical and general Press, decide to keep the electric lighting of their districts in their own hands. This is the sign of progress, and the official compilation will, when issued, confirm the wisdom of the local authorities. As regards the character described as a touting electrician, who canvasses municipalities while in the pay of contractors, and while advising them as their consulting engineer, we have not yet met a representative of that class in England.

Perils of Asiatic Telegraphing.—The *Standard*, quoting from the *St. Louis Globe-Democrat*, says that when the Gilgit-Srinagar section of the British telegraph line to India was run, there were prophecies that the danger of maintenance would be so great as to dissuade operators from undertaking them. There has, as a matter of fact, been no difficulty in filling up the entire staff, but that the perils of the service were not over-estimated is seen in an incident told by a telegraph master as happening between two officers called Minmarg and Astor, near the dreaded Burzil Pass. The Burzil, 13,500ft., and the Rajdiangan, 11,600ft., are two most difficult passes, most dangerous to cross in winter. In the Burzil in severe weather the snow will lie to a depth of 20ft. The chief cause of damage to the line are breakdowns from the accumulation of snow on the wire and avalanches. The first is guarded against, as far as possible, by planting posts close together, and using steel wire in the most exposed places. But nothing can withstand an avalanche if it come down across the line of route. Shelter huts are built at short intervals for the use of repairing parties. When once the winter sets in the stations are cut off from the outer world except by wire. Two white men, with a suitable staff of native linemen and subordinates, are stationed at each office, and made as comfortable as circumstances will permit. They are fully rationed and equipped with suitable clothing, and furnished with snow-shoes. Rifles and ammunition for sporting purposes are provided, as well as books and games to enable the men to pass the monotonous hours of the dreary winter months. The telegraph men have no duties to perform, except to cut in on the wire at certain hours and satisfy themselves that the line is working and messages are passing between Gilgit and Srinagar. Directly there is an interruption, a repair party sets out, with provisions and bedding. In January last there was a fault near the Minimarg office, and a party of nine khalassis (labourers), one lineman, and the telegraph master left the office at 7 a.m., and reached the break, about two miles out, at 1 p.m. While the men were repairing the line the telegraph master heard the noise of a coming avalanche far above them, but he could not see its direction, as the snow was falling heavily. Finding escape impossible, he turned his head away and quietly awaited the result. He remembers, after the avalanche struck him, being carried along at a swift pace downward, sometimes nearly suffocated, when he was at the bottom of the rolling mass, and then thrown to the surface, and then to the bottom again, until the avalanche reached the Burzil stream, a distance of about 300ft., where it stopped. His body was entirely buried, but his right hand and wrist were free, and in hopes of attracting attention should anybody have escaped, he began shaking his hand. He was almost exhausted, his head being 2ft. under hard snow, and every muscle in his body tightly engripped. His senses were leaving him, when he felt someone take hold of his hand, and soon his lineman dug him out. He was badly dazed, and the lineman left him to dig out two khalassis, one of whom was completely buried except the crown of his head, while the other, who was found to be unconscious, had a foot visible. Two men who were thrown to the surface were running about, crying and wringing their hands. Another of the labourers was discovered buried head foremost, with one foot showing, but life was extinct. Four others were buried in the avalanche beyond recovery, and there was absolutely nothing found of the equipment the party had taken out with them. The prompt and plucky action of the lineman, Sarfarez Khan, saved three lives,

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BRUSSELS INTERNATIONAL EXHIBITION.

BY ERNEST KILBURN SCOTT, A.I.E.E.

Although there was unusual delay in getting the exhibition ready, now that it is in full swing it can undoubtedly claim to be a success, which is saying a good deal in a year when our Jubilee festivities have attracted so much attention. The general British section (thanks to the efforts of our executive commissioner) is well arranged, and includes collective exhibits by the Cleveland Ironmasters' Association, Leeds Chamber of Commerce, Machinery Trust Company, and the various railway and steamship companies, the latter having a very large display of mercantile flags. The usual ship models are shown, amongst them being the "Blanco Encalada," built by Sir W. Armstrong, and destroyed in the last Chilian war. The English sailors in attendance seem to be very popular. An interesting boat model is also to be seen at Messrs. Cook and Sons' stall. It was found in a tomb in Upper Egypt, and represents a funeral boat used for carrying the dead across the Nile for burial. It is estimated to be over 4,000 years old. Perhaps the most interesting exhibit in this section, from an engineering point of view, is that of Mr. Robert W. Blackwell, electric tramway expert, of Queen Victoria-street, Westminster. A detailed examination of this exhibit is almost an education in electric traction in itself, everything appertaining to this branch of electrical engineering being shown.

Amongst trolley-wire exhibits is the wire of dumb-bell section, which can be erected without the use of solder, the top part of the wire being mechanically gripped at the pole. It also ensures a uniform path for the trolley wheel, an important point at high speeds when a sudden increase of cross-section may be enough to bounce the wheel off the wire. In this case the pole springs up into a nearly vertical position, and unless the car is stopped in time may strike and damage a span wire.

"Aetna" insulators of the peculiar chocolate colour, spangled with mica particles, get a good show. This hydraulically-moulded composition has evidently come to stay, and, if the pottery makers do not mind, may encroach on the domain of the porcelain insulator, over which it has the advantage, in that its colour does not provide such an inviting target to the small boy, and if hit with a stone does not fly to pieces like pot. The composition gives the appearance of becoming slightly plastic under very hot climatic conditions, but such is not the case; and the writer had the pleasure of recommending their use in the overhead line work for the electric lighting of Coolgardie, West Australia, which at certain seasons is one of the hottest places on earth.

Amongst the rail material is the well-known Chicago rail bond, consisting of a copper rod slightly longer than the fishplate, with thickened ends which are inserted into holes in the webs of the rails and then expanded by driving in conical drift-pins. The Daniels modification, which enables the expanding drift-pin to be driven into position from the outside of the rail, does not require the removal of the pavement on both sides of the rail.

The Edison-Brown plastic alloy bond which Mr. Baylor brought to the notice of tramway engineers in this country in his recent paper before the Institute of Electrical Engineers is also shown. In this bond a plastic metallic composition is inserted between the rails and the fishplate, and is held in place by being surrounded with a cork frame or case, which is squeezed up by the bolts. It is claimed that such a bond on a 9in. rail will carry 1,500 amperes with a fall of but ·03 volt. The plastic compound is packed in small wooden boxes, holding the exact amount required for a joint. One platelayer cleans the contacts, another amalgamates them and slips the bond into place, whilst a third tightens up the bolts. These bonds are at present on their trial, but it has been decided to employ both forms of bonding on the extensions at Dublin. This plastic material is being used in America for making ordinary switchboard and other connections with excellent results.

Several of the latest types of electric tramway trucks, with motors and gear complete, are exhibited, the General Electric Company's and Westinghouse motors being shown side by side. The trucks of the Peckham cantilever machine-made type, which has had a large sale in America, are also shown. Amongst them are the "extra long" type, capable of supporting 35ft. car bodies on an extraordinarily short wheel base, and also the new swivel or bogie trucks, which run two to a car as in large steam trams, and which are now on trial in this country. The space between the axles is such that it is possible to mount two motors without difficulty, and the springs and fastenings are so arranged that with the body packed up, the truck frames can be run out for examination of the motors, etc. Dust-tight self-lubricating journal boxes with coil springs are used throughout, in which either oil or grease may be used. Ten to one lever brakes with positive pull-back coil springs to release the brake shoes are fitted, and also life-guards consisting of a rectangular frame of pipes carrying a netting.

Messrs. Parsons and Co. exhibit a 32-kw. continuous-current dynamo coupled direct to the improved steam-blast turbine, which is complete with jet condenser. The speed for 135 volts is 4,000 revolutions per minute, the air-pumps of the jet condenser being worked by means of a worm-wheel of 32 teeth worked by a single-thread screw on the turbine spindle; consequently, the air-pump takes one stroke in every 32 revolutions of the machine. Oiling is automatic by means of an oil-pump worked from the same worm-wheel as the air-pump, the oil being forced up underneath the bearings, and as it is used over and over again there is very little waste. The total weight of this plant is about 3½ tons. Steam is admitted to the turbine in gusts by means of a double-beat valve worked by a steam relay piston, the duration of the gust being controlled by an electrical governor, which is so quick in its action that the whole load can be suddenly switched off or on with only a momentary variation of the volts. Owing to there being no parts in contact in the turbine proper, and consequently no wear, the steam consumption does not increase after several years' running, as is the case with ordinary reciprocating engines, and also, as no lubrication is necessary, the condensed steam can be passed straight back into the boilers.

One London company has now 11 350 kw. turbo-alternators in two of their stations. The alternators are four-pole, with the armature coils wound in tunnels on the armature core, and the speed is 3,000 revolutions per minute. They work perfectly in parallel with other types of alternators running at much lower speeds, and the steam consumption is 38lb. per kilowatt when non-condensing, but a consumption as low as 14lb. per indicated horse-power has been obtained on a condensing steam turbine of 200 h.p.

Messrs. W. T. Glover and Co., Salford, exhibit their patent diatrine cables and twisted wire armature bars with solid ends burnt or melted on. They also show samples of reostene, a new resistance metal having a specific resistance 44 times higher than that of copper. Tramway cables, similar to those supplied to Leeds, are another feature of this interesting and up-to-date exhibit.

Messrs. Fielding and Platt, of Gloucester, show a 5-h.p. oil-engine, and also a very massive 75-h.p. gas-engine specially designed for driving dynamos direct. The engine takes its explosion every time whatever the load, the governing being effected by a sensitive high-speed ball governor, which controls the gas and air inlets. It might be mentioned, in passing, that 60-h.p. and 120-h.p. two-cylinder gas-engines, driving 8 and 10 ten-pole dynamos direct, are used for part of the public lighting of Brussels.

J. C. and J. Field, Limited, of Lambeth, one of the very oldest firms in London, show Galician ozokerit, which is so extensively used by the Brush Company and several other firms for insulating and waterproofing, especially for transformers.

Some dynamos made by the Society Hydraulic and Electric of Charlerois for the Belgian Government are shown coupled direct to Carel's high-speed enclosed engines, something like the Belliss engine in appearance. The Society Gramme of Paris show the two largest dynamos in the exhibition, and dynamos are also shown by Jaspar, of Liège.

All the multipolar machines have parallel-wound armatures, that is, with as many sets of brushes as

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poles, and the calm way in which these machines are turned out abroad, all with parallel winding, leads one to the belief that the warning Mr. Swinburne delivered in *Industries* some years ago, that such winding would give trouble if the armature was to get out of centre from wear of bearings or other cause, was a mare's nest after all. Two electric locomotives, one suitable for mining work, are shown, besides motors coupled to pumps and fans.

Messrs. Ganz and Co.'s exhibit is too extensive and weighty for it to be in the Hungarian gallery, so it is separated in one corner of the machinery hall. They show several types of inductor alternator and transformers for both single and multi-phase high-tension currents, and a line of three-phase 300-volt motors, ranging from 1 h.p. to 100 h.p., a 3-h.p. machine for working an electric lift being complete with its reversing apparatus, and another motor coupled to a hydro-extractor. There are also several synchronous and asynchronous monophase 100-volt motors of ½ h.p. to 25 h.p. Messrs. Ganz appear to be taking up traction work in a thorough manner, and have on exhibition a four-pole 500-volt series-wound tramway motor; a magnetic blow-out controller, like the Thomson-Houston, but with two or three slight improvements; and a new-type controller, built in the plate or panel form; also lightning arresters, magnetic cut-outs, etc. A Blathy automatic rheostat, a 5,000-volt condenser, and a portable electric milling machine for trimming plate edges are interesting. This firm go in for very heavy engineering work, and a pyramid of railway wheels, a 160-h.p. Gerard horizontal turbine, and a 320-h.p. vertical turbine is imposing. The finish and strength of parts are more like British work than is the case with other Continental manufacturers, and the windings on the electric machines is specially noticeable for neatness.

This exhibition differs from all others in being divided into two distinct parts, which are about six miles apart. The more remote portion is in the very beautiful park of Tervueren, and is approached by what will eventually be one of the finest avenues in the world. The making of this avenue, together with its electric tramway service and arc lighting, has been part of the exhibition scheme, and one in which the King has interested himself very much. It cuts right through a portion of the forest of Soignes, the natural beauties of which are well worth the journey to see. At night, when the 300 odd arc lamps are lighted, the view from Tervueren, and in the forests, is magnificent. One cannot help contrasting the lighting of this avenue (through six miles of absolutely open country) with the lighting of, say, the Thames Embankment. The arc lamps are suspended on very high lattice poles.

The electric tramway service has only been in operation a few months, and it has been put down by a separate company to the one that runs the trams in Brussels proper. The generating station is situated at Auderghene, on the way to Tervueren, and the principal point of difference to the Brussels tramway being the narrower gauge and the adoption of the Dickenson swinging trolley pole, as used on the South Staffordshire line. It is made of a tapered steel tube about 20ft. long. One very significant feature of the Continental tramways is the almost universal adoption of the Thomson-Houston car equipment—*i.e.*, magnetic blow-out controllers and G. E. 800 motors. The Elektricitäts Gesellschaft of Berlin, who represent the Thomson-Houston Company on the Continent, will no doubt soon manufacture these details, as they are now doing the dynamos; but for the present they appear to be content to import from America.

The arc lighting at Tervueren has been carried out by M. Fabius Henrion, of Nancy, and consists of 150 10-ampere arc lamps arranged five in series on a 240-volt circuit; the carbons are 11mm. solid and 16mm. soft core. All the wire is overhead, a good deal of bar iron being used. The lamps are lowered for retrimming.

A somewhat novel form of switchback has been fitted up by M. Henrion, and which, like all such harmless contrivances, appears to be coining money. The rails are arranged round and round in the form of a spiral, finishing up with a run through an underground tunnel. In order to save passengers the trouble of ascending a number of steps to get into the cars, they simply walk in on the ground level, and are raised up a 30deg. incline to about 25ft. high by an endless chain driven by a 10-h.p. electric motor.

The Behr monorail or lightning express railway at Tervueren constitutes one of the most distinct novelties of the exhibition on account of the high speed at which the carriage will travel, and also because the propelling agency is electricity. The track is constructed on the Lartigue system, with which Mr. Behr, the designer, has had considerable experience at Killarney and elsewhere. It is extra strongly built to withstand the extreme stresses, and is about three miles long, consisting of two straight sections joined at the ends by curves of 1,600ft. radius.

The carriage, made by the Gloucester Carriage and Wagon Company, Limited, is 59ft. long, and specially constructed with an air brake, so the resistance of the air in front of the carriage is utilised for reducing speed when required. The lower part of the carriage consists of two bogies connected together by a flexible joint, and they carry the main and guide wheels and the electric motors. The upper part of the body has seats for 100 persons, and two compartments for the driver and conductor at either end. Each bogie carries 16 horizontal guide wheels, or 32 altogether, their object being to maintain equilibrium and transmit to the guide rails the pressure produced by centrifugal force in rounding curves.

The line itself is very solidly constructed of steel, so as to easily resist any pressure which may be produced, and it is chiefly the construction of the line in its relation to the guide wheels and the carriage generally which enables the train to travel at very high rates of speed without danger of derailment, or the accidents liable to happen under similar circumstances on ordinary double-rail track.

The carriage weighs 50 tons, or half a ton of dead-weight per passenger, and the centrifugal force exerted at the curve at 100 miles an hour is about 18 tons. In order to reduce the starting effort as much as possible, roller bearings are used, the axle boxes being supplied by the Roller Bearings Company, Limited, of Westminster.

The electricity is supplied to the motors from an electrical generating station furnishing about 1,000 h.p., erected in the machinery hall at Tervueren. This electric station consists of six four-pole dynamos by Dulait and Co., of Charleroi, each giving 750 volts and 130 amperes. In this matter of power, Mr. Behr has been somewhat unfortunate in his relations with the exhibition authorities, as it appears he was to have been provided with current at a very much earlier date than he actually did get it. Fortunately, he was able to get current for the recent visit of the Lord Mayor, but since then there have been several stoppages of the generating plant.

The motive power on the train is supplied by four series-wound motors of the four-pole type, having toothed armatures wound with Eickemeyer coils. Each motor is capable of working up to 150 b.h.p. when supplied with current at an E.M.F. of 700 volts, and running at a speed of 600 revolutions per minute. It transmits energy to the wheels by means of two "Renold" patent steel chains from pinions geared on each end of armature shaft. The chain wheels are of hematite iron, and are flanged, and have 32 machine-cut teeth. The pitch is 1¼in., and the outside diameter 12¾in., which gives a chain speed of 2,000ft. per minute. The chain is of laminated or silent type, which was recently introduced by Mr. Renold, and which gives an even load distribution over all the teeth in the circumference clasped by the chain. Each chain is 4in. wide, there being one to each of the four motors and axles. The gear is level—that is, both the motor and the axle run at 600 revolutions, but the chain is necessary in order to get the motor low down and to allow for the movement on the springs of the carriage. The motors are controlled by a set of switch-gear fixed in the driver's box. At starting, the four motors are connected in two parallel groups, with a resistance in series with them. This resistance is gradually cut out, and the connections are then changed, so that all four motors are connected in parallel with the resistance in series. This latter is then cut out, so that the four motors in parallel then become connected directly across the full E.M.F. To attain a still higher speed, the series field winding of the motors is shunted through the

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resistances. A double-pole automatic magnetic cut-out is fixed above the controlling switch, and circuit is made and broken entirely by this either automatically in event of too much current being demanded for any reason, or by the man in charge when he wishes to stop the train. A reversing arrangement is provided, so that the train can be run in the reverse direction at a slow speed should it be necessary.

The electrical conductor placed along the line consists of a steel rail of channel section, 4½in. by 2in., supported on china insulators attached to the steel sleepers. Rotating wheels running along this rail pick up the current as the train moves, the return circuit being made through the wheels and ordinary rails.

The Government invited Mr. Behr to construct the experimental line at Tervueren with a view, if it was successful, of adopting such a system from Antwerp to Brussels. The designer estimates that the cost of constructing such a line, including rolling-stock, electrical generating station, and everything complete (exclusive of land), would be about £9,000 per mile; and the tests have shown that the working expenses would be much less than with ordinary double-rail track wherever a large and regular passenger service is assured. This is distinctly the case with Antwerp and Brussels, which are almost analogous to Glasgow and Edinburgh; and if reasonable fares could be charged, there is not the slightest doubt that Brussels would benefit largely by such a line.

Owing to the temporary character of the line at Tervueren, and the two curves in so short a length, the trials are being carried out under more difficult circumstances than would be met with on such a trunk line as is proposed. The difficulty of finding suitable ground has been so great that it became necessary to construct an embankment 18ft. high, besides a deep cutting, in order to obtain possible working gradients. The starting point had to be placed in the middle of the curve instead of on the straight, and the curves are very much sharper than would be employed in actual practice. The transition curves between the principal curves and the straight line could not be made of the length required, for the simple reason that if they had been, the four transition curves alone would have absorbed the whole length of the line. From the above it will be seen that the conditions are extreme ones, and if Mr. Behr can get his train to run at 70 to 80 miles an hour on such a line, there is not the least doubt that he could safely travel at a 50 per cent. greater speed on a properly constructed line.

The first time the train was run round it attained a speed of over 70 miles an hour, and the side strain due to centrifugal force was sufficient to alter the angle of the rails on the embankment from 4deg. to 11½deg. This was a good deal due to the loose, sandy soil of the embankment, but it shows how valuable the experiments which are now being conducted at Tervueren are to those interested, and which will form the basis of the future high-speed lines which we are bound to have before many more years are past.

It is a satisfaction to know that Mr. Behr is quite convinced that electricity will have to be the power employed. He is undoubtedly on the right track for attaining high rates of travel, which, in the entire absence of points, should be quite as safe as 60 miles with steam locomotives and an ordinary 4ft. 8½in. track. From a British point of view, a very satisfactory feature in connection with the line is the fact that the motors, controllers, switchboard, etc., were designed and supplied by Messrs. Thomas Parker, Limited, of Wolverhampton. In choosing this firm as the contractors for what may be called the brainy part of the work, the promoters were no doubt largely influenced by the plucky way in which Mr. Parker and his young men (as he affectionately calls the prominent members of his staff) met and successfully carried out the electrical equipment of the Liverpool Overhead Railway. Before leaving Wolverhampton the motors were exhaustively tested at the speeds and, as far as possible, under the same conditions as they will be under when travelling at 120 miles an hour, and were passed as thoroughly satisfactory. When the car is going at 100 miles an hour, the speed of the motor is 600 revolutions per minute.

THE BALLISTIC GALVANOMETER IN THEORY AND PRACTICE.

BY ELLIS H. CRAPPER, A.I.E.E.

(*Continued from page 235.*)

§ 4. *Logarithmic Decrement.*—The fundamental formula (5) giving Q, the quantity of electricity discharged through the coils of a ballistic galvanometer in terms of α, is, in practice, found not to be true whenever energy is lost in consequence of air friction and the retardation due to currents induced by the oscillating needle. In deducing the formula, the effects of damping, even if slight, were entirely omitted; but it is clear that the throw, α, in the formula, is greater than the arc through which the needle would be actually deflected in cases where the damping is an appreciable quantity. It is in consequence of damping that the consecutive throws are considerably diminished, rendering it necessary to introduce a *damping constant* in our working formula. In determining the value of this constant we shall refer only to general cases, in which the damping does not lead to complications, but which is such that allowance may be made for the quantity of electricity thus lost, by making the necessary correction to the throw observed to give the theoretical throw. We shall now determine this constant, and prove that if

δ = actual throw when damping is present, and

δ_0 = true throw which would be observed if no damping existed; then

$$\sin\frac{\delta_0}{2}=\left(1+\frac{\lambda}{2}\right)\sin\frac{\delta}{2}.$$

In other words, the observed value, $\sin\frac{\delta}{2}$, is multiplied by the damping constant $\left(1+\frac{\lambda}{2}\right)$ to give the true value, $\sin\frac{\delta_0}{2}$, and our fundamental formula becomes

$$\left.\begin{aligned} Q&=\frac{H}{G}\times\frac{T}{\pi}\times\sin\frac{\alpha}{2}\left(1+\frac{\lambda}{2}\right)\\ \text{or,}\quad Q&=\frac{H}{G}\times\frac{T}{2}\times\frac{\alpha}{\pi}\left(1+\frac{\lambda}{2}\right)\end{aligned}\right\}\quad\ldots\quad(6)$$

Now, since the needle of a ballistic galvanometer is a body which oscillates under the influence of a force proportional to its angular displacement, and at the same time is influenced by damping which is proportional to its velocity, the amplitudes of the oscillations of the needle gradually diminish, and it may be shown that the successive amplitudes will always be diminished in the same proportion. In fact, they diminish in geometrical progression, so that the ratio between the amplitudes of any two consecutive oscillations is constant. Therefore, if $\delta_1, \delta_2 \ldots \delta_n$, etc., represent consecutive amplitudes,

$$\frac{\delta_1}{\delta_2}=\frac{\delta_2}{\delta_3}=\frac{\delta_3}{\delta_4}=\quad\ldots\quad=\frac{\delta_n}{\delta_{n+1}}=\rho$$

where ρ = the *ratio of damping.*

$$\therefore\ \log_\epsilon\delta_1-\log_\epsilon\delta_2=\log_\epsilon\delta_2-\log_\epsilon\delta_3=\quad\ldots\quad=\log_\epsilon\rho.$$

To ρ, "*the ratio of the amplitude of one oscillation to the amplitude of the succeeding one,*" the name of *decrement* has been given; and *the constant difference between the logarithms* (to the base *e*) *of the amplitudes of successive oscillations—i.e.*, $\log_\epsilon\rho$—is called *the logarithmic decrement*, and is usually denoted by the Greek letter, λ.

$$\therefore\ \log_\epsilon\delta_n-\log_\epsilon\delta_{n+1}=\log_\epsilon\rho=\lambda,$$

and

$$\lambda=\log_\epsilon\frac{\delta_n}{\delta_{n+1}}\quad\ldots\quad(7)$$

When the damping is small the magnitudes of the consecutive amplitudes differ very little from each other, and the following relationship enables more accurate values of λ to be obtained than by taking the logarithm of the ratio of two consecutives amplitudes.

Since $\delta_1=\rho\,\delta_2,\ \delta_2=\rho\,\delta_3,\ \delta_3=\rho\,\delta_4$, etc.,

$$\therefore\ \delta_1=\rho\,(\rho\,\delta_3)=\rho^2\,\delta_3,$$

and generally $\delta_1=\rho^{n-1}\,\delta_n$,

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$$\therefore \log_\epsilon \frac{\delta_1}{\delta_n} = \log_\epsilon \rho^{n-1} = (n-1)\log_\epsilon \rho$$
$$= (n-1)\lambda;$$
$$\therefore \lambda = \frac{1}{n-1}(\log_\epsilon \delta_1 - \log_\epsilon \delta_n)$$
$$= \frac{1}{n} \times \log_\epsilon \frac{\text{amplitude of any oscillation}}{\text{,, the } n\text{th ,, after it}} \quad (8)$$

And in extreme cases where errors of reading result from the oscillations being so rapid, a very convenient method is suggested by the following:

$$\frac{\delta_1}{\delta_n} = \frac{\delta_3}{\delta_{n+2}} = \frac{\delta_5}{\delta_{n+4}} = \text{etc.} = \rho^{n-1};$$
$$\therefore \frac{\delta_1}{\delta_n} = \frac{\delta_1+\delta_3+\delta_5+\ldots}{\delta_n+\delta_{n+2}+\delta_{n+4}+\ldots} = \rho^{n-1};$$
$$\therefore (n-1)\lambda$$
$$= \log_\epsilon (\delta_1+\delta_3+\delta_5+\ldots) - \log_\epsilon (\delta_n+\delta_{n+2}+\delta_{n+4}+\ldots)$$
$$\text{and } \lambda = \frac{1}{n-1}\{\log_\epsilon (\delta_1+\delta_3+\ldots) - \log_\epsilon (\delta_n+\delta_{n+2}+\ldots)\} \quad (9)$$

Note on the Systems of Logarithms in Use.—Many students, no doubt, are conversant with the method of using the common system of logarithms—*i.e.*, logarithms to the base 10—and will very readily follow the method adopted in exercises in which logarithms to the base e ($e = 2\cdot71828$), or Napierian logarithms, are used. It is with the intention of drawing attention to the importance of being able to use both systems of logarithms that this note is added, since logarithms to the base e frequently occur in theoretical investigations.

Let N be any number whose logarithm to base e is required.

Let $e^x = N$; then $\log_e N = x$.

And by taking logarithms to base 10 in the usual way,

$$\log (e^x) = \log N;$$
$$\text{and } x \log e = \log N;$$
$$\therefore x = \frac{1}{\log e} \times \log N;$$
$$\text{and } \log_\epsilon N = \frac{1}{\log e} \times \log N$$
$$= \frac{1}{\log 2\cdot71828} \times \log N = \frac{1}{0\cdot434} \times \log N$$
$$= 2\cdot3026 \times \log N \quad (10)$$

That is, the logarithm of a number to base e is found by multiplying the common logarithm of the number (as taken from tables of logarithms) by 2·3026, the modulus of the Napierian system of logarithms. Thus, let $\lambda_1 = \log \rho$, then $\lambda = \log_\epsilon \rho = \log \rho \times 2\cdot3026 = \lambda_1 \times 2\cdot3026$.

Advantage is taken of this in finding λ as shown below:

Example I.—Determine the logarithmic decrement, λ, of a galvanometer with which the following readings were taken:

Elongations.				Amplitudes.		
(α) To the right.		(β) To the left.		$\alpha+\beta$.		$\beta+\alpha_1$.
330	.....	318	.....	$648 = \delta_1$	.....	$638 = \delta_2$
320	.....	308	.....	$628 = \delta_3$	.....	$618 = \delta_4$
310	.....	290	.....	$600 = \delta_5$	.....	$594 = \delta_6$
304	.....	280	.....	$584 = \delta_7$	.....	$572 = \delta_8$
292	.....	270	.....	$562 = \delta_9$	.....	$553 - \delta_{10}$
283	.....	260	.....	$543 = \delta_{11}$	.....	$526 = \delta_{12}$
266	.....	255	.....	$521 - \delta_{13}$	.....	$515 = \delta_{14}$
260	.....	249	.....	$509 = \delta_{15}$	.....	$500 = \delta_{16}$
251	.....	241	.....	$492 = \delta_{17}$	.....	$483 = \delta_{18}$
242	.....	232	.....	$474 = \delta_{19}$	.....	—

(a) Using formula (7)

$$\rho = \frac{\delta_1}{\delta_2} = \frac{\delta_2}{\delta_3} = \text{etc.}, = \frac{\delta_{16}}{\delta_{17}} = \frac{\delta_{17}}{\delta_{18}}$$
$$= 1\cdot016 \text{ (approx.)},$$
$$\text{and } \lambda_1 = \log 1\cdot016 = 0\cdot00706;$$
$$\therefore \lambda = \lambda_1 \times 2\cdot3026 = 0\cdot00706 \times 2\cdot3026$$
$$= 0\cdot016356.$$

(b) Using formula (8) $\lambda = \frac{1}{n-1}(\log_\epsilon \delta_1 - \log_\epsilon \delta_n)$;

$$\therefore \lambda_1 = \frac{1}{16-1}(\log \delta_1 - \log \delta_{16}) = \frac{1}{15}(\log 648 - \log 500)$$
$$= \frac{2\cdot8116 - 2\cdot6990}{15} = 0\cdot0075;$$
$$\therefore \lambda = \lambda_1 \times 2\cdot3026 = 0\cdot0075 \times 2\cdot3026$$
$$= 0\cdot0173$$

(c) Using formula (9)

$$\lambda = \frac{1}{n-1}\{\log_\epsilon (\delta_1 + \delta_3 + \ldots) - \log_\epsilon (\delta_n + \delta_{n+2} + \ldots)\};$$
$$\therefore \lambda_1 = \frac{1}{11-1}\{\log (648+628+600+584+562) - \log (543+521+509+492+474)\}$$
$$= \frac{1}{10}\{\log 3022 - \log 2539\}$$
$$= \frac{1}{10}\{3\cdot4803 - 3\cdot4047\} = 0\cdot00756;$$
$$\therefore \lambda = \lambda_1 \times 2\cdot3026 = 0\cdot00756 \times 2\cdot3026$$
$$= 0\cdot0174.$$

These results differ, showing that care must be taken in the determination of λ, especially if the oscillations be very rapid. The first method is satisfactory only when it is easy to determine the extent of each swing. Theoretically it may be shown that the errors of observation have the least influence when $\frac{\delta_1}{\delta_n} = e = 2\cdot718$ or 3 (approximately).

§ 5. *The Value of the Damping Constant.*

Let α = the true first throw of needle of ballistic galvanometer;

α_1 = the actual first throw of needle of ballistic galvanometer.

Then, from what we have said above, α_1 is smaller than α by an amount due to damping during *half* a vibration;

$$\therefore \tfrac{1}{2}\lambda = \log_e \alpha - \log_e \alpha_1,$$
$$\text{and } \log_e \alpha = \tfrac{1}{2}\lambda + \log_e \alpha_1;$$

and since, by the theory of logarithms, $e^x = N$, when $\log_e N = x$, we may write

$$\alpha = e^{\log_e \alpha} = e^{\frac{1}{2}\lambda + \log_e \alpha_1} = e^{\frac{1}{2}\lambda} \times e^{\log_e \alpha_1}$$
$$= e^{\frac{1}{2}\lambda} \times \alpha_1.$$

But λ is small, therefore the second and higher powers of λ, in the expansion of $e^{\frac{1}{2}\lambda}$ as a logarithmic series, may be neglected

$$\text{Now } e^{\frac{1}{2}\lambda} = 1 + \frac{\frac{1}{2}\lambda}{\lfloor 1} + \frac{(\frac{1}{2}\lambda)^2}{\lfloor 2} + \ldots$$
$$\therefore e^{\frac{1}{2}\lambda} = (1 + \tfrac{1}{2}\lambda);$$
$$\text{and } \alpha = (1 + \tfrac{1}{2}\lambda)\alpha_1 \quad (11)$$

From which it is obvious that $(1 + \frac{1}{2}\lambda)$ is the value of the damping constant when the oscillations of a needle of a ballistic galvanometer are retarded by damping.

Example II.—Determine the value of the damping constant for a ballistic galvanometer whose needle, having been set vibrating, the first elongation observed was 104 scale divisions, and the twenty-fourth elongation was 45·5 scale divisions, given that

$$\frac{1}{23}\log_e \frac{104}{45\cdot5} = \log_e 1\cdot0366.$$

Solution.—Since $\lambda = \log_e \rho$ $\therefore \rho = e^\lambda$

$$= 1 + \frac{\lambda}{\lfloor 1} + \frac{\lambda^2}{\lfloor 2} + \ldots$$
$$= 1 + \lambda \text{ (approximately)}$$
$$\therefore \rho = 1\cdot0366 = 1 + \lambda;$$

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and $$\frac{\lambda}{2} = \frac{1{\cdot}0366 - 1}{2} = 0{\cdot}0183;$$

$$\therefore 1 + \frac{\lambda}{2} = 1{\cdot}0183.$$

Exercises to be Worked.—(1) If $\frac{\delta_1}{\delta_2} = \rho$, prove that $\lambda = \frac{1}{3}\log_e \frac{\delta_n}{\delta_{n+3}}$, and that $\lambda = \frac{1}{m-n}(\log_e \delta_m - \log_e \delta_n)$.

(2) With $\lambda = 0{\cdot}0173$ in Example I., calculate the ratio of the amplitudes of the first and eighteenth oscillations.

In our next we shall consider the practical work with the galvanometer.

(To be continued.)

THE MECHANICAL CONSTRUCTION OF ELECTRICAL MACHINERY.

BY F. M. WEYMOUTH.

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The Dynamo.

(Continued from page 232.)

Bearings (continued).—Another form of self-oiling bearing, similar in principle, though different in detail and general arrangement, to that which was shown Figs. 267 and 268, is presented herewith in Figs. 269 and 270. This is a design patented by Mr. Sydney Straker (patent No. 15,404, 1894), and is illustrated in some variety; and our drawings are reproduced from some of those shown in the specification. The method of throwing up the oil by means of a collar, *a a*, of large diameter on the shaft will be observed here as in the last case, such collar being forged on the shaft. Oil thrown up is caught in a trough, *c c*, from whence it drains away through a small hole, *e*, into the oil-box, *b b*. In the latter we find a feature not present in any bearing that we have hitherto considered. This is an oil filter indicated at *d d*, whereby any grit on foreign matter that may have become suspended in the oil is removed therefrom before the oil passes on to the journal through the holes, *n n*.

It will be observed that in Fig. 269, beside the chamber, *f*, containing the trough, *c*, there are two other chambers lettered *g* and *h*; and the central chamber, *g*, contains a

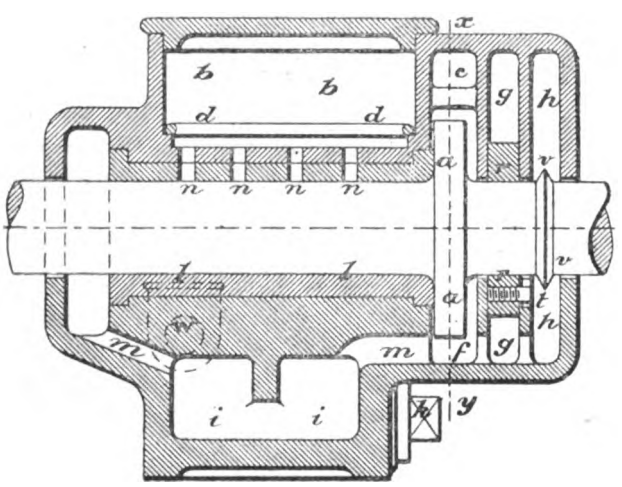
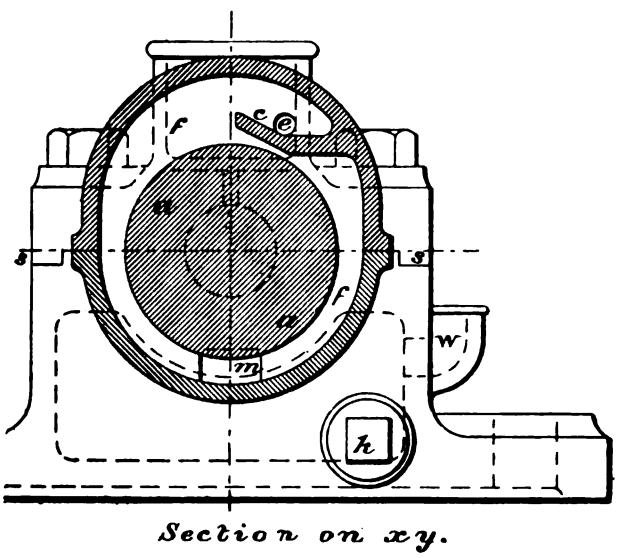


Fig. 269.

circular brass block or collar, *r r*, which is bored to a working fit on the shaft, but is prevented from rotating therewith by a pin, *t*. This latter, as shown, is free to move vertically in a slot in the partition between *g* and *h*. As the lower brass, *l l*, of the bearing wears down, this loose collar is thus not withheld by the pin from sinking with, or from remaining concentric with, the shaft: though, as we have previously intimated, this particular feature has not much point in a dynamo or motor wherewith new bottom brasses must be at once inserted if the shaft shows signs of sinking. The object of the collar, *r r*, however, is to prevent excessive flowing of oil from the chamber, *f*, along the shaft. For it is evident that, of the oil thrown up by the collar, *a a*, a large portion, splashing sideways, will creep down the side of the partition between *f* and *g* above the shaft, and so would escape freely if not retarded. Any residue of oil that may pass *r r* will be flung off the thrower, *v v*, in the usual manner, and be caught in the hood or chamber *h*. It will seen that all oil exuding from either end of the bearing returns to the well, *i i*, through passages, *m m*, one of which latter extends also to the chambers, *g* and *h*, as shown; and it may be entirely



Section on *xy*.

Fig. 270.

drawn off when required by the plug hole, *k*. For watching the level of the oil within the well a cup, *w*, is cast on the outside communicating with the interior. This cup, which may be fitted with a lid or cover, also serves for the admission of fresh oil. We thus find in this instance a combination of the gauge with means for replenishing the oil; whereas, in former cases, we have found the gauge combined with means for withdrawing the oil.

In general design it may be seen that the sideways registering of the cap on the base is effected in the same manner as that shown in the case of the "Agir" motor

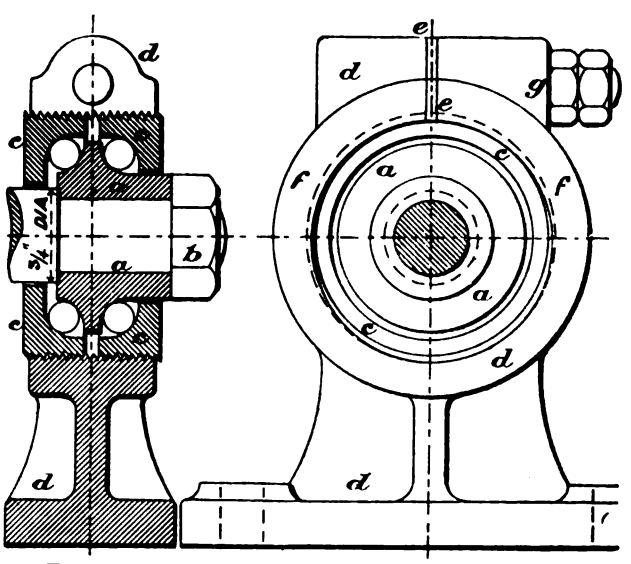


Fig. 271. Fig. 272.

(Fig. 243); and while the greater part of the joint is in the horizontal plain through the axis of the shaft, a step down, *s s*, at the sides projects below this level. Other arrangements, also included within the patent, indicate means by which the extra collar, *r r*, may be dispensed with, and all end play of the shaft prevented.

Before leaving the subject of self-oiling bearings, some remarks may be added on the manufacture of oiling rings, such as are used in most bearings of this general type. Though steel has been tried, yet brass or gunmetal appear to be more common as regards material. Thus Messrs.

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Ernest Scott and Mountain inform the writer that they use gunmetal for this purpose. Messrs. The India Rubber, Gutta Percha, and Telegraph Works Company cut the rings from brass tube, and finish them off all over in the lathe. At the Newton Electrical Works a brass bush is cast which is turned and bored in a face-plate lathe to the proper internal and external diameters, and parted with a V-shaped tool to form the right width of ring, and thus several rings are made from the one bush. Mr. Wilson Hartnell also shows rings of brass or gunmetal.

We now approach another totally different type of bearing, though one which has been used successfully in electrical machinery. This is the ball bearing. Some examples of this kind of bearing designed for use in dynamos and motors are represented herewith in Figs. 271 to 273; and we may thank Messrs. The Auto-Machinery Company, Limited, Coventry, for the drawings from which our illustrations are made. Figs. 271 and 272 show a design on a reduced scale for a ¾in. diameter spindle. It will be observed that the end of the shaft is shouldered down, and a steel bush or die, *a a*, on the small diameter is kept there by a nut, *b*, as shown. The main casting, *d d*, is bored and screwed on the inside so as to receive two correspondingly screwed dies, *c c*, which can be screwed home to the proper working fit on the ball. A split or saw cut, *e e*, at the top of the bearing will permit the two sides or jaws, *f f*, to be drawn together by means of a stud, *g*, so as to tightly grip the dies, *c c*, when once set; and this stud carries a lock-nut as an additional safeguard against loosening under vibration. The saw cut may be subsequently filled, as shown, so as to prevent the ingress of foreign matter from above. Fig. 272 is an end view, with the nut, *b*, and one die, *c c*, and the balls removed.

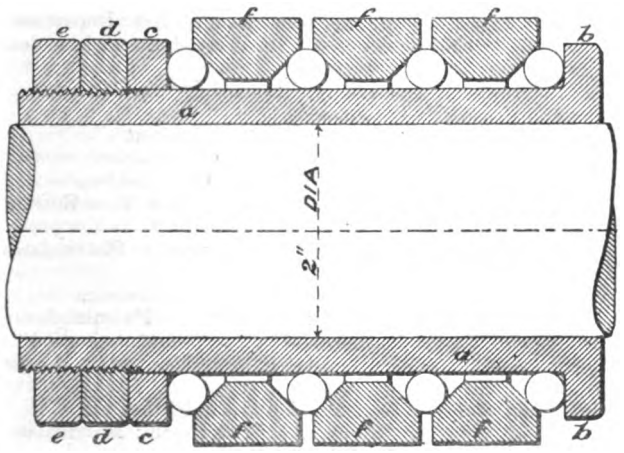

FIG. 273.

Fig. 273 shows a design, also to a reduced scale, of a ball bearing for a 2in. shaft. In the foregoing bearing there were two annular rows of balls. Here there are four such rows. Essentially, however, it will be seen that this arrangement consists of a sleeve, *a a*, which is fitted on the shaft, with a collar or flange, *b b*, at one end, and a loose collar, *c c*, and circular nut and lock-nut, *d d* and *e e* respectively, at the other end. These latter are worked by tommy holes not indicated. Between these parts there are three hard-steel coned rings, *f f*, and the balls as depicted. These latter are here ⅜in. in diameter. The main bearing will thus receive the rings, *f f*. To adjust the tightness of the balls it is, of course, only necessary to slack back or tighten the nuts *d d* and *e e*.

One particular difference between this design and the last is that in this case the balls run on surfaces which in one sense are flat, whereas in the last they were curved. In other words, in one case the section through the ball race is bounded by straight lines; but in the other by curved lines. It is to be noted, however, that a ball could not be kept in place between two straight lines or surfaces, as these would not retard it from slipping sideways. To securely lock in the ball, therefore, if there are only two surfaces, these must each be curved inwards: while if there are three or more, these may in one sense be straight, as shown in Fig. 273. Though we say three or more, it is at the same time obvious that the best equilibrium of pressure round the ball is attained by enclosing it within only three surfaces, as in the illustration. Surfaces in one sense straight are also more easily machined and worked up.

A further point that may be noted as regards Fig. 271 is that this bearing also prevents end play of the shaft. On the other hand, it would also appear to be possible, by screwing both of the dies, *c c*, in the same direction, either backwards or forwards, to effect some slight adjustment of the shaft itself longitudinally. End play in the bearing shown Fig. 273 will depend on whether or not the shaft is allowed to slide in the sleeve, *a a*, or is firmly keyed therein.

As is well known by experience, balls tend to wear a grooved path for themselves in the surfaces they run on; and if these surfaces are of metal not sufficiently hard, they may by their action not only wear a groove, but also mill the metal up into a fringe or ragged edge along the sides of such groove. To reduce wear of the balls themselves it is important, of course, to keep them free from dust and grit; though in a properly sheltered house or shop, such as usually machinery is placed within, there may not be much dust about likely to enter and damage a bearing. Any or all these sources of wear, however, will render a readjustment of the tightness of the ball races necessary, as otherwise the shaft would become loose and be able, with the balls, to rattle and chatter in the bearings.

It may be advantageous, perhaps, at this juncture to consider what may be the reason that ball bearings run with such freedom in spite of the fact that there is nothing to prevent the balls from touching one another. An explanation may also the more seem needed when it is further reflected that, as indicated by small curved arrows at *c c*, Fig. 274, the surfaces of two balls at their point of contact must necessarily be passing each other in opposite directions, and thus cause seemingly a still greater amount of friction between. This question will thus be better considered by means of

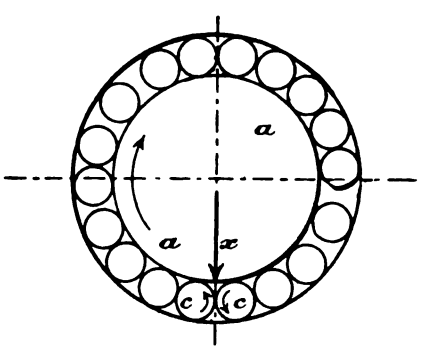

FIG. 274.

the diagram shown Fig. 274. Let the central portion here, *a a*, be the end view of a shaft having a load directed downwards as indicated by the arrow, *x*: such load may therefore be considered as coming on the two balls in particular, *c c*. It may now be assumed that as the shaft rotates, say, in the direction of the curved arrow, these balls, tightly held under the load, will grind one against the other with much friction. Gradually, however, as the shaft revolves, these two balls will arrive at the top, where there is no load, and they are consequently only held with comparative lightness between the sides of the ball race. They will therefore spring apart, so as only lightly to rub one against the other: for it is plain they cannot bear hard together without means so to hold them. It has thus now to be noted that as the two balls again approach the lowermost position, travelling down the other side, there is no reason or cause why the hindmost ball should overtake the foremost ball any amount whatever sufficient to make it again grind heavily against it: and this argument holds good for the whole passage of the balls under the load once more. The validity of this particular argument of course depends on the balls being accurately of the same diameter. But, on the other hand, if the possibility be assumed that either of the balls is to the least extent larger than the other, then the larger ball will obviously take the weight off the smaller; and thus the latter will not be tightly held,

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and consequently it will not grind heavily on the large ball. Thus, on either assumption, it will be seen that there is no cause or reason why adjacent balls should rub heavily on each other. The same argument will apply to a row of more than two balls, as may be perceived on consideration. It is thus that the free running of ball bearings may be explained.

Counter to the above, however, it is to be noted that if the balls are held tightly all round the circle, as would be the case were the adjusting nuts or screws screwed up too tight, then two or more balls might be held so as to bear hard against one another all round the circle with a pressure corresponding to that effected by the bad adjustment, and there would be no opportunity for the balls to slack apart. Under such circumstances, therefore, the bearing would not, as in practice it does not, run free; and even if some balls were larger than others, two large balls might have some of the smaller balls bearing tight together between them similarly without chance of release. It is thus important for the sake of free running that the adjustment should not be made too tight, so that though the balls made be loaded on one side of the bearing they are yet comparatively free on the other side, with only a working fit such as would permit sideways slip, but not any loose rattling or shaking.

(To be continued.)

INSTITUTION OF CIVIL ENGINEERS.

SYLLABUS OF EXAMINATIONS APPOINTED AND HELD BY THE COUNCIL UNDER THE PROVISIONS OF SECTIONS III. AND IV. OF THE BY-LAWS.

ADMISSION OF STUDENTS.

1. ENGLISH (one paper; *time allowed, three hours*). A general paper comprising questions in geography, history, and literature.

2. MATHEMATICS (two papers; *time allowed, three hours for each*). Comprising algebra as far as and including quadratic equations and the binomial theorem, mensuration of areas and volumes, centres of gravity and radii of gyration, the theory and use of logarithms, plane trigonometry, including the solution of triangles and the calculation of areas, the problems and theorems included in the first four books of Euclid, the elements of projective geometry and perspective and the delineation of plane curves from their equations.

3. Two of the following subjects, not more than one of which shall be a language (*time allowed, three hours for each paper*):

(*a*) LATIN;	Translation,	prose composition	and grammar.
(*b*) GREEK;	Do.	Do.	Do.
(*c*) FRENCH;	Do.	Do.	Do.
(*d*) GERMAN;	Do.	Do.	Do.
(*e*) ITALIAN;	Do.	Do.	Do.
(*f*) SPANISH;	Do.	Do.	Do.

Note.—The Latin and Greek translation will be from books previously prescribed by the examiners.

(*g*) ELEMENTARY PHYSICS, including elementary mechanics, the laws of motion, heat, light, electricity, and magnetism.

(*h*) ELEMENTARY CHEMISTRY, including the principal properties of matter, the laws of chemical affinity, atomic weights, valency, and the chemistry of the principal inorganic elements.

(*i*) GEOMETRICAL AND FREEHAND DRAWING, including projective and descriptive geometry and perspective.

If a candidate has passed elsewhere examinations recognised by the council as equivalent in the requisite subjects in Clause 3, he may take only the examination in English or in mathematics, or in both those subjects, and may there by complete this part of his qualification for admission as a student.

The following are recognised by the council as qualifying, wholly or partially, in lieu of the above-mentioned examination.

Qualifying Examinations.

University of Oxford: Moderations (Mathematics being taken).
University of Cambridge: Previous Examination.
University of London: Matriculation Examination.
Victoria University: Preliminary Examination.
University of St. Andrews: Preliminary Examination in Arts or Science.
University of Glasgow: Preliminary Examination in Arts or Science.
University of Aberdeen: Preliminary Examination in Arts or Science.
University of Edinburgh: Preliminary Examination in Arts or Science.
University of Dublin: General Examination at end of Senior Freshman year; Public Entrance Examination.
Royal University of Ireland: Matriculation Examination.
King's College, London: Special Matriculation Examination (Engineering Department).
University College, London: Matriculation Examination (Engineering Department).
City and Guilds of London Technical Institute: Matriculation Examination (Engineering Department).
Royal Indian Engineering College, Coopers Hill: Examination at the end of the second year.
Queen's College, Belfast: Matriculation Examination.
Queen's College, Cork: Matriculation Examination.
Queen's College, Galway: Matriculation Examination.
Glasgow and West of Scotland Technical College: Preliminary Examination for the Diploma.
Mason College, Birmingham: Preliminary Examination (Engineering Department).
St. David's College, Lampeter: Responsions, Special (D, mathematical).
University College, Bristol: Preliminary Examination (Engineering Department).

Examinations Recognised, so far as they embrace the Qualifying Subjects for the Examination held by the Council.

University of Durham: Examination for Associateship in Physical Science at the end of the first year.
The Examinations of the Science and Art Department. (Third Stage in Mathematics, and Advanced Stage in Science subjects.)
Examinations for the Higher Grade Leaving Certificates of the Scotch Education Department.
University of Calcutta: Entrance Examination.
University of Madras: Matriculation Examination.
University of Bombay: Matriculation Examination.
University of McGill College, Montreal: First Year Entrance Examination.
University of Bishop's College, Montreal: Matriculation Examination.
University of Toronto: Matriculation Examination.
Victoria University, Toronto: Matriculation Examination.
Trinity University, Toronto: Matriculation Examination.
Queen's College and University, Kingston, Canada: Matriculation Examination.
University of Manitoba: Previous Examination.
University of New Brunswick, Fredericton: Matriculation Examination.
University of King's College, Windsor, Nova Scotia: Matriculation Examination.
University of Halifax, Nova Scotia: Matriculation Examination.
Dalhousie College and University, Halifax, Nova Scotia: Matriculation and Sessional Examinations.
University of Melbourne: Matriculation Examination.
University of Sydney: Matriculation Examination.
University of Adelaide: Matriculation Examination.
University of Tasmania: Senior Public Examination.
University of the Cape of Good Hope: Matriculation Examination.
University of New Zealand: Matriculation Examination.

ELECTION.—ASSOCIATE MEMBERS.

Part I.—General Knowledge.

Candidates will be required to prove their knowledge of the English language and their attainments in general knowledge by writing an essay of about 1,000 words upon a set subject. Each candidate will be allowed to select one out of several subjects of general knowledge, including English history and literature, prescribed by the examiners (*time allowed, three hours*). Persons who are, or who have been, students of the institution, or who produce such qualifications as would, under the existing regulations, exempt from the examination applying to admission of students, will not be required to pass Part I. of this examination as a condition of being presented for ballot as associate members.

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Part II.—Scientific Knowledge.

1. THEORETICAL AND ELEMENTARY APPLIED MECHANICS (two papers; *time allowed, three hours for each*).

2. THEORY OF STRUCTURES AND THE STRENGTH AND ELASTICITY OF MATERIALS (two papers; *time allowed, three hours for each*).

3. One of the following optional subjects (one paper in each subject; *time allowed, three hours*):

(i.) GEODESY.
(ii.) HYDRAULICS.
(iii.) THEORY OF HEAT ENGINES.
(iv.) METALLURGY.
(v.) GEOLOGY AND MINERALOGY.
(vi) STABILITY AND RESISTANCE OF SHIPS.
(vii.) THERMO- AND ELECTRO-CHEMISTRY.
(viii.) ELECTRICITY AND MAGNETISM.

Mathematics.—The standard of mathematics required for the papers in Part II. of the examination is that of the mathematical portion of the examination for the admission of students, though questions may be set involving the use of higher mathematics.

The range of the examinations in the several subjects, in each of which a choice of questions will be allowed, is indicated generally hereunder:

1. *Theoretical and Elementary Applied Mechanics.*—Statics of solids and fluids; statical problems connected with loaded structures; gravity and attraction; friction; static, kinematic and kinetic problems relating to machines; conservation of energy; theory of mechanisms.

2. *Theory of Structures and the Strength and Elasticity of Materials.*—Graphic and analytic methods for the calculation of bending moments and of shearing forces, and of the stresses in the individual members of framework structures loaded at the joints; plate and box girders; incomplete and redundant frames; theory of continuous girders and principal methods of calculation; travelling loads; riveted and pin-joint girders; rigid and hinged arches; strains due to weight of structures; theory of earth pressure and of foundations; stability of masonry and brickwork structures. Coefficients of elasticity; elastic resistance to tension, compression, shearing, and torsion; uniform and varying stress; moment of stress and of resistance in beams of various sections; distribution of shearing stress in beams; stresses suddenly applied and effects of impact; buckling of struts; effect of different end-fastenings on their resistance; combined strains; calculations connected with statically indeterminate problems, as beams supported at three points, etc.; limit of elasticity, yield point, and ultimate resistance of various materials as tested; the plastic state; principal forms of testing machines and of appliances used in measurements for the determination of coefficients of elasticity; calculation of extension, deflection, buckling, etc., within elastic limits, and of ultimate strength and ductility for ordinary materials of construction.

3. *Optional Subjects*—(i.) *Geodesy.*—The principal surveying and levelling instruments—their theory, structure and adjustment; contouring; setting-out curves; nautical surveying; observation of currents; astronomical surveying; determination of latitude and longitude.

(ii.) *Hydraulics.*—The laws of the flow of water by orifices, notches, and weirs; laws of fluid friction; steady flow in pipes or channels of uniform section; resistance of valves and bends; general phenomena of flow in rivers; methods of determining the discharge of streams; tidal action; generation and effect of waves; impulse and reaction of jets of water; transmission of energy by fluids; principles of machines acting by the weight and pressure of water; theory and structure of turbines and pumps; distinction between impulse and pressure turbines.

(iii.) *Theory of Heat Engines.*—Thermodynamic laws; internal and external work; graphical representation of changes in the condition of a fluid; theory of heat engines working with a perfect gas; air and gas engine cycles; reversibility, conditions necessary for maximum possible efficiency in any cycle; properties of steam; the Carnot and Clausius cycles; entropy and entropy-temperature diagrams, and their application in the study of heat engines; actual heat-engine cycles and their thermodynamic losses; effects of clearance and throttling; initial condensation; testing of heat engines, and the apparatus employed; performances of typical engines of different classes; efficiency.

(iv.) *Metallurgy.*—The physical properties of metals generally used by engineers; structure, density, thermal, and electric conductivity; microscopic examination of metals; modifications produced by local stresses, cold rolling, hard drawing, and hammering; nature of annealing. The production of high temperatures; pyrometry; the chemical reactions that occur at high temperatures, so far as they affect metallurgical processes; refractory materials; furnaces and combustion chambers; fuels; principles of iron and steel manufacture by modern methods; the influence of carbon and other substances upon iron and its alloys; the principal ores and processes of extraction of copper, lead, tin, zinc, silver, and gold; the laws of electrolysis as regards their application to metallurgical processes; electro-heating for metallurgical purposes.

(v.) *Geology and Mineralogy.*—The nature of common minerals and the methods by which they can be discriminated; mode of occurrence of minerals in rocks and in mineral veins; composition and classification of the rocks forming the earth's crust; changes taking place in the earth's crust by the action of the atmosphere and of water upon it; denudation and the formation of fluviatile, glacial, lacustrine, deltaic, and marine deposits; action of internal forces upon the globe; volcanic phenomena and earthquakes; movements of terrestrial rock masses; methods of measuring and recording in sections and maps the positions of the rock masses of the globe; the general succession of the stratified deposits in the British islands, based on the study of the fossils which they contain.

(vi.) *Stability and Resistance of Ships.*—The principles of buoyancy, stability, and oscillation for floating bodies, with special application to ships, and methods of calculation and experiment; principles of the structural strength of ships; the straining forces acting upon ships afloat and ashore; methods of calculation for strength and stiffness; nature of the wave-forming and other resistances experienced by ships moving through water; stream lines; methods of model experiments on resistance; influence of forms and proportions upon resistance; mechanical theory of propellers and relative efficiency of various kinds of propellers; estimates of horse-power for assigned speeds; manœuvring of ships under the action of rudders or propellers.

(vii.) *Thermo- and Electro-Chemistry.*—The nature of the principal fuels; theory of combustion; calorific value of carbon and hydrogen as used for the production of heat, and of the principal fuels—solid, liquid, and gaseous; examination of the chemical processes which occur in the working of open and closed furnaces, and in the working of engines either by coal or producer gas, or by petroleum, etc.; theory and use of the principal apparatus employed in the determination of calorific values; methods of production and calorific value of coal gas, water gas, and producer gas; calculation of thermal changes in industrial processes; calorific intensity and the instruments used for its measurement; theory of electrolysis and of the principal electrolytic processes; chemistry of primary and secondary batteries; the use of electric currents for heating and for chemical decomposition.

(viii.) *Electricity and Magnetism.*—The theory of the generation, storage, transformation, and distribution of electrical energy; continuous and alternating currents; electromagnetism; polyphase systems; calculation of the losses in electrical processes, and of the efficiency of electrical machinery and apparatus; arc and incandescent lamps; electrical and magnetic measurement and measuring instruments.

The examination may, in the discretion of the council, be taken by persons, whether students of the institution or not, either before or after recommendations in favour of their election into the institution have been lodged with the secretary. Certain degrees and collegiate certificates (of which a list will be published in due course) will be recognised by the council as proving a sufficient standard of attainment in the requisite subjects; and the graduates and holders of such certificates will be exempted from passing the examination appointed by the council.

SOME NEW PRINCIPLES IN DYNAMO DESIGN.*

BY ALBERT W. SMITH.

In the present types of dynamo the field distortion, due to armature reaction, is combated by the employment either of a large air-gap, or over-saturation of the core teeth, or both, the object being to oppose as much reluctance as possible to the magnetomotive forces of the armature, and thus resist or limit field distortion due thereto. Unfortunately, however, the reluctance obtained by these means is equally opposed to both the armature and field windings.

These methods, therefore, necessitate the employment of large field coils, which impose the necessity of long magnet cores, which in turn imposes a large and heavy ring or yoke structure.

In spite of the large air-gap reluctance, more or less field distortion, according to load, takes place, thus necessitating

* The *Electrical Engineer* (New York).

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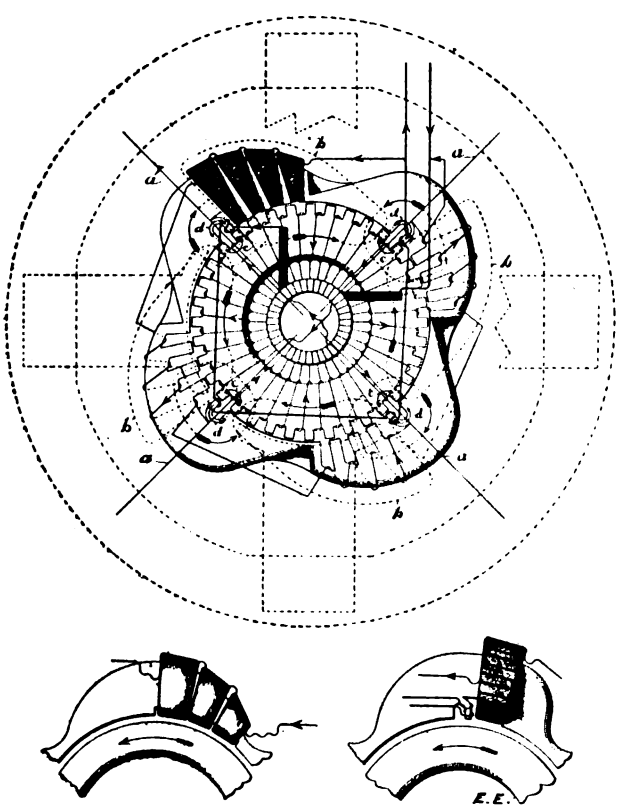
a forward shifting of the brushes, which in turn destroys the balance between the front and back armature turns interlinking with the field flux, thus proportionately weakening the field magnetism, and therefore imposing the necessity of using series or compounding coils, which still further increases the length of the magnet cores, and the amount of magnetising energy, etc.

All of the above-named conditions, therefore, conspire to impose the necessity of using a field-magnet structure which is several times heavier than the armature, and which requires a large amount of magnetising energy, and adds enormously to the weight of the machine per unit of output.

To overcome the above-named untoward conditions, it is proposed to displace the field-magnet coils rearwardly from the neutral or commutating points, and to wind them in or across the flux paths of their respective magnets, and close to the armature, as shown in the accompanying illustrations.

Argument.—It is obvious that the magnetism generated by any given turn or section of a field coil must pass through that turn or section, though it need not necessarily pass through all of the turns or sections of the coil, but may leak out through the side of the coil adjacent to its own turn or section; it follows, therefore, that the magnetism generated by a field coil cannot be shifted forward further than the width of the coil.



The Smith Improved Field Magnet Winding.

It is then only necessary to wind the coils entirely back of the neutral lines, *a a*, and as close to the armature as practicable, to insure the desired freedom from field distortion; this is made possible by using a field-magnet structure which has on one side of its neutral points a single wide pole, or polar area, and on the other side thereof a plurality of smaller poles, forming between them coil-containing spaces (or instead of plural poles a single large coil space), in which space or spaces the coils are wound, as shown in accompanying diagrams.

By this method of winding the field coils, a long exernal air path of very great reluctance is opposed to the armature magnetomotive forces, *b b*, thus obviating the present necessity for a large air-gap reluctance; the size of the air-gap is, therefore, imposed entirely by mechanical conditions, and can be made very small, while the core teeth can also have the same low reluctance as other parts of the magnetic circuit. The magnets consequently requiring only a small fraction of the magnetising energy now necessary, and the coils being correspondingly smaller, consequently require proportionately less winding space, thus insuring a field-magnet structure which has about the same weight as the armature, or somewhat less. The dotted outline shows in contrast the ordinary form of field structure, consisting of cast-iron yoke ring with wrought-iron cores cast in.

The present method of commutating under the leading pole corners is defective, because the brushes cannot remain in a fixed position without sacrificing other desirable qualities, and also because it imposes the use of carbon brushes, which cause a considerable waste of energy.

To obviate these defects, it is proposed to entirely prevent the spark causing self-induction, due to the rise or increase of current in the armature coils at the moment when their segments leave the brushes. This is accomplished by interlinking the coils at the moment when their segments leave the brushes—and when tending to produce self-induction causing magnetomotive forces, due to current increase, as represented by arrows, *c c*—with counter magnetomotive forces represented by arrows, *d d*, which, being equal or superior to them in strength, suppress those due to the armature coils, and thus absolutely prevent the existence of any spark causing self-induction in the commutable coils; thus insuring sparkless commutation, and enabling the use of metal brushes, which may be either solid, laminated, or of gauze construction, and which remain in a fixed position for all variations of load and speed.

With this method of commutation the coil does not cut a magnetic field at the moment when its segment leaves the brush, as it does in the present used method; the E.M.F. due to self-induction is therefore not neutralised or counteracted by an opposing E.M.F., due to the cutting of a field, but is absolutely prevented from coming into existence, by interlinkage of the coil with a field of contrary direction to that which the armature coils tend to set up at the moment when the segment breaks contact with the brush. It will be apparent that the conditions and results obtained with this method of commutation are analogous and equivalent to those which prevail in motor-generators having both windings on the same armature. In this type of machine, as is well known, the brushes remain fixed for all conditions of load, and commutation is sparkless and perfect. The absence of field distortion and sparking makes it possible to arbitrarily locate the position of the brushes when designing a machine for any given service, thus enabling any kind or amount of automatic regulation to be obtained by simply determining or fixing the constant ratio or proportion between the front and back armature turns interlinking with the field flux, thus enabling a machine to compensate for drop in engine speed, to have a rising voltage, as for railway work, or to have a falling voltage, as for some kinds of electrolytic work, without the use of any series or compounding coils.

With the present types of dynamo the output of the machine is limited by the current-carrying capacity of the armature, and by the sparking at the brushes. The carrying capacity, and, therefore, the output of most armatures in present use, could be greatly increased by a better design of winding, eliminating spiral end connections, etc.

This has not been generally done, for the reason that the present low sparking limit would permit of no material increase in output; the absence, however, of both field distortion and sparking in the present design makes it possible to take full and complete advantage of all available means for increasing the carrying capacity of the armature, and therefore makes possible a proportionately greater output or effectiveness from a given size of armature.

The absence of field distortion and sparking also makes it possible to design high-voltage direct-current machines for power transmission over long distances, thus securing higher efficiency, especially at part load, and lower first cost than is possible with the present used methods.

It is sometimes desirable to directly connect dynamos to high-speed turbines, thus obtaining large output, due to high velocity. While it is possible to do this with dynamos of the present type, much difficulty is experienced, due to the inherent defects of field distortion, and self-induction in the armature coils, all the bad effects of which

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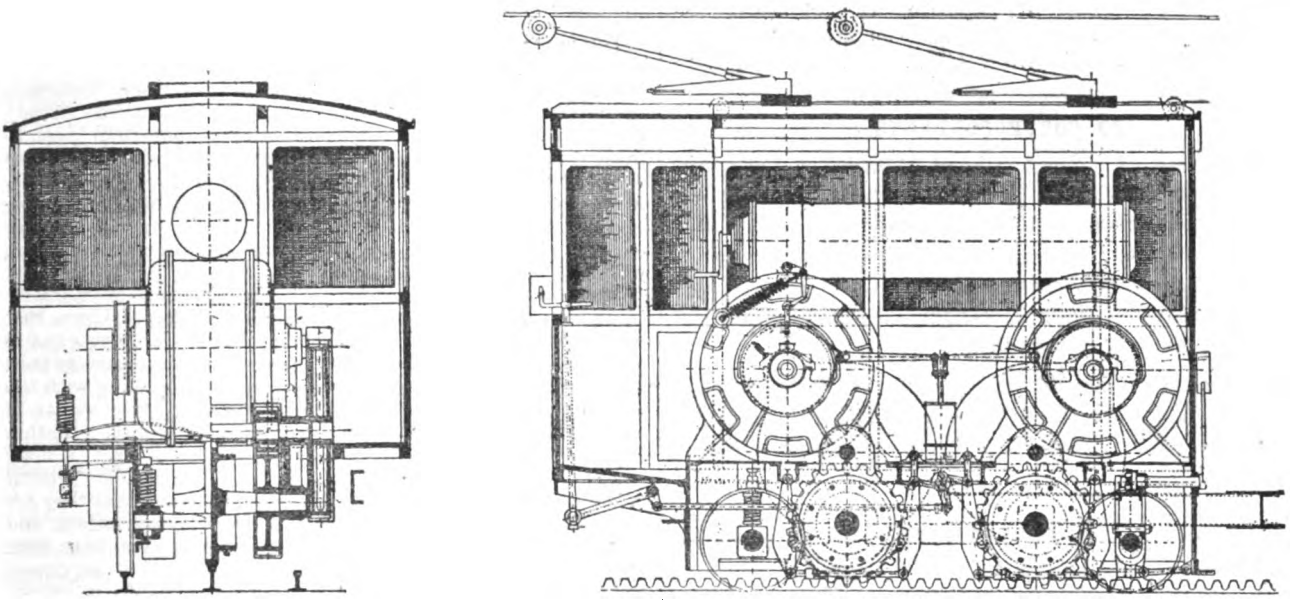
are greatly aggravated under those conditions, and, therefore, tend to impose a kind of speed limit on the armature.

In the design here proposed, however, the speed limit does not exist, and in so far as difficulty from these sources is concerned, the armature can be run up close to the mechanical or bursting limit, thus making it possible to obtain under these conditions a very large output per unit of weight and also very high electrical efficiency.

THE JUNGFRAU ELECTRIC LOCOMOTIVES.*

The trains on this line are very heavy, on account of the endeavours of the management to combine great power with great economy. A train consists of one passenger car with motors on it, and one other car for either passengers or goods. Fig. 1 represents the cross-section, and Fig. 2 the longitudinal section of the car containing the motors and driving gear. The combination of the locomotive with a passenger car gives greater weight on the driving or braking wheels, and hence the cogs are less likely to rise out of the rack should the brakes be applied too suddenly. This arrangement also gives greater economy, in that the total weight of the train is reduced and its carrying capacity increased. The locomotive alone would have to weigh 12 tons, while the combined car as now to be constructed will only weigh 13 tons.



FIGS. 1 AND 2.—The Alternate-Current Electric Locomotive for the Jungfrau Railway.

The carriage and the motor truck may be easily separated from each other in case repairs are necessary. The locomotive weight comes upon the two axles, seen in Fig. 2. The spiral springs shown are arranged to be not easily deflected, and their movement is limited to about $\frac{2}{5}$in. The frame is built like the frame of an ordinary locomotive, and contains between the two supporting axles the two driving axles, on which are the cogwheels. Two electromotors, each of 125 h.p. at 800 revolutions, drive, by means of double-reduction gearing, the main cogwheel. These reduction gears are duplicated on each motor, being arranged symmetrically on each side of the same.

The highest output of these machines will be 300 h.p., corresponding to about 285 apparent kilowatts, or about 235 amperes per phase at a pressure of 500 volts. The pinions are made of aluminium bronze, the large spur wheels of cast steel, and the driving cogwheels are made of cast steel which has also been wrought. The reduction gears have only a $1\frac{3}{4}$in. pitch, and are machine-cut on the skew so as to secure an easy running and no side pressure. The driving cogwheels are made as large as possible in order to get a good grip of the teeth in the rack, and little wear from friction as possible. The driver's cab is enclosed, and is constructed of wood, on account of the cold. The locomotive has the following brakes :

1. An electric brake on the motor shaft, which is available as long as there is current passing through the motors. This brake is combined with the electric regulator, in this sense that the latter interrupts the current should an excessive speed obtain.

2. A hand-brake which acts by means of levers upon each of the brake blocks on the driving cog. The brake blocks are made of bronze.

3. The third set of brakes acts by gripping the rails. The engineer, as well as the conductor on the upper platform, may operate this brake. The gripping brake may also be used as a regulating brake when descending with the current interrupted.

The Jungfraubergbahnelectromotive is the most powerful cogwheel locomotive which has been constructed so far. It has, besides the longest name, a tractive effort of 14,500lb. The locomotive is being constructed by Messrs. Brown and Boveri, of Baden, and it will work on the three-phase system.

* From the *Schweizer Bauzeitung*.

REVIEWS.

The Universal Directory of Railway Officials, 1897. Compiled from official sources by S. RICHARDSON BLUNDSTONE. The Directory Publishing Company, 8, Catherine-street, Strand. Price 10s.

This is the third year of publication of this directory. The work seems to be very complete, and the information is exceedingly useful to all concerned with railway work. The arrangement is to give the railways alphabetically for each continent, then to give a collected personal index, also alphabetically. Thus it is easy to refer to any railway in any country or to any person. Great care has evidently been taken in the compilation, and the references we have made have been correct

Equilibrium in Flight.—Mr. James Richardson, writing in the *Scientific American* on the above subject, points out a well-known fatal defect in all flying machines at present invented. "The machines," he says, "have almost always come to grief for lack of that stable equipoise which the bird maintains by instinct under the varying conditions of flight and wing. To get into the air is not so hard, many have done that to their sorrow. To stay in the air master of the situation is another matter. To be able to rest in air without risk of overturning, competent to move in any direction at will, and able to return to the point of starting surely and without shock—that is the critical test." Unfortunately, the author does not do more than tell us that we are wrong in trying to fly before equilibrium has been obtained. He concludes by the graphic dictum that "suicide, however scientifically or picturesquely attempted, is not commendable, and smashed machines, however cleverly constructed, are not worth any more than dead inventors for the promotion of aerial navigation."

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SECRECY IN TELEGRAPHY.

Two publications of the greatest importance have appeared this week, and we venture to think that one of these will hasten the laying of the Pacific cable, although it does not touch upon that question at all, while the other deals specifically with it. On Wednesday a parliamentary paper was issued dealing with the "proceedings of a conference between the Secretary of State for the Colonies and the premiers of the self-governing colonies" held in London this year. The introduction is in the form of a despatch from Mr. Chamberlain to the Earl of Aberdeen, the Governor-General of Canada. It is to one or two paragraphs of this despatch to which we desire to call special attention. Reference in one paragraph is made to the Paris Exhibition of 1900 and the Royal Commission thereon. If Britain and her Colonies are going to exhibit, concerted action between them will greatly assist in making the section controlled by them a success. From our point of view, the most important paragraph reads as follows:

PACIFIC CABLE.

The next point to which I will allude very briefly in connection with our commercial relations is the question of improved communications. That was the subject of very important resolutions at the time of the conference at Ottawa, and already I am happy to think that considerable effect has been given to those resolutions in regard to the fast mail service, which was the first and probably the most important of those resolutions. Arrangements are now in progress by which it will be accomplished, and I hope that in connection with that the service between Canada and Australia will also be improved, and there will be nothing further to be desired.

There is, however, still pending the question of a Pacific cable passing entirely through British territory. Upon that we desire to have the opinions of the gentlemen present as to how far they are prepared to go. I would say in regard to this, and also in regard to the fast steam service, in dealing with the matter at all, we are giving the most striking proof we can of our goodwill and of our desire to meet your wishes. Neither of these proposals would have been made by us. I must frankly say that we are not dissatisfied with the present arrangements; we do not feel, although we think that they are valuable proposals, yet we do not feel that they are urgent, and therefore we should not ourselves, or by ourselves, have been disposed to offer subsidies either to the steamboat service or to the Pacific cable, and we are only induced to do it by our desire to show that in any matter in which our colonies are themselves deeply interested they may count upon the support and assistance of the mother country. Well, in regard to the Pacific cable, the matter stands thus. A representative committee was appointed, which has discussed the whole subject; it has come to the conclusion that such a cable is practicable, has roughly estimated the cost (which is probably less than was originally anticipated), and has also estimated the probable returns. What remains, however, to be enquired into is as to the subsidies which the several colonies are prepared to give towards this undertaking. Without in this venturing to pledge my colleagues, I say that to any proposal which may be made by the Colonies the Government will give their most favourable consideration.

Our readers know the views we have always supported—viz., that the value of such a cable must be considered from two standpoints: (1) commercial, (2) strategic, the latter of which is by far the more important. If proof of imperialistic views were required in this case, it is given to the full in a letter to the *Times* of Thursday, August 26. This letter reads as follows:

THE FRENCH TELEGRAPHIC ADMINISTRATION AND THE PRESS.

TO THE EDITOR OF THE "TIMES."

Sir,—The French Telegraphic Administration having become as unsafe as the Ottoman Post Office, I am compelled to write by the ordinary post in order to show the way in which the secrecy of telegraphic correspondence is respected in France.

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On Monday, August 16, the journal *Le Temps*, the well-known Governmental French paper, published the following lines, in which it summarised and criticised a telegram from your Rome correspondent referring to "the Royal duel":

. . . On télégraphie de Rome au *Times* que parmi les télégrammes de félicitations ou de sympathie reçus, comme toujours en pareil cas, par le comte de Turin, on en trouve un de l'empereur d'Allemagne. Le fait n'a rien de bien surprenant ni d'exceptionnel; mais le correspondant anglais dit que ce télégramme est particulièrement "chaleureux." L'a-t-il lu? On n'en connaît pas le texte; mais tout le monde peut deviner ce que le télégramme contiendrait, si l'empereur d'Allemagne en avait confié la rédaction au correspondant gallophobe du *Times* à Rome.

Now, the telegram from your Rome correspondent appeared only in your issue of Tuesday, August 17 (12 hours after it was "quoted" in *Le Temps*); but it had passed through Paris, on the 16th, at an early hour.

Not only must someone connected with the French Administration have committed the dishonest act of communicating a telegram which had not yet appeared in your columns, thus defrauding you of the *primeur* of information for the transmission of which you had paid, but the *Temps*, as you will see, attacked your Rome correspondent for comments on the German Emperor's telegrams, comments which were never made. On the contrary, your Rome correspondent reproduced faithfully the opinions of the Italian papers, "eulogising the impartial and dispassionate attitude generally assumed by the French Press."

The following is the text of the telegram in question, as published in the *Times* of the 17th, more than 12 hours after its "quotation" by *Le Temps*:

Rome, August 16.

Neither the Italian Press nor the public are at pains to disguise their lively satisfaction at the result of yesterday's encounter. The receipt of the news was followed by spontaneous and enthusiastic demonstrations in all parts of Italy. On arriving at Turin early this morning the Count met with a cordial reception from the populace.

Telegrams of congratulation to the Royal family and the Count of Turin have been exceedingly numerous, among them, it is stated, being two from the German Emperor. Official journals adopt a tone of complacency, saying that all's well that ends well. They make a point, however, of eulogising the impartial and dispassionate attitude generally assumed by the French Press as being calculated to preclude unfavourable political consequences arising from the incident.

For the information of the public, I may add that such a case is not an isolated one, that it occurs continually, and that I have had to complain about it many times.

I am, Sir, your obedient servant,

YOUR PARIS CORRESPONDENT.

[*** We await explanations from the French Telegraphic Administration and *Le Temps*.]

It is difficult to see how the French Telegraphic Administration can explain away this matter. If a telegram concerning a sentimental matter is thus tampered with, how much more probable is a systematic tampering with commercial messages which may bring in large sums of money; and, above all, how improbable it is that political messages would escape. Cyphers are safe up to a point, but we doubt if cypher messages are altogether free from the supervision of those for whom they are not intended. Sceptical we have always been as to the inviolability of telegraphic information through foreign countries, and we imagine it would be better to provide against the possibility of a secret important political message being known than to rely on someone's goodwill or the secrecy of a cypher. "All is fair in love and war," says the old adage; and as no sane persons believe all foreign nations love us, it is as well to follow the advice of another old saw and to be "Wise in time."

Inventions Exhibition in Paris.—An exhibition of new inventions will be opened in Paris on September 26 under distinguished patronage. The exhibition will be held at the Lac Saint-Fargeau. The object is to give inventors a chance of showing their inventions to the public.

THE ALTERNATING-CURRENT INDUCTION MOTOR.*

BY CHARLES PROTEUS STEINMETZ.

(Continued from page 239.)

The apparent efficiency is quite fair, and the exciting current the same as in the first motor, thus due to the decreased output of this motor a somewhat higher percentage of full-load current, when rating the motor at two-thirds maximum torque.

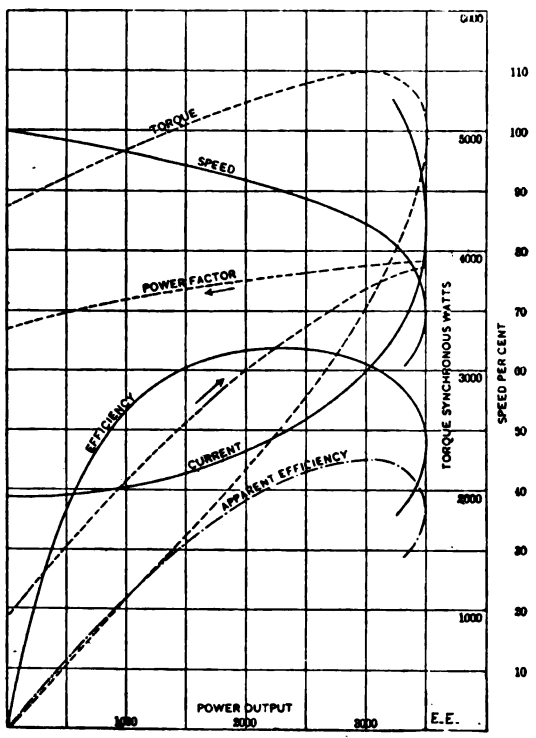

FIG. 5.—Induction Motor. Load Curves. $Z = \cdot 3 - \cdot 3j$. $Y = \cdot 04 + \cdot 4j$.

If besides high resistance the motor has high admittance also, as Number 3 in Fig. 5, the high efficiency maximum at light loads is cut off and the efficiency curve flattened and lowered. The power factor rises very slowly at light loads, reaching a lower maximum. Characteristic, however, remains the large drop in speed, while the exciting current has increased very greatly also.

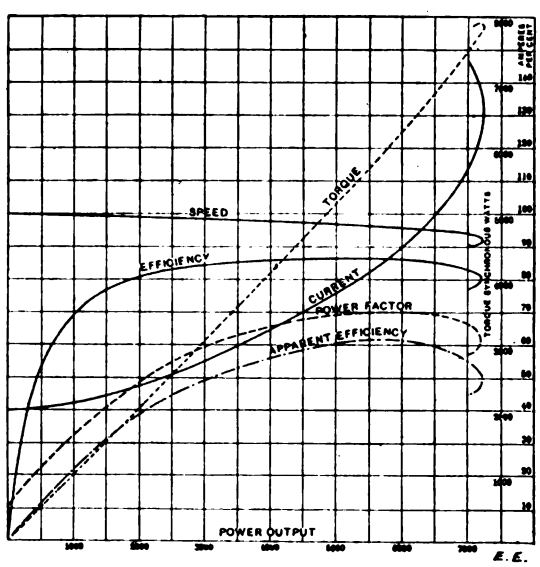

FIG. 6.—Induction Motor. Load Curves. $Z = \cdot 05 - \cdot 3i$. $Y = \cdot 04 + \cdot 4j$.

If the high resistance is in the field or primary only, but the armature or secondary of low resistance, even the characteristic feature of poor speed regulation is less marked, and the high resistance recognised only by comparing efficiency, power factor, and speed curve.

The reverse, a high-reactance motor, is motor Number 4,

* *Transactions* of the American Institute of Electrical Engineers.

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shown in Fig. 6. Characteristic of this motor is the constancy of speed, 3·3 per cent. drop at full load, and especially the efficiency curve, which rises slowly, but reaches a fairly high maximum at or rather above full load. Power factor and apparent efficiency are low, with maxima beyond full load, and rise very slowly—that is, are poor at light loads. As seen, such a motor is in general unsatisfactory and may be less objectionable only in special cases, where it is running constantly at or near full load, or where very close speed regulation is required and wattless currents less objected to.

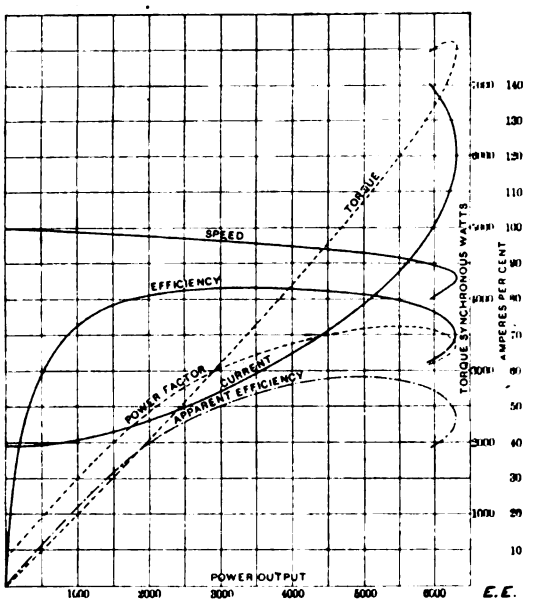

FIG. 7.—Induction Motor. Load Curves. $Z = \cdot1 - \cdot3j$. $Y = \cdot02 + 4j$.

Number 5, in Fig. 7, shows a high-susceptance motor. This motor is characterised by good efficiency at light loads as well as heavy loads, but power factor and apparent efficiency are very low at light loads and rise very slowly and reach their maximum only at or above full loads.

Comparing the different motors with each other, we see that a good motor is characterised by high values of power factor, efficiency, and apparent efficiency at light loads as well as heavy loads, by fairly close speed regulation and low exciting current.

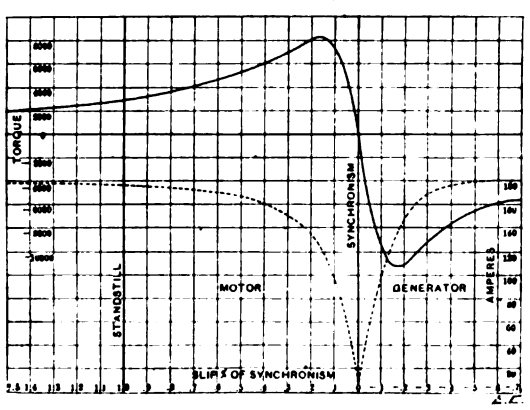

FIG. 8.—Induction Motor. Speed Curves. $Z = \cdot1 - 3j$. $Y = 01 + \cdot1j$.

High resistance is characterised by poor speed regulation and lowering of the efficiency at heavy loads; high reactance by very good speed regulation, good efficiency at heavy loads, and low power factor and apparent efficiency at light loads; high admittance by high exciting current, and poor power factor and apparent efficiency at light loads.

An abstract of the data of these motors and a number of other motors is given in Table I.

§ 2. *Speed Curves.*—The load curves discussed in the preceding are especially characteristic of the action of the motor when doing work at its proper speed near synchronism. The action in starting, or in running at intermediate speeds, or beyond synchronism, or when driven backwards, are best shown by what I may call the speed curves of the motor. A set of such curves, corresponding to the motor Number 1 in Fig. 3, are shown in Fig. 8 of the constants

$$Y = \cdot01 + \cdot1j, \quad Z = \cdot1 - 3j.$$

These curves give with the speed—that is, the slip, as abscissæ—the torque in watts at synchronism and the current input of the motor. As seen, the torque is zero at synchronism, increases with increasing slip—that is, decreasing speed—reaches a maximum of 8,250 synchronous watts at 16·5 per cent. slip, and then decreases again, reaching 2,920 synchronous watts at $s = 1$—that is, standstill—and keeps on decreasing for $s > 1$—that is, backward rotation—without change of direction, thus representing consumption of energy by the motor. For $s < 0$—that is, above synchronism—the torque curve is the counterpart of the torque curve for $s > 0$, but is negative, representing consumption of mechanical energy and thus production of electrical energy. It again reaches a maximum at $s = -16{\cdot}5$ per cent., of 11,400 synchronous watts, and then decreases. The negative or generator part of the torque curve is higher than the positive or motor part—that is, driven as generator above synchronism the machine consumes more mechanical torque than it produces running as motor below synchronism.

Thus, the induction motor shares with the continuous-current shunt motor the feature to be a motor only below a definite speed, but to become generator or act as brake, by returning energy into the line, when driven above its speed.

The load curve of the motor corresponds to the part of

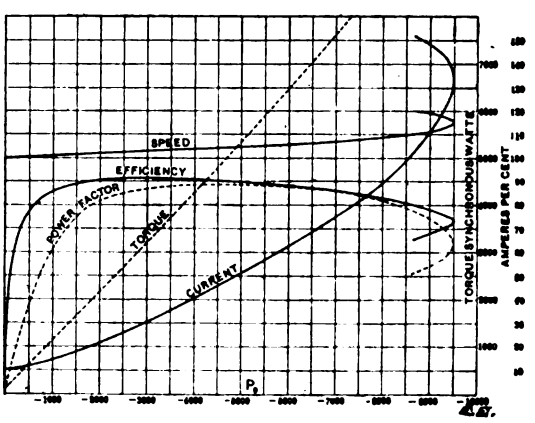

FIG. 9.—Induction Generator. Load Curves. $Z = \cdot1 - \cdot3j$. $Y = \cdot01 + \cdot1i$.

the speed curve between synchronism and maximum torque at positive slip. From the part of the speed curve between synchronism and maximum torque at negative slip, or above synchronism, a corresponding load curve can be constructed of the machine as induction generator. This curve is shown in Fig. 9. As seen, it is very similar to the motor load curve, except that the speed curve bends upwards.

As generator the induction machine differs from the synchronous alternating-current generator, or generator with constantly excited field, in so far as the latter can yield current and output at any power factor—that is, any phase displacement corresponding to the load—while in the induction generator at given terminal voltage to every value of current output a certain power factor of load corresponds. That is, to derive a certain value of current from the induction generator, the total load put on it must have the particular power factor corresponding to this current, and besides leading current, or if the power factor of the load changes, current and voltage of the induction generator will change accordingly. In consequence thereof, in general the induction generator is stable only, if at least a part of the load consists of synchronous motors.

The current in the induction machine is a minimum at synchronism and decreases on either side of synchronism, first very rapidly and then slower, and becomes fairly constant afterwards, as seen in Fig. 8. In the particular motor under discussion, the whole variation of current is practically comprised within the range from $s = +\cdot4$ to $s = -\cdot3$—that is, the current at standstill is very large and remains

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practically constant until about two-thirds of synchronous speed is reached. Thus, such a motor with low armature resistance will require a very large current, not only in starting, but also at intermediate speeds.

Restricting our attention to that part of the torque curve below synchronism, we see that the torque curve consists of two branches—the upper branch from maximum torque to synchronism, and the lower branch from maximum torque to standstill. The same torque is reached on either branch; for instance, the torque of 4,800 synchronous watts at $s = \cdot 05$, and at $s = \cdot 6$. The currents corresponding to the two values of speed at the same torque are very different, however, 52·5 amperes on the upper, 171 amperes on the lower branch. On the upper branch the motor is stable—that is, with constant load runs at constant speed. On the lower branch, however, the motor is unstable and cannot maintain its speed, but must either slow down and come to standstill, or accelerate and reach the upper or stable branch, if loaded by constant torque.

In the same way above synchronism the machine, as brake is stable between synchronism and maximum torque, and unstable beyond maximum torque.

As seen from the preceding, the motor Number 1, while very satisfactory at speed, requires excessive current and gives little torque at low speed and in starting, and is thus unsatisfactory therein.

In the discussion of load curves in the preceding we have seen that high-resistance motors have a large drop of speed, and thus reach a maximum torque point at lower speeds—that is, are in starting nearer to the maximum torque point, or in other words, have a greater starting torque.

From the equations of the induction motor it is obvious that this greater torque at low speeds is not due to the primary resistance, but exclusively to the secondary or armature resistance.

The armature resistance, r_1, enters only in the equation of secondary current:

$$I_1 = \frac{s\,e}{r_1 - j\,s\,x_1} = e\left[\frac{s\,r_1}{r_1^2 + s^2 x_1^2} + j\,\frac{s^2 x_1}{r_1^2 + s^2 x_1^2}\right] = e\,(a_1 + j\,a_2),$$

and in the further equations only indirectly in so far as r_1 is contained in a_1 and a_2.

Increasing the armature resistance n-fold, to $n\,r_1$ we get at an n-fold increased slip $n\,s$:

$$I_1 = \frac{n\,s\,e}{n\,r_1 - j\,n\,s\,x_1} = \frac{s\,e}{r_1 - j\,s\,x_1},$$

that is the same value, and thus the same values for e, I_0, T, P_0, δ, while the power is decreased from $P = (1-s)\,\tau$ to $P = (1-n\,s)\,T$, and the efficiency and apparent efficiency are correspondingly reduced. The power factor is not changed. Hence,

An increase of armature resistance r_1 produces a proportional increase of slip n, and thereby corresponding decrease of power, efficiency, and apparent efficiency, but does not change the torque, current, and power factor.

Thus the insertion of resistance in the armature or secondary of the induction motor offers a means to reduce the speed corresponding to a given torque, and thereby any desired torque can be produced at any speed below that corresponding to armature short-circuit, without changing torque or current.

Hence, given the speed-torque curve of a short-circuited motor, the torque curve with resistance inserted in the armature can be derived therefrom directly by increasing the slip in proportion to the increased resistance.

This is done in Fig. 10, in which are shown the speed curves of the motor Number 1 between standstill and synchronism, for:

Short-circuited armature: $r_1 = \cdot 1$.

·15 ohm resistance inserted in armature: $r_1 = \cdot 25$.

·5 ohm additional resistance inserted in the armature: $r_1 = \cdot 6$.

1·5 ohm additional resistance inserted in the armature: $r_1 = 1 \cdot 6$.

The corresponding current curves are shown on the same sheet.

As seen, with short-circuited armature, the maximum torque of 8,250 synchronous watts is reached at 16·5 per cent. slip. The starting torque is 2,950 synchronous watts, and the starting current 176 amperes.

With armature resistance $r_1 = \cdot 25$, the same maximum torque is reached at 40 per cent. slip, the starting torque is increased to 6,050 synchronous watts, and the starting current decreased to 160 amperes.

With armature resistance $r_1 = \cdot 6$, the maximum torque of 8,250 synchronous watts takes place in starting, and the starting current is decreased to 124 amperes.

With armature resistance $r_1 = 1 \cdot 6$, the starting torque is below the maximum, 5,620 synchronous watts, and the starting current is only 64 amperes.

In the two latter cases the lower branch of the torque curve has altogether disappeared and the motor speed is stable over the whole range—that is, the motor starts with the maximum torque which it can reach—and with increasing speed torque and current decrease—that is, the motor has the characteristic of the continuous-current series motor, except that it cannot race, but its maximum speed is limited by synchronism.

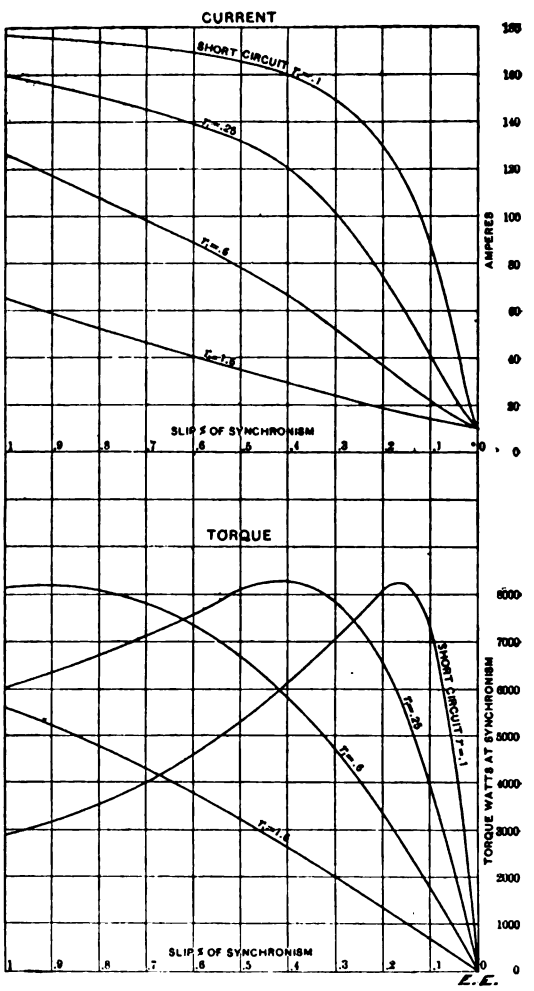

FIG. 10.—Induction Motor. Speed Curves. Torque and Current. $Y = \cdot 01 + \cdot 1j$. $Z = \cdot 1 - \cdot 3j$. Arm. Resistance: $r_1 = \cdot 1$, ·25, ·6, 1·6.

On the same diagram (Fig. 10) are shown the currents corresponding to the different values of secondary resistance.

The apparent torque efficiencies of the motor under the four conditions of armature resistance are given in Fig. 11. They show that, although a considerable starting torque can be reached by a moderate armature resistance of $r_1 = \cdot 25$, the apparent torque efficiency or torque per ampere input is still very low under this condition—that is, the motor starts very inefficiently—and, as seen in the preceding discussion of high-resistance motors, is rather inefficient at speed. The same diagram also shows the torque efficiencies. It follows herefrom that permanent resistance in the armature of an induction motor can be used to secure good starting torque at the sacrifice of current in starting, and of efficiency and speed regulation when running, but cannot be used to limit the starting current, the latter requiring

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so large an armature resistance as to make the motor entirely unfit when running.

This brings us to the investigation of the action of the induction motor in starting.

The condition in starting is $s = 1$.

Substituting $s = 1$ in the induction motor equations gives starting torque, current, power factor, etc.

$$I_1 = \frac{e}{r_1 - j\,x_1} = e\left[\frac{r_1}{r_1^2 + x_1^2} + \frac{j\,x_1}{r_1^2 + x_1^2}\right] = e\,(a_1 + j\,a_2)$$

$$a_1 = \frac{r_1}{r_1^2 + x_1^2} \qquad a_2 = \frac{x_1}{r_1^2\,x_1^2}.$$

$$I_{00} = e\,(g + j\,b).$$

$$I_0 = I_1 + I_{00} = e\,[(a_1 + g) + j\,(a_2 + b)] = e\,(b_1 + j\,b_2)$$

$$b_1 = a_1 + g \qquad b_2 = a_2 + b.$$

$$E_0 = e + I_0\,Z_0 = e\,[1 + (b_1 + j\,b_2)\,(r_0 - j\,x_0)] = e\,(c_1 + j\,c_2)$$

$$c_1 = 1 + r_0\,b_1 + x_0\,b_2 \qquad c_2 = r_0\,b_2 - x_0\,b_1.$$

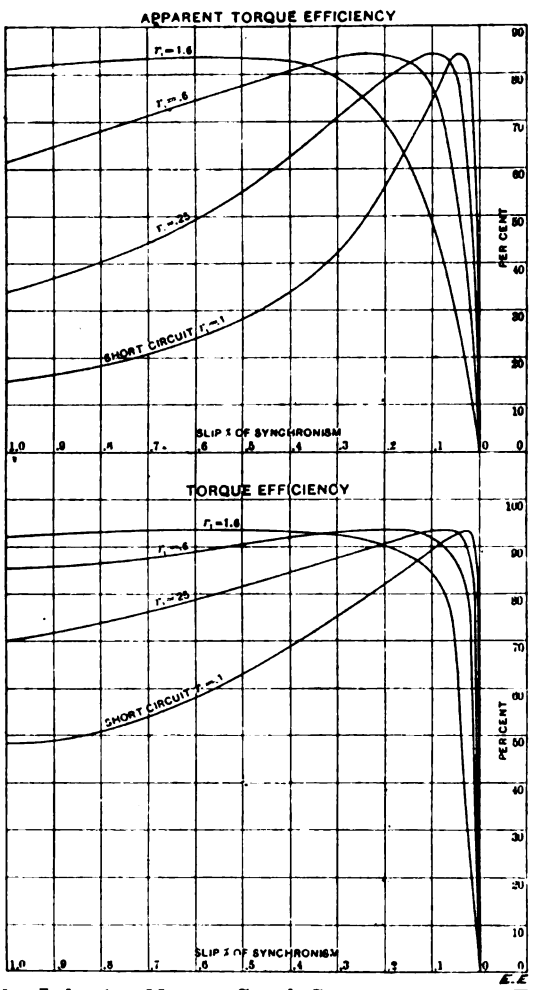

FIG. 11.—Induction Motor. Speed Curves. Apparent Torque Efficiency and Torque Efficiency. $Y = \cdot01 + \cdot1\,j$. $Z = \cdot1 - \cdot3\,j$. Armature Resistance $r_1 = 1{\cdot}6,\ \cdot6,\ \cdot25,\ \cdot1$.

$$e = \frac{E_0}{\sqrt{c_1^2 + c_2^2}}.$$

$$I_0 = e\,\sqrt{b_1^2 + b_2^2}.$$

$$T = e^2\,a_1.$$

$$P_0 = [I_0\,E_0] = e^2\,(b_1\,c_1 + b_2\,c_2).$$

$$Q = I_0\,E_0.$$

$$\text{Power factor } \frac{P_0}{Q}.$$

$$\text{Torque efficiency } \frac{T}{P_0}.$$

$$\text{Apparent torque efficiency } \frac{T}{Q}.$$

From these equations are calculated for the motor Number 1 of

$$Y = \cdot01 + \cdot1\,j,$$
$$Z = \cdot1 - \cdot3\,j,$$

the starting torque, current, and torque efficiencies at various resistances and reactances in the secondary and in the primary, and plotted in the diagrams, Figs. 12 and 13.

In Fig. 12 is given, with additional armature resistance, R, as abscissæ, the values of starting torque, starting current, power factor, torque efficiency, and apparent torque efficiency.

In Fig. 13 are given the corresponding values, with reactance inserted in the secondary.

The insertion of resistance or reactance in the primary has only the effect of decreasing the voltage at the motor terminals and thereby decreasing the torque in proportion to the square of the voltage at the motor terminals, and the apparent torque efficiency directly proportional to the voltage at the motor terminals—that is, is a very inefficient and unsatisfactory means of starting, and suitable by its simplicity only where no starting torque is required, to limit the starting current. By the use of additional resistance in the armature or secondary in starting torque can be produced, as seen, with the same current, power factor, and torque efficiencies as correspond to the same torque when running.

In Fig. 13, representing the effect of reactance in the secondary circuit, the torque, current, etc., are shown for

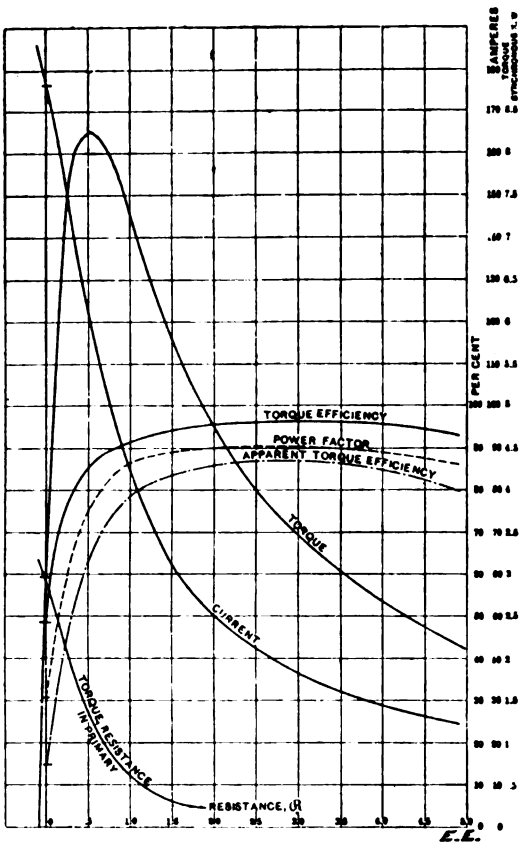

FIG. 12. — Induction Motor. Starting Torque, Current, Efficiencies, and Power Factor. $Y = \cdot01 + \cdot1\,j$. $Z = 1 - \cdot3\,j$. Resistance in Armature.

positive values or reactive coils, as well as negative values or condensers.

As seen, by the insertion of reactive coils in the secondary of the induction motor, the torque decreases rapidly, and the effect of secondary inductive reactance is practically identical with that of the insertion of reactance in the primary circuit—that is, the use of inductive reactance in the armature, or the secondary is of no practical value.

By the insertion of negative reactance or capacity, however, torque and current of the motor rise enormously, reaching a maximum of 30,200 synchronous watts and 530 amperes at $-\cdot58$ ohm additional capacity reactance—that is, 3·66 times the maximum torque available with armature resistance—at 4·22 times the current corresponding thereto. At this point the power factor is 100 per cent.—that is, the current in phase with the impressed E.M.F. On one side of this point the current leads, on the other it lags. Torque efficiency, however, and apparent torque efficiency with the use of capacity in the secondary are very low, the torque efficiency in the whole range being about 50 per

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cent., while by the use of resistance in the armature a torque efficiency considerably above 90 per cent. is reached. That means, capacity in the secondary, outside of the general inconvenience of the condenser, is far inferior in starting, to the use of non-inductive resistance, except in so far as the maximum available torque is far larger. But the current corresponding to this torque is far beyond the carrying capacity of the motor, and where such an excessive torque should be required, it could much more efficiently—that is, with a relatively lesser expenditure of current—be secured by varying the voltage impressed upon the motor by means of a potential regulator or transformer of variable ratio of transformation. By such a potential regulator the starting torque of the motor can be changed

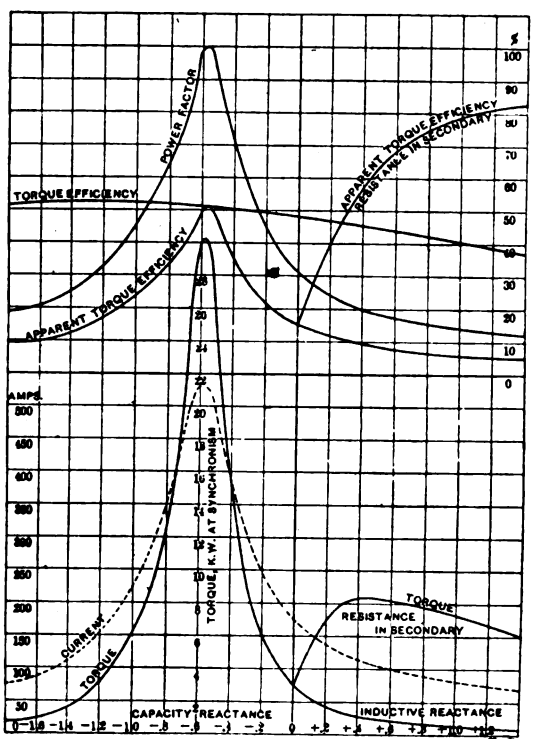

FIG. 13.—Induction Motor. Starting Torque, Current, Efficiencies, and Power Factor. $Y = \cdot 01 + \cdot 1j$. $Z = \cdot 1 - \cdot 3j$. Reactance in Armature.

in any desired manner without a change of torque efficiency, etc.—that is, the current input at primary side of the potential regulator will vary proportional to the torque developed by the motor.

(To be continued.)

THE DERI PROPOSED SYSTEM OF ELECTRIC TRACTION.

The current number of the *Elektrotechnische Zeitschrift* contains more details of the above system, which we reproduce herewith There is a steady increase in the use of electric power for railways, yet, as a rule, the continuous-current system is employed with a potential seldom exceeding 500 to 600 volts. In consequence of this fact, only comparatively short lines can be worked from one station. Long lines cannot be worked with a continuous current of that potential, yet longer lines could often use electric power, especially where water power is available at a distance. The system invented by Mr. Max Déri is designed to enable us to overcome this difficulty. He recommends the use of alternating currents, either single- or multi-phase, in as direct a way as possible, and in conjunction with batteries and continuous-current motors, for the working of trains at certain times, such as when starting

It has been repeatedly proposed by others to erect transformer stations near the railway line, in order to transform the total electric power of the alternating current into continuous currents, so as to at least indirectly utilise alternating currents for the transmission of power for railway purposes. This new system of Déri's requires no transformer stations, as the transformation takes place on the locomotives. In comparison to the other alternating-continuous-current systems this method is far more economic, because the largest part of the power is usually obtained direct through alternating currents, and only a small part of it is transformed and put into the accumulators.

Single- or multi-phase alternating currents are conducted from the central station at the source of power to the railway lines, and then supplied either directly or through transformers to the line wires. It does not make the slightest difference whether the latter are overhead, underground, or surface lines; but it is specially pointed out that it is not necessary to lay a continuous wire along the permanent way, but the wire may be interrupted—that is to say, discontinued—at any point where it would be difficult to maintain it, or where it would be in the way of the cross traffic; for instance at points, crossings, or between station platforms, etc. The usual methods are employed on the cars to collect the alternating current from these wires. The trains have both alternating-current and continuous-current motors on the axles, the latter acting at times as dynamos, giving current to the accumulators. The alternating motor and a continuous-current motor may be placed side by side, or they may be constructed as one alternating-continuous-current transformer upon the same axle, or some of the driving axles may be fitted with the one kind of motor and some with the other. The wires conduct the current to the alternating motors, which supply the bulk of the driving power. The accumulators on the cars are used in conjunction with the continuous-current motors. The driving axles of such a train form a kind of transmission gear between the electric motors, and when running at full speed the continuous-current motor charges the accumulators. Besides this, the accumulator reaction on the motors acts as a buffer, equalising the amount of power required from the line. For instance, if on a slight down grade the power of the alternating-current motor is more than sufficient to move the train along, the latter is able to give the surplus power during the run to the continuous-current motors, which then act as dynamos and charge the battery. On the contrary, on a heavy up grade, when the resistance of the train is greater, the power required from the alternating current is reduced by the battery driving the continuous-current motor, which gives out power to assist the alternating-current motor.

In other places where the conductors for the alternating currents are interrupted, the whole of the power is supplied by the battery. Thus, when in the station, the current from the accumulators starts the train, and keeps it going until the conductors are again available. Since it is possible to start the train without using the alternating current, it follows that it is also possible to use single-phase alternating currents, the induction motors of which cannot, as is well known, start against a load, although they work excellently as soon as a certain speed has been attained. The alternating currents carried by conductors have to be calculated by adding to the power required, the losses in transforming, and also the increase in the current due to the fact that current is not taken by the motors over the whole length of the railway line.

The employment of two motors does not necessarily imply an additional cost as compared with the usual single-current system, for only in a few exceptional cases are two motors, each large enough to supply the full power required to run the train.

According to this system, the ordinary or average work is done by the alternator, while the continuous motor helps (mostly for a very short time only) when additional power is required. At all moments where more power is wanted, all the motors in the trains, alternating and continuous, unite to do the work. Therefore, as a rule, the two motors will only require to be of half the power each of the continuous-current motors ordinarily used.

No controllers worth mentioning are required, as regulators are used in continuous-current circuit. While the train is moving in the usual way, a very simple automatic regulator is used (described below).

The great advantage claimed by Mr. Déri is that the alternate-current motors will be always working at nearly

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full power—*i.e.*, at their most economical load. The use of the direct-current plant and accumulators tends to keep this load constant, and the parts also can be employed to store energy, which otherwise would be wasted.

Our illustration represents an electric locomotive with four driving axles, and using three-phase alternating current. The illustration shows the connections of the plant, but not the details of the controller. In the diagram, L L represents the two lines of wires of the three-phase circuit; W W, the alternate-current motors; G G, the continuous-current motors; and M M their field magnets. B is the battery of accumulators, divided into two halves; and A the automatic regulator. R is a regulating resistance for the field magnet of the direct-current machines; and U a reversing switch for both kinds of current used, so as to change the direction of the motion of the train. The automatic regulator keeps the strength of the alternating current equal between two given limits, and does this by changing the E.M.F. of the continuous-current motors in such a way that the accumulators are either charged or discharged according as the power of the alternating-current motors is either below or above that required by the train.

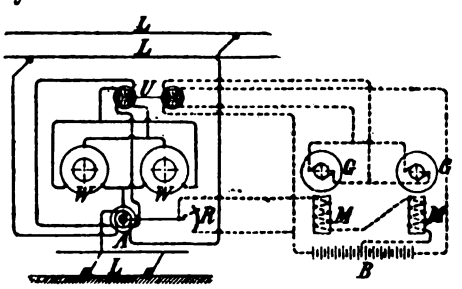

Diagram of Connections for the Oerl System of Traction.

The speed of the alternating motors is nearly constant, and even a very small change in the speed causes a considerable change of the current. The automatic regulator, A, keeps this strength of current as uniform as possible, as its influence upon the work of the continuous-current motors causes a corresponding loading or unloading of the alternator side of the system. The continuous-current motors are placed side by side, as shown in the illustration, and the strength of their fields is regulated through a rheostat. The lever of this rheostat is acted upon by the regulator, A. The latter consists of a revolving magnetic field and a core, the torque on which is balanced by a spring. An ordinary controller regulates the speed of the continuous-current motor, while the train is being propelled by the current from the battery. Another remarkable feature of this new system is that the current may be conducted to the vehicle without making use of the rail for that purpose. As the wires may be intercepted at crossings and points, and are therefore only used at the straight or nearly straight parts of the line, it is very easy to insulate the whole of the conductors.

NEW CAPITAL.

Subjoined is a statement of new capital authorised and the capital issued during the six months ended June 30, 1897, based on the announcements of new electrical companies, loans, or other issues made in the *Times*; with certain particulars relating to the creation, or issue, of the capital; and also of the purchase-moneys payable to vendors, so far as such particulars are stated in the prospectuses announcing the issues, taken from the *Times* half-yearly list:

—	Security — Amount	Security — To be paid up.	Capital. — Authorised.	Capital. — Issued.	Price of issue.	Taken by vendors. — Securities	Taken by vendors. — Cash.	Taken by vendors. — Securities or cash.	Date of allotment if announced.
	£	£	£	£	£	£	£	£	
Amazon Telegraph, 5 p c. Debs. ...	100	100	200,000	125,000	95	—	—	—	—
Calcutta Electric Supply ...	5	5	100,000	100,000	5	—	—	—	May 26.
Charing Cross and Strand Electricity, 4½ p.c. Pref.	5	5	—	50,000	5	—	—	—	March 14.
Commercial Cable, 4 p.c. Bonds ...	100	100	4,120,000	400,000	94	—	—	—	—
Detroit Telephone, 6 p c. Gold Bonds Red.	—	—	—	40,000	95 p.c.	—	—	—	—
Edison and Swan United Electric, 4 p.c. Deb. Stock	100	100	—	80,000	100	—	—	—	—
Edmundson's Electricity Corporation, Ordinary	5	5	177 500	100 000	5	43.500	9,000	—	—
Deferred	5	5	22 500	22,500	5	22,500			
India Rubber (Mexico)	1	—	400,000	400,000	1	—	150,000	406,000	April 9.
Deferred	1	—	6,000	6,000	1	—			
7 p.c. Debs.	50	—	200,000	200,000	50	—			
Montreal, Royal Electric Company of, 100dol. shares	20	20	—	50,000	23 15 6	—	—	—	—
South London Electric Supply	5	5	325,000	325,000	5	—	—	—	April 1.
London Motor Van and Wagon ..	5	5	300 000	300,000	5	—	—	150,000	Feb. 21.

Amongst the issues offered by tender we note National Telephone 5 p.c. 3rd Preference, with a capital amount of £653,830 redeemable at par; the minimum price during the half-year was 5¾, and the average price obtained was £5. 16s. 6d.

THE BRITISH ASSOCIATION.

Address to the Mechanical Science Section.

BY G. F. DEACON, M.I.C.E., PRESIDENT OF THE SECTION.

In this ever-memorable year of the Victorian age, it is not unnatural that anyone called to fill the chair I occupy to-day should experience a sense of oppression when contemplating the fruits of mechanical science during the last 60 years, and the tremendous vista, fading in the distance to a dream, of the fruits it is destined to produce before such another period shall have passed away. There would be no possibility in the time at my disposal, even if I were qualified to attempt it, of adequately reviewing the past; and however fascinating the thought may be, it would ill become my office to venture far along the vista before us, lest a too airy imagination should break the bonds of that knowledge and that truth to which she must ever remain, in our rightful speculations, a helpful, if not always an obedient, handmaiden.

In the year 1831, two places—the one ancient and memorable, the other young, but destined to become memorable—bore the name of York. At the first of these, amid relics of ancient Rome and lasting memorials of the better phases of Britain's mediæval history, were met together in that year the earliest members of the British Association. And as the sun at noonday shone on that ancient York, it rose upon the other York—a little town, scarcely more than a village, of 1,700 people, fast springing from a plain on the shores of Ontario, where the wigwam of the Chippewa had lately been; and between the two lay the Atlantic and a distance of 4,000 miles. Sixty-six years later, the British Association meets in that other York, distinguished under the name of Toronto, and grown into a noble city. Painfully, in stage coaches, must many of the founders of this association have travelled to that ancient York; peacefully and amid all comfort and luxury have we from the mother country reached, at her invitation, this great city—chiefest, in its people, its commerce, and its university, of the cities of Western Canada. Neither at the meeting in York of 1831, nor elsewhere, until many years later, was there any expectation of the possibility of these things. Six years later, about the beginning of that glorious reign of which the sixty-first year is now passing—although two or three vessels had already crossed the Atlantic under steam, it was still seriously doubted whether, without the aid of a Government subsidy of considerable amount, a line of steamers, even for the New York service, could be permanently maintained. It was not, indeed, until 1838 that the "Great Western" inaugurated the attempt on a commercial basis, and she performed in 15 days the voyage which is now regularly performed with complete commercial success in five.

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Would not the suggestion of such a change, of such a spanning of great distances, of such a consequent growth of prosperity and of culture, within the reign of a princess then approaching womanhood, have been received as the wildest of forecasts by the British Association of 1831? Yet this is but one of a multitude of results, no less startling, which the same agencies have brought about. We are now holding the second meeting of the association in Canada, and at the first such meeting, held 13 years ago in Montreal, some hundreds of miles nearer home, Sir Frederick Bramwell told you from this chair, in his own inimitable way, the causes of so great a change, and he pointed out to you, as I venture to point out again, that the visible instruments of that change have been forged by the men who are, or were, or ought to be, the members of Section G. To such encouragement as Section G has given is largely due the progress and triumph of applied mechanics as the natural outcome of theoretical investigation and physical research. Finally, and with no reserve in the minds of reasonable men, the old fallacy of a discord between theory and practice has been swept away. For centuries that fallacy held apart, as it were, the oxygen and the nitrogen of that atmosphere in which alone the new life could exist. It limited the philosopher who examined the laws of nature almost entirely to the study of phenomena external to the earth on which he dwelt, and it stamped the practical man as a lower being, the possessor of certain necessary knowledge, having no relation to the studies of the schoolmen, and which it would be beneath their dignity to pursue. And notwithstanding the great names which have stood out in opposition to these views, the popular idea of discord between theory and practice took long to die, and only within the Victorian age has the complete truth been generally recognised, that if one fails to account for the result of any physical combination, the cause is to be found not in any discord with theory, but in the fact that the observer has failed to discover the whole of the theory.

We English-speaking people, alone, I believe, among civilised nations, use this word theory with unpardonable looseness—as almost synonymous in effect with hypothesis, and the result is fruitful of error. Until the truth of any hypothesis is placed beyond all manner of doubt it is not, and should never be called, the theory. Within these walls the *genius loci* impels me to thoughts which have not often entered into discussions of Section G; and, perhaps, if this address were to be discussed, I should choose subjects and premises, the proof of which, to the satisfaction of others than myself, it would probably be less difficult to maintain. In this University of Toronto under whose ægis all that was best in the older schools of thought is cultivated by the side of those practical applications of science which in bygone days were distinguished as the unworthy uses of philosophy, one's thoughts insensibly turn to the marvellous change in the opportunities afforded for acquiring a knowledge of applied science—for becoming, in short, an engineer.

It is not proposed to discuss the progress and prosperity which mechanical science has brought about in the Victorian era, much less that which the succeeding years will yield; but I venture to think that a proper subject for consideration from this chair, if not for discussion in this section, is to be found in any unnecessary waste of energy which may occur in the process of mental development of the men who are to succeed us in the great work to which we devote our lives. Obviously it is to the interests of our calling, and consequently of the nation at large, that such waste should be reduced to a minimum, and therefore I make no apology for mentioning certain points in which its presence is particularly striking. There may be waste of potential, as well as of actual energy, and if we fail to expend energy on certain subjects because our time is occupied with others which are less useful, it is waste of energy only differing in degree from its expenditure on useless subjects. There is assuredly no lack of potential energy in the coming race. In spite of any training, whether well or ill directed, a large proportion will become actual and useful energy; but guidance and direction being given, the mode of that guidance and direction should be the one best calculated to secure the highest possible proportion of useful effect.

If we look back at the greatest names among the engineers and inventors of the latter part of the eighteenth century and the first half of this, we find that the majority were brought up in pursuits quite distinct from the work of their after-lives, and by which they have become so familiar to us. There were scarcely any means whatever, beyond the original thought and dogged perseverance of the worker, by which those men could attain the knowledge they used with such effect. Men of no less exceptional parts are among us now, but the whole environment of their early work has changed. We have given to the exceptional man a starting point of knowledge which, wisely used, lifts him as high above our heads as of old, but we have given to the average man a comparatively easy means of attaining the same knowledge. We cannot ensure the wise use of that knowledge, but we can at least endeavour to impart it in such a manner that the sense of right proportion shall be acquired and maintained. We have made it more difficult to distinguish between the exceptional and the commonplace—between the gold and the silver, if not between the silver and the brass; let us be careful, so far as early guidance can control it, that the knowledge imparted to the average mind gives to that mind a fair start concerning the relations, undivided and indivisible, between true theory and sound practice.

Having myself passed as an ordinary apprentice through workshops of mechanical engineering in the old days when working hours were longer than they are now—from six in the morning till six in the evening—and that, too, on the banks of the Clyde, where no special indulgence was given to what was sometimes called the "gentleman apprentice," and feeling convinced, as I still do, of the immense and permanent advantage derived from that experience, I shall not be judged to underrate its value in the case of others who have yet to choose the details of the career by which they expect to gain a place in the profession or business of an engineer. On the other hand, as a student 34 years ago under the late Prof. Macquorn Rankine and the present Lord Kelvin, I shall not be prone to under-estimate the advantages of academical training in its proper application to the profession to which I am proud to belong.

In the pursuit of that profession it has fallen to my lot to observe the training as engineers of many younger men—men of variously constituted minds, but one and all bent on learning some portion of "the art of directing the great sources of power in nature for the use and convenience of man," words wisely chosen 69 years ago, and set out as the object of the profession in the Royal charter of the Institution of Civil Civil Engineers. It is a noble object, this direction of the great forces of nature for the use and convenience of man; it is an ambitious object, and one which I venture to think demands for its right performance the best energies of well-balanced minds working upon a store of knowledge which nothing but years of untiring study and observation can give. Yet there is no hesitation shown to enter the lists. The number of candidates is appalling. In the old country, at least, there certainly is not work for all, but when one points this out, anxious parents only reply that the difficulty is as great in connection with any other profession. Whether this be so or not I cannot judge, but I am persuaded that of those who do enter the business or profession of the engineer, the enormous majority are not born engineers, and cannot, in the nature of things, hope for success unless they take advantage of the best facilities open to them—the best facilities; here is the difficulty: from the multitude of facilities how are we to choose?

Do not suppose that I think the training of the born engineer should not be controlled. He will stand head and shoulders above the rest of us whatever we may do with him; but in order that his exceptional parts may not wreck him as an engineer, and in order that his energies may be rightly directed at the start, he, too, should have the advantages of that systematic training which to his less gifted brethren is becoming more and more absolutely essential to success. At the time I began practice, the large majority of young engineers were left entirely to their own devices so far as the attainment of any scientific knowledge was concerned. As pupils or apprentices, articled or not, they entered an engineer's works or office; for a certain number of years they had the run of the place, and some encouragement if they worked well, but it could not, in the nature of things, amount to much more. This was a very necessary, perhaps the most necessary, element of their training, but except to the few who were so constituted that with little or no guidance they could supplement their practical knowledge with the study of principles elsewhere, it was entirely ineffectual in the production of that well-balanced attitude of mind which any person who properly assumes the name of an engineer must hold towards every engineering problem, great or small, which he is called upon to solve. And so strongly have I felt this, that in the earlier days, when there were fewer schools of practical science, and when their utility was little understood, I required, wherever the matter was under my control, the insertion into the articles of apprenticeship of a clause by which, at some inconvenience to the office, the pupil was required to attend two sessions at the science classes of Glasgow University, or at some other approved school of practical science, and without this condition I declined to take the responsibility attaching to the introduction into the profession of men who, in their earlier careers, from no fault of their own, had not even acquired a knowledge of what there was to learn, much less of how to learn it. More recently this course has generally become unnecessary, for in Westminster, at least, the young engineer rarely enters an office until he has acquired some knowledge of what he has to learn. He enters, in short, at a much more advanced age than formerly. When it is essential that he should be earning something soon after he comes of age, anything like a complete training is an impossibility. His work ceases to be general, and his practice is more or less confined in a much narrower sphere than need be the case if the pursuit of further knowledge continues to be his chief duty.

But whatever course his circumstances may permit him to adopt, the difficulty of gaining the required knowledge in the

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time available is a serious one. This is not the place to enquire whether public school education in the mother country is or is not the best for the general purposes of after-life, or to discuss what improvements may be made in it, and of higher education in Canada I unfortunately know little or nothing. Personally, I admit the possibility of improvement in the English system, and slowly, but surely, improvement is creeping in, as such changes rightly find their way into institutions which have done so much for Englishmen. In this particular I lean to the conservative side, and whatever our individual views may be concerning the time spent on the study of Latin and Greek, we should all probably agree that the school education of an engineer should be as thorough and liberal as for any other profession. But for the sake of a technical training to follow, this school education is often unduly curtailed, to the great after-grief, in very many cases, of the successful engineer, and, not infrequently, also of the less successful engineer, who, in some phases of his professional career, has been only too keenly alive to the self-reproach and sense of inferiority which want of thoroughness or of time, or of both, at school has brought upon him. But at some time the boy must leave school. Let us hope that he does not aspire "to control the great forces of nature"; but if he does we must make the best we can of him. It is not desirable, at least so it appears to me, that even at this stage his training should be specialised in view of the particular branch of the profession or business he is likely to follow. The fundamental principles of any branch of mechanical engineering are broadly the fundamental principles of any branch of the profession. I hesitate to speak of civil engineering as if it were a separate branch, instead of being, as it really is, the generic name of the profession; but the training demanded for the various branches of civil engineering in its narrower sense is precisely the same as that required in its earlier stages for mechanical engineering pure and simple.

I shall make no attempt to review the large number of excellent courses which are now available for the teaching of applied science in relation to engineering. Experience of the results as judged by the students who have come directly under my notice, and examination of many calendars, has aroused various thoughts concerning them, and this thought is, perhaps, uppermost; are we not in some cases attempting at too early a stage the teaching of subjects instead of principles? Complete subjects, I mean, including the practical working of details which will become the regular study of the student in the office or works of an engineer. It certainly seems to me to be so. I do not say that subject training of this kind at college may not be useful; but we have to consider whether it does not, for the sake of some little anticipation of his office work, divert the attention of the student from the better mastery of those principles which it is so essential for him to grasp at the earliest possible time, and which do not limit his choice in the battle of life to any branch whatever of the profession or business of an engineer, but which, on the contrary, qualify him better to pursue with success whatever branches his inclination or his opportunities or his means may suggest. Not one in a hundred of us can hope to emulate the careers of exceptional men in our profession, but it is sometimes useful to observe those careers, and whenever we do so we find the very reverse of specialisation. The minds of such men are impregnated with the fundamental principles which we may call the common law of our art; it has happened that their practice has been large in certain branches, and small or wanting in certain others; but in any it would have been equally successful. Of no class of men can it be said with greater truth than of engineers that their standard should be sound knowledge of the principles of many things and of the practice of a few.

There is some danger in the usual limitation of compulsory subjects in examinations for certificates and degrees. When an examination has to be passed subjects not made compulsory are too often entirely neglected, however important to the engineer they may be. A little learning is certainly not a dangerous thing if within its limits it is sound, and every engineer will in after-life be grateful to those who in his student days insisted upon his acquiring some knowledge of the principles of such subjects as electricity and chemistry. At present it too often happens that unless an engineering student is predestined to practise electrical work or some chemical industry, he begins life as an engineer with no knowledge of the principles of either the one or the other, and chiefly as a result of their neglect for the sake of certain subjects made compulsory for the test he has had to pass, which subjects too occasionally include the highly specialised favourites of a particular professor, or verge too completely on perfected details which, I venture to think, cannot be rightly mastered in schools. It is natural and right that each professor of a principal subject should seek to make the best, from his own particular standpoint, of every student who attends his lectures or his laboratories; and the professor of a compulsory subject cannot be expected to encourage the inclusion, in a course already overcrowded, of secondary or collateral subjects which are dealt with by other professors; while, on the other hand, the professors of secondary subjects, such as electricity or chemistry, not unnaturally value chiefly the students who make those subjects their principal work. For these reasons it appears to me that a certain very moderate standard in all such subjects should be made compulsory if a certificate of proficiency, whether by degree or otherwise, is to be given in engineering or even in physical science. In the teaching of mathematics within the Victorian age a considerable change has taken place, and I plead for still a little more change in the same direction where the training of the engineer is concerned. Mathematics, as taught in our public schools—let us say for the Cambridge University Tripos—may be all that is claimed for it as a mode of mental culture; but of kindred mental culture the engineer must necessarily have more than most men, and much might therefore be omitted which, to him at least, has only an abstract value, to the great advantage of his mastery over those branches which at once train his mind and give point and direct utility to his solutions.

In America I understand that a college course of engineering generally includes workshop practice designed to supersede the old system of apprenticeship to a mechanical engineer. This fact and other important differences between the English and American practice have only lately come to my knowledge, and before they did so the substance of this address had been written. It might, in some particulars, require modification as applied to Canada, but it remains the result of my observations concerning the conditions of engineering education which obtain in the mother country.

A few words now in relation to that physical and mental training gained laboriously, and somewhat wastefully as I think, at the joiner's bench, in the fitting and turning shops, the foundry and the forge, during the old course of mechanical engineering apprenticeship. I am convinced that the kind of knowledge which comes of thoughtful chipping and filing and turning and forging, though only applied to a few of the materials with which in after-life the engineer has to deal, are quite as important as tables of density and strength to his future sense of rightness in constructive design. The use of such work is not merely to teach one the parts and combinations of any particular machine; in a still higher degree it is the insensible mastery of a much more subtle knowledge or mental power, the application of the senses of sight and touch and force, it may be of other senses also, to the determination of the nature of things. (I am not going to apologise for referring to the sense of force. The vexed question of its separate existence appears to me to have been settled 14 years ago by Lord Kelvin in his address at Birmingham on "the six gateways of knowledge," and I may well leave it where he left it.) I should altogether fail to describe adequately what this mastery means. It appears to be to be inscrutable. The value and nature of the power can only be appreciated by those who have experienced it, and who have felt its defect in those of their assistants or in others who do not possess it. But the great workshop training has still further advantages. The apprentice is surrounded by skilled workers from whose example, if he is wise, he learns a great deal; and apart from this, it is no small profit to have rubbed against the British workman, to have discovered what manner of man he is, and to comprehend how little the world knows of his best parts. The whole time spent in large engineering works cannot, however, be equally beneficial; the apprentice must take the work as it comes; the most interesting or instructive portions cannot be reserved for him, and he often feels that some of his time is being well-nigh wasted. A few years ago I should not have thought it practicable usefully to substitute for such a course anything that could be undertaken in a student's workshop, however organised; but the impossibility, in many cases, of including such experience without neglecting something equally important has led me to view with satisfaction the introduction of workshop training into certain schools of applied science in England. Such a change cannot, of course, carry with it all the advantages of experience in the great workshop and of contact with its workers, but those advantages which it does retain may be secured in a shorter time where there is no commercial interest to be served.

In Canada and the United States, as I have already said, the principle of the student's workshop has been carried considerably further. Compared with the old country, I believe the number of young assistant engineers who in proportion to the number of their chiefs can find employment in America is much greater, and that it would be practically impossible for the British system of pupilage to be generally employed. Here, therefore, the whole college training of an engineer is designed to fit him for immediate employment in some specific branch of the profession, and up to this point his training is, necessarily no doubt, more academic than in England, where the application of the principles he has acquired at college is still generally left for the office or works of the engineer. With this difference I am not at present concerned, but I desire to reiterate what I have already said to the effect that where, as in England, the student of engineering has the opportunity of continuing his training in the office or works, it is better than his limited

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college course should cover all that is possible of the principles of those sciences which may prove useful or necessary to him in after-life, rather than that any of them should be omitted for the sake of anticipating the practical application of certain others.

The compulsory inclusion of the principles of all such subjects as chemistry, electricity, geology, and many others, in science courses intended for a future engineer is desirable, not only because a fundamental knowledge of them leaves open a very much wider field from which the engineer may, as opportunity offers, increase his knowledge and practice in the future, but because many of such subjects are inseparable from an intelligent understanding of almost any great engineering work. "Nothing so difficult as a beginning" may be a proverb of rather too far-reaching a nature, but it contains the suggestion of a great truth, increasing in weight as we grow older, and the beginning of such collateral sciences should therefore find a place in every engineering student's store of early knowledge.

But after all, when these things have been done in the best manner—when the scientific and practical training of the engineering student has been all that can be desired—it is a matter of general experience among engineers who have closely watched the rising generation, that the most successful men in after-life are not produced exclusively from the ranks of those whose college course has been most successful. No doubt such men have on the average been nearer the top than the bottom, but it is an undoubted fact that when we class them according to their earlier successes or failures, we find the most remarkable disparities. We find many who in academic days gave but little promise, and we miss large numbers who promised great things. These facts are not confined to the profession of the engineer, but they seem to me to be accentuated in that profession. We shall no doubt be right in attributing the disparity to differences of mental temperament and of opportunity; but does it follow that there are no faculties which may be cultivated to reduce the effect of such differences? I venture to think there are. I will instance only one, but perhaps the most important of such faculties, and which, in my experience among young engineers, is exceptionally rare. I refer to the power of marshalling facts, and so thinking, or speaking, or writing of them that each maintains its due significance and value.

In the minds of many young engineers a mathematical training undoubtedly has the effect of making it extremely difficult to avoid spending an amount of time upon some issues out of all proportion to their importance; while other issues which do not readily lend themselves to mathematical treatment, but which are many times more important, are taken for granted upon utterly insufficient data, and chiefly because they cannot be treated by any process of calculation. I believe that nothing but well-directed observation and long experience can enable one to assign to each part of a large engineering problem its due importance; but much may be done in early training also, and I think ought to be done, to lead the mind in broader lines, to accustom it to look all round the problem, and to control the imagination or the natural predilection for one phase from disguising the real importance of others. In the practical design and execution of important works the man will sooner or later be recognised who has the power so to formulate his knowledge, and on the same principles has succeeded in so marshalling and expressing his thoughts, as to convey to those by whom he is employed just so much as may be necessary and proper for their use. Such considerations are not, it is true, a branch of mechanical science, but being essentially important to the attainment of maximum usefulness in the application of any science to the various branches of engineering which are the chief ends and aims of mechanical science, they are, I think, worthy of mention from this chair. In proportion as the engineer possesses and exercises such powers he will avoid those innumerable pitfalls to which imperfectly instructed ingenuity is so particularly liable, and to which the Patent Office is so sad a witness, and in the same proportion must always be the useful outcome of the great schools of science which have become so striking a feature of the later Victorian age.

In relation to the results of applied science, I have spoken only of the steamship. Add the telegraph, and I think we have the most important tools by which the present conditions of modern civilisation have been rendered possible. And, more than this, I think we have, in the lessening of space, and the facility for intercourse they give, the chief secret of that marvellous development of the empire which this year has so pleasantly and so memorably signalised. Is "Our Lady of" the Sunshine and "the Snows" no nearer to the mother land than 60 years ago? Are the Australias—New Zealand—no nearer to both? Assuredly they are. Would British Africa, would the Indian Empire have been possible to Britain on the principles and the methods of Imperial Rome? Unquestionably not. Then let me say again that I claim for the objects and the work of Section G a magnificent record, an abiding power for the peace of the world, and for the unity and prosperity of the great empire to which we belong.

Address to the Chemical Section.

BY PROF. WILLIAM RAMSAY, PH.D., LL.D., SC.D., F.R.S., PRESIDENT OF THE SECTION.

An Undiscovered Gas.

A sectional address to members of the British Association falls under one of three heads. It may be historical, or actual, or prophetic; it may refer to the past, the present, or the future. In many cases, indeed in all, this classification overlaps. Your former presidents have given sometimes a historical introduction, followed by an account of the actual state of some branch of our science, and, though rarely, concluding with prophetic remarks. To those who have an affection for the past, the historical side appeals forcibly; to the practical man, and to the investigator engaged in research, the actual, perhaps, presents more charm; while to the general public, to whom novelty is often more of an attraction than truth, the prophetic aspect excites most interest. In this address I must endeavour to tickle all palates, and perhaps I may be excused if I take this opportunity of indulging in the dangerous luxury of prophecy, a luxury which the managers of scientific journals do not often permit their readers to taste.

The subject of my remarks to-day is a new gas. I shall describe to you later its curious properties; but it would be unfair not to put you at once in possession of the knowledge of its most remarkable property—it has not yet been discovered. As it is still unborn, it has not yet been named. The naming of a new element is no easy matter. For there are only 26 letters in our alphabet, and there already over 70 elements. To select a name expressible by a symbol which has not already been claimed for one of the known elements is difficult, and the difficulty is enhanced when it is at the same time required to select a name which shall be descriptive of the properties (or want of properties) of the element. It is now my task to bring before you the evidence for the existence of this undiscovered element. It was noticed by Döbereiner, as long ago as 1817, that certain elements could be arranged in groups of three. The choice of the elements selected to form these triads was made on account of their analogous properties, and on the sequence of their atomic weights, which had at that time only recently been discovered. Thus calcium, strontium, and barium formed such a group; their oxides, lime, strontia, and baryta are all easily slaked, combining with water to form soluble lime-water, strontia-water, and baryta-water. Their sulphates are all sparingly soluble, and resemblance had been noticed between their respective chlorides and between their nitrates. Regularity was also displayed by their atomic weights. The numbers then accepted were 20, 42·5, and 65; and the atomic weight of strontium, 42·5, is the arithmetical mean of those of the other two elements, for $(65 + 20)/2 = 42·5$. The existence of other similar groups of three was pointed out by Döbereiner, and such groups became known as "Döbereiner's triads."

Another method of classifying the elements, also depending on their atomic weights, was suggested by Pettenkofer, and afterwards elaborated by Kremers, Gladstone, and Cooke. It consisted in seeking for some expression which would represent the differences between the atomic weights of certain allied elements. Thus, the difference between the atomic weight of lithium, 7, and sodium, 23, is 16; and between that of sodium and of potassium, 39, is also 16. The regularity is not always so conspicuous; Dumas, in 1857, contrived a somewhat complicated expression which, to some extent, exhibited regularity in the atomic weights of fluorine, chlorine, bromine, and iodine; and also of nitrogen, phosphorus, arsenic, antimony, and bismuth. The upshot of these efforts to discover regularity was that, in 1864, Mr. John Newlands, having arranged the elements in eight groups, found that when placed in the order of their atomic weights, "the eighth element, starting from a given one, is a kind of repetition of the first, like the eighth note of an octave in music." To this regularity he gave the name "the law of octaves." The development of this idea, as all chemists know, was due to the late Prof. Lothar Meyer, of Tübingen, and to Prof. Mendeléeff, of St. Petersburg. It is generally known as the "periodic law." One of the simplest methods of showing this arrangement is by means of a cylinder divided into eight segments by lines drawn parallel to its axis; a spiral line is then traced round the cylinder, which will, of course, be cut by these lines eight times at each revolution. Holding the cylinder vertically, the name and atomic weight of an element is written at each intersection of the spiral with a vertical line, following the numerical order of the atomic weights. It will be found, according to Lothar Meyer and Mendeléeff, that the elements grouped down each of the vertical lines form a natural class; they possess similar properties, form similar compounds, and exhibit a graded relationship between their densities, melting points, and many of their other properties. One of these vertical columns, however, differs from the others, inasmuch as on it there are three groups, each consisting of three elements with approxi-

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mately equal atomic weights. The elements in question are iron, cobalt, and nickel: palladium, rhodium, and ruthenium; and platinum, iridium, and osmium. There is apparently room for a fourth group of three elements in this column, and it may be a fifth. And the discovery of such a group is not unlikely, for when this table was first drawn up Prof. Mendeléeff drew attention to certain gaps, which have since been filled up by the discovery of gallium, germanium, and others.

The discovery of argon at once raised the curiosity of Lord Rayleigh and myself as to its position in this table. With a density of nearly 20, if a diatomic gas, like oxygen and nitrogen, it would follow fluorine in the periodic table; and our first idea was that argon was probably a mixture of three gases, all of which possessed nearly the same atomic weights, like iron, cobalt, and nickel. Indeed, their names were suggested, on this supposition, with patriotic bias, as Anglium, Scotium, and Hibernium! But when the ratio of its specific heats had, at least in our opinion, unmistakably shown that it was molecularly monatomic, and not diatomic, as at first conjectured, it was necessary to believe that its atomic weight was 40, and not 20, and that it followed chlorine in the atomic table, and not fluorine. But here arises a difficulty. The atomic weight of chlorine is 35·5, and that of potassium, the next element in order in the table, is 39·1; and that of argon, 40, follows, and does not precede, that of potassium, as it might be expected to do. It still remains possible that argon, instead of consisting wholly of monatomic molecules, may contain a small percentage of diatomic molecules; but the evidence in favour of this supposition is, in my opinion, far from strong. Another possibility is that argon, as at first conjectured, may consist of a mixture of more than one element; but unless the atomic weight of one of the elements in the supposed mixture is very high, say 82, the case is not bettered, for one of the elements in the supposed trio would still have a higher atomic weight than potassium. And very careful experiments, carried out by Dr. Norman Collie and myself, on the fractional diffusion of argon, have disproved the existence of any such element with high atomic weight in argon, and, indeed, have practically demonstrated that argon is a simple substance, and not a mixture.

The discovery of helium has thrown a new light on this subject. Helium, it will be remembered, is evolved on heating certain minerals, notably those containing uranium; although it appears to be contained in others in which uranium is not present, except in traces. Among these minerals are clèveite, monazite, fergusonite, and a host of similar complex mixtures, all containing rare elements, such as niobium, tantalum, yttrium, cerium, etc. The spectrum of helium is characterised by a remarkably brilliant yellow line, which had been observed as long ago as 1868 by Profs. Frankland and Lockyer in the spectrum of the sun's chromosphere, and named "helium" at that early date. The density of helium proved to be very close to 2·0, and, like argon, the ratio of its specific heat showed that it, too, was a monatomic gas. Its atomic weight, therefore, is identical with its molecular weight—viz., 4·0—and its place in the periodic table is between hydrogen and lithium, the atomic weight of which is 7·0. The difference between the atomic weights of helium and argon is thus 36, or 40 – 4. Now there are several cases of such a difference. For instance, in the group the first member of which is fluorine we have—

Fluorine	19	
		16·5
Chlorine	35·5	
		19·5
Manganese	55	

In the oxygen group—

Oxygen	16	
		16
Sulphur	32	
		20·3
Chromium	52·3	

In the nitrogen group—

Nitrogen	14	
		17
Phosphorus	31	
		20·4
Vanadium	51·4	

And in the carbon group—

Carbon	12	
		16·3
Silicon	28·3	
		19·8
Titanium	48·1	

These instances suffice to show that approximately the differences are 16 and 20 between consecutive members of the corresponding groups of elements. The total differences between the extreme members of the short series mentioned are—

Manganese – fluorine	36
Chromium – oxygen	36·3
Vanadium – nitrogen	37·4
Titanium – carbon	36·1

This is approximately the difference between the atomic weights of helium and argon, 36.

There should, therefore, be an undiscovered element between helium and argon, with an atomic weight 16 units higher than that of helium, and 20 units lower than that of argon—namely, 20. And if this unknown element, like helium and argon, should prove to consist of monatomic molecules, then its density should be half its atomic weight, 10. And pushing the analogy still farther, it is to be expected that this element should be as indifferent to union with other elements as the two allied elements. My assistant, Mr. Morris Travers, has indefatigably aided me in a search for this unknown gas. There is a proverb about looking for a needle in a haystack; modern science, with the aid of suitable magnetic appliances, would, if the reward were sufficient, make short work of that proverbial needle. But here is a supposed unknown gas, endowed no doubt with negative properties, and the whole world to find it in. Still, the attempt had to be made. We first directed our attention to the sources of helium—minerals. Almost every mineral which we could obtain was heated in a vacuum, and the gas which was evolved examined. The results are interesting. Most minerals give off gas when heated, and the gas contains, as a rule, a considerable amount of hydrogen, mixed with carbonic acid, questionable traces of nitrogen, and carbonic oxide. Many of the minerals, in addition, gave helium, which proved to be widely distributed, though only in minute proportion. One mineral—malacone—gave appreciable quantities of argon; and it is noteworthy that argon was not found except in it (and, curiously, in much larger amount than helium), and in a specimen of meteoric iron. Other specimens of meteoric iron were examined, but were found to contain mainly hydrogen, with no trace of either argon or helium. It is probable that the sources of meteorites might be traced in this manner, and that each could be relegated to its particular swarm. Among the minerals examined was one to which our attention had been directed by Prof. Lockyer, named eliasite, from which he said that he had extracted a gas in which he had observed spectrum lines foreign to helium. He was kind enough to furnish us with a specimen of this mineral, which is exceedingly rare, but the sample which we tested contained nothing but undoubted helium. During a trip to Iceland in 1895, I collected some gas from the boiling springs there; it consisted, for the most part, of air, but contained somewhat more argon than is usually dissolved when air is shaken with water. In the spring of 1896 Mr. Travers and I made a trip to the Pyrenees to collect gas from the mineral springs of Cauterets, to which our attention had been directed by Dr. Bouchard, who pointed out that these gases are rich in helium. We examined a number of samples from the various springs, and confirmed Dr. Bouchard's results, but there was no sign of any unknown lines in the spectrum of these gases. Our quest was in vain.

We must now turn to another aspect of the subject. Shortly after the discovery of helium, its spectrum was very carefully examined by Profs. Runge and Paschen, the renowned spectroscopists. The spectrum was photographed, special attention being paid to the invisible portions, termed the "ultra-violet" and "infra-red." The lines thus registered were found to have a harmonic relation to each other. They admitted of division into two sets, each complete in itself. Now, a similar process had been applied to the spectrum of lithium and to that of sodium, and the spectra of these elements gave only one series each. Hence, Profs. Runge and Paschen concluded that the gas, to which the provisional name of helium had been given, was, in reality, a mixture of two gases, closely resembling each other in properties. As we know no other elements with atomic weights between those of hydrogen and lithium, there is no chemical evidence either for or against this supposition. Prof. Runge supposed that he had obtained evidence of the separation of these imagined elements from each other by means of diffusion; but Mr. Travers and I pointed out that the same alteration of spectrum, which was apparently produced by diffusion, could also be caused by altering the pressure of the gas in the vacuum tube: and shortly after Prof. Runge acknowledged his mistake. These considerations, however, made it desirable to subject helium to systematic diffusion, in the same way as argon had been tried. The experiments were carried out in the summer of 1896 by Dr. Collie and myself. The result was encouraging. It was found possible to separate helium into two portions of different rates of diffusion, and consequently of different density by this means. The limits of separation, however, were not very great. On the one hand, we obtained gas of a density close on 2·0; and on the other, a sample of density 2·4 or thereabouts. The difficulty was increased by the curious behaviour, which we have often had occasion to confirm, that helium possesses a rate of diffusion too rapid for its density. Thus, the density of the lightest portion of the diffused gas, calculated from its rate of diffusion, was 1·874; but this corresponds to a real density of about 2·0. After our paper, giving an account of these experiments, had been published, a German investigator, Herr A. Hagenbach, repeated our work and confirmed our results.

The two samples of gas of different density differ also in other properties. Different transparent substances differ in the rate at which they allow light to pass through them. Thus, light travels through water at a much slower rate than through air, and at a slower rate through air than through hydrogen. Now Lord Rayleigh found that helium offers less opposition to the passage of light than any other

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substance does, and the heavier of the two portions into which helium had been split offered more opposition than the lighter portion, and the retardation of the light, unlike what has usually been observed, was nearly proportional to the densities of the samples. The spectrum of these two samples did not differ in the minutest particular, therefore it did not appear quite out of the question to hazard the speculation that the process of diffusion was instrumental, not necessarily in separating two kinds of gas from each other, but actually in removing light molecules of the same kind from heavy molecules. This idea is not new. It had been advanced by Prof. Schutzenberger (whose recent death all chemists have to deplore), and later, by Mr. Crookes, that what we term the atomic weight of an element is a mean; that when we say that the atomic weight of oxygen is 16, we merely state that the average atomic weight is 16: and it is not inconceivable that a certain number of molecules have a weight somewhat higher than 32, while a certain number have a lower weight. We therefore thought it necessary to test this question by direct experiment with some known gas, and we chose nitrogen as a good material with which to test the point. A much larger and more convenient apparatus for diffusing gases was built by Mr. Travers and myself, and a set of systematic diffusions of nitrogen was carried out. After 30 rounds, corresponding to 180 diffusions, the density of the nitrogen was unaltered, and that of the portion which should have diffused most slowly, had there been any difference in rate, was identical with that of the most quickly diffusing portion—*i.e.*, with that of the portion which passed first through the porous plug. This attempt, therefore, was unsuccessful, but it was worth carrying out, for it is now certain that it is not possible to separate a gas of undoubted chemical unity into portions of different density by diffusion. And these experiments rendered it exceedingly improbable that the difference in density of the two fractions of helium was due to separation of light molecules of helium from heavy molecules.

The apparatus used for diffusion had a capacity of about two litres. It was filled with helium, and the operation of diffusion was carried through 30 times. There were six reservoirs, each full of gas, and each was separated into two by diffusion. To the heavier portion of one lot the lighter portion of the next was added, and in this manner all six reservoirs were successively passed through the diffusion apparatus. This process was carried out 30 times, each of the six reservoirs having had its gas diffused each time, thus involving 180 diffusions. After this process the density of the more quickly diffusing gas was reduced to 2·02, while that of the less quickly diffusing had increased to 2·27. The light portion on rediffusion hardly altered in density, while the heavier portion, when divided into three portions by diffusion, showed a considerable difference in density between the first third and the last third. A similar set of operations was carried out with a fresh quantity of helium in order to accumulate enough gas to obtain a sufficient quantity for a second series of diffusions. The more quickly diffusing portions of both gases were mixed and rediffused. The density of the lightest portion of these gases was 1·98: and after other 15 diffusions the density of the lightest portion had not decreased. The end had been reached. It was not possible to obtain a lighter portion by diffusion. The density of the main body of this gas is therefore 1·98, and its refractivity, air being taken as unity, is 0·1245. The spectrum of this portion does not differ in any respect from the usual spectrum of helium. As rediffusion does not alter the density or the refractivity of this gas, it is right to suppose that either one definite element has now been isolated; or that if there are more elements than one present, they possess the same, or very nearly the same, density and refractivity. There may be a group of elements, say three, like iron, cobalt, and nickel; but there is no proof that this idea is correct, and the simplicity of the spectrum would be an argument against such a supposition. This substance, forming by far the larger part of the whole amount of the gas, must, in the present state of our knowledge, be regarded as pure helium.

On the other hand, the heavier residue is easily altered in density by rediffusion, and this would imply that it consists of a small quantity of a heavy gas mixed with a large quantity of the light gas. Repeated rediffusion convinced us that there was only a very small amount of the heavy gas present in the mixture. The portion which contained the largest amount of heavy gas was found to have the density 2·275, and its refractive index was found to be 0·1333. On rediffusion this portion of gas until only a trace sufficient to fill a Plücker's tube was left, and then examining the spectrum, no unknown lines could be detected, but, on interposing a jar and spark gap, the well-known blue lines of argon became visible; and even without the jar the red lines of argon, and the two green groups, were distinctly visible. The amount of argon present calculated from the density was 1·64 per cent., and from the refractivity 1·14 per cent. The conclusion had therefore to be drawn that the heavy constituent of helium, as it comes off the minerals containing it, is nothing new, but, so far as can be made out, merely a small amount of argon. If, then, there is a new gas in what is generally termed helium, it is mixed with argon, and it must be present in extremely minute traces. As neither helium nor argon has been induced to form compounds, there does not appear to be any method, other than diffusion, for isolating such a gas, if it exists, and that method has failed in our hands to give any evidence of the existence of such a gas. It by no means follows that the gas does not exist; the only conclusion to be drawn is that we have not yet stumbled on the material which contains it. In fact, the haystack is too large and the needle too inconspicuous. Reference to the periodic table will show that between the elements aluminium and indium there occurs gallium, a substance occurring only in the minutest amount on the earth's surface; and following silicon, and preceding tin, appears the element germanium, a body which has as yet been recognised only in one of the rarest of minerals, argyrodite. Now, the amount of helium in fergusonite, one of the minerals which yields it in reasonable quantity, is only 33 parts by weight in 100,000 of the mineral; and it is not improbable that some other mineral may contain the new gas in even more minute proportion. If, however, it is accompanied in its still undiscovered source by argon and helium, it will be a work of extreme difficulty to effect a separation from these gases.

In these remarks it has been assumed that the new gas will resemble argon and helium in being indifferent to the action of reagents, and in not forming compounds. This supposition is worth examining. In considering it, the analogy with other elements is all that we have to guide us. We have already paid some attention to several triads of elements. We have seen that the differences in atomic weights between the elements fluorine and manganese, oxygen and chromium, nitrogen and vanadium, carbon and titanium, is in each case approximately the same as that between helium and argon—viz., 36. If elements further back in the periodic table be examined, it is to be noticed that the differences grow less, the smaller the atomic weights. Thus, between boron and scandium, the difference is 33; between beryllium (glucinum) and calcium, 31; and between lithium and potassium, 32. At the same time, we may remark that the elements grow like each other, the lower the atomic weights. Now, helium and argon are very like each other in physical properties. It may be fairly concluded, I think, that in so far they justify their position. Moreover, the pair of elements which show the smallest difference between their atomic weights is beryllium and calcium; there is a somewhat greater difference between lithium and potassium. And it is in accordance with this fragment of regularity that helium and argon show a greater difference. Then again, sodium, the middle element of the lithium triad, is very similar in properties both to lithium and potassium, and we might therefore expect that the unknown element of the helium series should closely resemble both helium and argon.

Leaving now the consideration of the new element, let us turn our attention to the more general question of the atomic weight of argon, and its anomalous position in the periodic scheme of the elements. The apparent difficulty is this: the atomic weight of argon is 40; it has no power to form compounds, and thus possesses no valency; it must follow chlorine in the periodic table, and precede potassium; but its atomic weight is greater than that of potassium, whereas it is generally contended that the elements should follow each other in the order of their atomic weights. If this contention is correct, argon should have an atomic weight smaller than 40.

Let us examine this contention. Taking the first row of elements, we have:

Li=7, Be=9·8, B=11, C=12, N=14, O=16, F=19, ?=20.

The differences are:

2·8, 1·2, 1·0, 2·0, 2·0, 3·0, 1·0.

It is obvious that they are irregular. The next row shows similar irregularities. Thus:

(?=20), Na=23, Mg=24·3, Al=27, Si=28, P=31, S=32, Cl=35·5, A=40.

And the differences:

3·0, 1·3, 2·7, 1·0, 3·0, 1·0, 3·5, 4·5.

The same irregularity might be illustrated by a consideration of each succeeding row. Between argon and the next in order, potassium, there is a difference of −0·9—that is to say, argon has a higher atomic weight than potassium by 0·9 unit—whereas it might be expected to have a lower one, seeing that potassium follows argon in the table. Farther on in the table there is a similar discrepancy. The row is as follows:

Ag=108, Cd=112, In=114, Sn=119, Sb=120·5, Te=127·7, I=127.

The differences are:

4·0, 2·0, 5·0, 1·5, 7·2, −0·7.

Here, again, there is a negative difference between tellurium and iodine. And this apparent discrepancy has led to many and careful redeterminations of the atomic weight of tellurium. Prof. Brauner, indeed, has submitted tellurium to methodical fractionation, with no positive results. All the recent determi-

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nations of its atomic weight give practically the same number, 127·7.

Again, there have been almost innumerable attempts to reduce the differences between the atomic weights to regularity, by contriving some formula which will express the numbers which represent the atomic weights, with all their irregularities. Needless to say, such attempts have in no case been successful. Apparent success is always attained at the expense of accuracy, and the numbers reproduced are not those accepted as the true atomic weights. Such attempts, in my opinion, are futile. Still, the human mind does not rest contented in merely chronicling such an irregularity; it strives to understand why such an irregularity should exist. And, in connection with this, there are two matters which call for our consideration. These are: Does some circumstance modify these "combining proportions" which we term "atomic weights"? And is there any reason to suppose that we can modify them at our will? Are they true "constants of nature," unchangeable, and once for all determined? Or are they constant merely so long as other circumstances, a change in which would modify them, remain unchanged? In order to understand the real scope of such questions, it is necessary to consider the relation of the "atomic weights" to other magnitudes, and especially to the important quantity termed "energy." It is known that energy manifests itself under different forms, and that one form of energy is quantitatively convertible into another form, without loss. It is also known that each form of energy is expressible as the product of two factors, one of which has been termed the "intensity factor," and the other the "capacity factor." Prof. Ostwald, in the last edition of his "Allgemeine Chemie," classifies some of these forms of energy as follows:

Kinetic energy is the product of mass into the square of velocity.			
Linear	,,	,,	length into force.
Surface	,,	,,	surface into surface tension.
Volume	,,	,,	volume into pressure.
Heat	,,	,,	heat capacity (entropy) into temperature.
Electrical	,,	,,	electric capacity into potential.
Chemical	,,	,,	"atomic weight" into affinity.

In each statement of factors, the "capacity factor" is placed first, and the "intensity factor" second. In considering the "capacity factors," it is noticeable that they may be divided into two classes. The two first kinds of energy—kinetic and linear—are independent of the nature of the material which is subject to the energy. A mass of lead offers as much resistance to a given force, or, in other words, possesses as great inertia as an equal mass of hydrogen. A mass of iridium, the densest solid, counterbalances an equal mass of lithium, the lightest known solid. On the other hand, surface energy deals with molecules, and not with masses. So does volume energy. The volume energy of two grammes of hydrogen, contained in a vessel of one litre capacity, is equal to that of 32 grammes of oxygen at the same temperature, and contained in a vessel of equal size. Equal masses of tin and lead have not equal capacity for heat; but 119 grammes of tin has the same capacity as 207 grammes of lead—that is, equal atomic masses have the same heat capacity. The quantity of electricity conveyed through an electrolyte under equal difference of potential is proportional, not to the mass of the dissolved body, but to its equivalent—that is, to some simple fraction of its atomic weight—and the capacity factor of chemical energy is the atomic weight of the substance subjected to the energy. We see, therefore, that while mass or inertia are important adjuncts of kinetic and linear energies, all other kinds of energy are connected with atomic weights, either directly or indirectly.

Such considerations draw attention to the fact that quantity of matter (assuming that there exists such a carrier of properties as we term "matter") need not necessarily be measured by its inertia or by gravitational attraction. In fact, the word "mass" has two totally distinct significations. Because we adopt the convention to measure quantity of matter by its mass, the word "mass" has come to denote "quantity of matter." But it is open to anyone to measure a quantity of matter by any other of its energy factors. I may, if I choose, state that those quantities of matter which possess equal capacities for heat are equal; or that "equal numbers of atoms" represent equal quantities of matter. Indeed, we regard the value of material as due rather to what it can do, than to its mass; and we buy food, in the main, on an atomic, or, perhaps, a molecular basis, according to its content of albumen. And most articles depend for their value on the amount of food required by the producer or the manufacturer. The various forms of energy may therefore be classified as those which can be referred to an "atomic" factor, and those which possess a "mass" factor. The former are in the majority. And the periodic law is the bridge between them; as yet, an imperfect connection. For the atomic factors, arranged in the order of their masses, display only a partial regularity. It is undoubtedly one of the main problems of physics and chemistry to solve this mystery. What the solution will be is beyond my power of prophecy; whether it is to be found in the influence of some circumstance on the atomic weights, hitherto regarded as among the most certain "constants of Nature"; or whether it will turn out that mass and gravitational attraction are influenced by temperature, or by electrical charge, I cannot tell. But that some means will ultimately be found of reconciling these apparent discrepancies, I firmly believe. Such a reconciliation is necessary, whatever view be taken of the nature of the universe and of its mode of action; whatever units we may choose to regard as fundamental among those which lie at our disposal.

In this address I have endeavoured to fulfil my promise to combine a little history, a little actuality, and a little prophecy. The history belongs to the Old World; I have endeavoured to share passing events with the New; and I will ask you to join with me in the hope that much of the prophecy may meet with its fulfilment on this side of the ocean.

CONTRACTS FOR ELECTRICAL SUPPLIES

CONTRACTS OPEN.

Switzerland.—Tenders are invited at Lausanne for a concession for erection and lease of electric works. Applications to be made to the Municipality before September 25.

Jassy (Roumania).—Contracts will close on September 18 at 4 p.m. for the electric lighting of the town of Jassy. Specifications, plans, and all particulars may be obtained at Paris, 80 rue de Varenne, at the Bureau des renseignements commerciaux.

Sofia (Bulgaria).—On September 10 tenders will close for the erection of an electric lighting and motor plant, together with the concession for working the whole of the urban and suburban tramways. Details will be supplied at the Municipal Offices, Sofia. Foreigners may compete.

Paris.—Tenders are invited for two large contracts for the supply of copper, iron, insulated wire, and other materials for telegraphs and telephones. The tenders close on September 12 and 17 respectively. Full particulars may be obtained at the office of the Under Secretary for Posts and Telegraphs, 103, Rue de Grenelle, Paris.

Sydney (New South Wales).—Tenders are required by October 18, at noon, at the General Post Office, for supplies to the Telegraph, Telephone, and Post Office Departments, including iron, copper, and insulated wire, insulators, nails, screws, nuts, bolts, electric batteries with all accessories and chemicals, diaphragms, arc lamps, incandescent lights, 11,000ft. carbon for arc lamps, and various other appliances.

Sale by Tender.—The receiver for the debenture-holders of the Electrical Manufacturers, Limited (in liquidation), 223, Upper Thames-street, E.C., is prepared to receive tenders for the purchase of the stock-in-trade and furniture of the company. Particulars and conditions of sale and forms of tender can be obtained by application at 223, Upper Thames-street, E.C., and the goods will be on view there from 10 a.m. to 6 p.m. each day (Saturdays, 10 a.m. to 1 p.m.). Tenders will be received by the Receiver up to and inclusive of September 3.

Derby.—The Corporation are prepared to receive tenders for the supply of one alternating-current dynamo and engine and for the supply to the present engine of one continuous-current dynamo. Specifications, etc., form of tender may be had on deposit of £1. 1s. (which will be returned on receipt of a bona fide tender) from Mr. J. E. Stewart, engineer, Electric Lighting Station, Derby. Tenders, endorsed "Electric Lighting, Tender for Dynamo, etc.," to be sent to Mr. H. F. Gadsby, town clerk, by 12 noon on 30th inst.

Blackburn.—Tenders will close on the 28th inst. for extension and alteration of the buildings at the electricity works, Jubilee-street, Blackburn, for the Corporation. The form of tender and schedule of quantities may be obtained on the payment of £2. 2s. (returnable on receipt of bona fide tender) at the office of Mr. E. M. Lacey, consulting engineer to the Corporation, 10, Delahay-street, Westminster, and copies of the specification and plans may be seen at the Electricity Works, Jubilee-street, Blackburn. Sealed tenders, endorsed "Tender for Electricity Works Extension," to be delivered to Mr. Robert E. Fox, town clerk, Town Hall, Blackburn.

Ludlow.—The Corporation offers a prize of £20 for the best and most economical scheme of electric lighting for the borough. The scheme must deal exhaustively with the whole matter, and give definite information of the cost of steam and water power for the purpose of comparison with the total cost of the undertaking and working expenses. Schemes to be delivered at the offices of Mr. John Herbert Williams, town clerk, Ludlow, marked "Scheme for Electric Lighting," before 4 p.m. on October 1. Should the Corporation employ the engineer whose scheme is awarded the prize to carry the work out, then the £20 will merge in the commission to which he would then be entitled to.

Whittingham.—Tenders are invited by the Lancashire Asylums Board for electric lighting and plant required at the new hospital and reception wards at the County Asylum, Whittingham. Plans and specification may be seen, and further information obtained, at the offices of Messrs. Simpson and Duckworth, architects, Richmond-chambers, Blackburn, and also at the offices of the consulting engineers, Messrs Fawcus and Clirehugh, Temple-chambers, Brazennose-street, Manchester, on and after 23th inst. General conditions, specification, and form of tender on deposit of

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£5. 5s., returned on receipt of bona fide tender. Tenders to Mr. J. P. Muspratt, County Offices, Preston, not later than first post on September 20.

Kingston-upon-Thames.—The Corporation are prepared to receive tenders for the extension of their electric light buildings. The plans can be inspected at the Borough Surveyor's Office, Clattern House. Persons desiring to tender will, on application, receive copy of the bill of quantities, and will be required to deposit with the borough surveyor £2. 2s., which amount will be returned to each builder from whom a bona fide tender is received. The builder whose tender is accepted will be required to enter into a contract and a bond, with two approved sureties (who must be named in the tender), for the performance of the work. Sealed tenders, endorsed "Electric Light Buildings," to be delivered at the office of Mr. Harold A. Winser, town clerk, Clattern House, Kingston-upon-Thames, by September 2

Barking Town.—The Barking Town Urban District Council are prepared to receive tenders for the supply and erection of the following plant: Section A —Generating plant boilers and fittings, economiser, feed pump, injector, etc.; steam dynamos, condensers, oil filter, fittings, etc.; steam, exhaust, feed, blow-off, and sundry pipes; valves water tank, etc. Section B —Storage batteries. Section C.—Switchboard and all connections. Section D.—Overhead travelling crane. Section E.—Conduits and mains for private supply. Section F.—Mains for public lighting, and adaptation of existing lamps. Section G.—Arc lamps and posts. Tenderers are at liberty to tender for any section or sections, or for the whole of the sections, but not for part of a section. Successful tenderers will be required to enter into a contract to pay the trades union rate of wages and to observe the trades union hours of labour. The ground plan of plant, diagram of switchboard, plan of streets, etc., and specifications, with forms of tender, may be obtained at the offices of Mr. W. C. C. Hawtayne, the consulting engineer to the Urban District Council Mansion House-chambers, 20, Bucklersbury, E.C, on payment of £2. 2s., which sum will be returned on receipt of a bona fide tender. Tenders, sealed and marked "Tender for Electric Lighting," addressed to the Chairman of the Urban District Council, Council Offices, Barking, must be sent in by noon on September 21.

Madras —Tenders are invited for the utilisation of water flowing from the Periyár Lake for purposes other than irrigation and not incompatible with the use of the water for drinking. The irrigating season extends over nine to ten months, during which time the discharge is likely to be from 1,100 to about 500 cubic feet a second, according to the demands for irrigation and the available quantity in the lake. Subject to the risk of interruption by accident or drought, supply can be given throughout the irrigation season. No supply can be guaranteed at other times, but, so long as water is available, the Government will be prepared to issue it in such daily quantities as may seem to it advisable with reference to the time which is likely to elapse before the supply is replenished by the setting in of the rains. The fall from the tunnel to the foot of the hills is approximately 900ft., and the distance measured along the course of the stream about 6,800ft. One cubic foot per second falling 900ft. is estimated to produce over 60 effective horse-power. Intending lessees should state the quantity of water required in cubic feet per second and the annual rent offered for each cubic foot per second. No rent will be charged for the first year from the date of the concession; for the second year the charge will be one-fifth, and an additional charge of one fifth will be made every year until the full rent is reached. The whole or part of the concession may be surrendered on a year's notice being given. Lessees will construct at their own expense, on plans to be approved by Government, all the weirs and other works required to divert the water from the river below the tunnel. For further information, application may be made to the Chief Engineer for Irrigation, Madras, by whom tenders will be received up to October 31, 1897.

Port Elizabeth (Cape Colony) —The Town Council of Port Elizabeth (Cape Colony) invite tenders for lighting the streets and municipal buildings of Port Elizabeth by electricity, in consideration of the grant of a concession for the exclusive right of supplying electric current through the streets and roads of the town, to private houses, stores, etc., for terms of 5, 15, 20, 25, or 30 years respectively. There are approximately about 54 miles of streets in the town, as follows: main thoroughfare, 5 miles 1,196 yards; principal streets, 16 miles 1,433 yards; minor streets, 32 miles. The streets of the town are at present lighted by 380 gas lamps of reputed 16-c.p. The municipal buildings consist of town hall municipal offices, morning market, feather market, wool market, and museum. The main streets are to be lighted by arc lamps, and the side streets and municipal buildings by incandescent lamps. Tenderers must state at what sum per annum they are prepared to adequately light the streets and municipal buildings for the various periods mentioned above, if they are granted a concession for any one of the periods referred to. The concession will provide, inter alia, that the particular system and plant to be adopted by the concessionaires shall be subject to the approval of Council; the charge for supplying current to private houses shall not exceed 1s. 9d. per London Board of Trade unit; and that the Council will have the option of taking over the whole undertaking, etc., at a valuation to be made in case of difference by two arbitrators or their umpire at the end of the period of the concession at the then value of the plant and mains. Tenders, endorsed "Port Elizabeth Electric Lighting," should be delivered to the agents of the Municipality, Messrs. Davis and Soper, 54, St. Mary-axe, London, E.C. (from whom further information may be obtained), on or before September 21,

RESULTS OF TENDERS.

Walsall.—The Town Council have accepted the tender of Belliss and Co., Birmingham, at £796, for supplying and fixing condensing plant at the generating station in Wolverhampton-street.

Graffham Grange (Bramley, Guildford).—The contract for the supply of accumulators, dynamos, and switchboards is in the hands of Messrs. H. Fentum, Phillips, and Co., of the Guildford Electrical Works.

Guildford.—The Directors of the County and Borough Halls Company, Limited, having invited tenders for the lighting of their hall by electricity, selected the tenders of three local firms, which are left to a sub-committee to examine.

Halifax —The following tenders have been accepted by the Town Council for tramway works, etc.: Electrical Construction Company, Limited, electrical equipment of tramway cars, £4,171. 10s, trolley wire, insulators, rail bonds, etc., and fixing £984. 7s., tramway generators and fixing £1,800; J. Spencer, Wednesbury, poles for the electrical overhead haulage of tramways £1,090. 10s.; Chloride Electrical Storage Syndicate, Limited, two batteries of accumulators £3,070; Callender's Cable and Construction Company, Limited, cable £1,237. 5s.

BUSINESS NOTES.

Guildford.—The Town Council are still considering the arc lighting of High-street from the local company's mains.

Chester.—A correspondent writes that the gas and electric lighting questions are still undergoing transition and discussion in the districts round about.

Exhibition at Turin.—Owing to demands of many intending exhibitors, the date for receiving applications for space has been extended to the 31st inst.

Smethwick. —The Gas Committee have recommended the District Council to apply for a provisional order to supply electricity for lighting and other purposes.

Kingston-upon-Hull.—The Corporation have decided to invite tenders for the electric equipment of their tramways, which are planned to extend over nine miles of double and half a mile of single track.

Lancaster.—At a quarterly meeting of the Lancaster Town Council, held on 25th inst., it was resolved that a new boiler for the electricity works should be purchased from the Oldham Boiler Company for £370.

Folkestone —A notice has been tabled at the Folkestone Town Council to discuss the question of taking steps to ensure that electric light may be available in Folkestone some time during the next 18 months.

Liverpool Overhead Railway —The traffic receipts of this railway for the week ended August 22 amounted to £1,518, as compared with £1 363 in the corresponding week of the previous year, being an increase of £155.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended August 20 were £2,691. 1s. 1d., compared with £2,517. 14s. 1d for the corresponding period of last year, being an increase of £173. 7s.

Chorley.—The Council are taking the necessary steps to oppose the application of the Electric Supply Corporation for powers within the borough and to apply in the next session of Parliament for a provisional order on behalf of the Corporation.

Hebden Bridge.—The committee of the Hebden Bridge Co-operative Society have decided to spend about £1,000 in putting down an electric lighting plant. The installation will include a 40-h.p gas-engine to drive a 400-light dynamo, and one 12-h.p. engine driving a 120-light dynamo.

Greenock.—It is stated that the proposed scheme, referred to in our last issue, to supply Greenock, Port Glasgow, and Gourock with a good electric lighting installation will cost £50,000. The proposal is to be further considered at the next meeting of the Law and Finance Committee of the Police Board.

City and South London Railway.—The returns for the week ended August 22 were £1,021, compared with £969 for the corresponding period of last year, being an increase of £52. The total receipts for the half-year 1897 amounted to £7,314, compared with £7,498 for the corresponding period last year, being a decrease of £184.

Jandus Arc Lamp.—We understand that the Jandus arc lamp has been adopted for the lighting throughout of Messrs. Jones and Higgins's premises at Peckham. Trials were made with both the Jandus and the ordinary type lamp, with the result that nearly 300 of the Jandus lamps were ordered from the agents (Messrs. Drake and Gorham).

Motor Development Corporation, Limited. — Mr. F. F. Wellington, and the staff of the Indestructible Ignition Tube Syndicate, Limited (now in liquidation) have joined the above Corporation with a view of continuing the business of the former. It appears that upwards of 9,000 of the ignition tubes have been sold to corporations, companies, and firms.

Salisbury.—We understand that at the last Board meeting of the Salisbury Electric Company the contracts for the work were approved, and that the work will at once be put in hand by Edmundsons, Limited. It was also agreed that, as far as possible, local workmen and builders should be employed, so that there will be no lack of work during the winter months,

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North-Eastern Railway.—At the half-yearly meeting of the North-Eastern Railway, the chairman (Sir J. W. Pease) said that the company had unexercised borrowing powers of £3,498,000. Amongst other items, he mentioned that at Blyth and Middlesbrough a sum of £6,600 had been spent for electrical purposes, and considerably more would yet have to be spent on that district.

Northwich.—The provisional order of the Electric Supply Company, Limited, having now passed both Houses of Parliament, the company is now proceeding with the carrying out of the necessary works, and expects to be in a position to supply current in the town before the end of November. Mr. Thomas H. Swinburn, Altrincham, was appointed resident electrician at the last meeting of the directors.

Chelsea Electricity Supply Company.—The fires which have occurred at electric lighting stations have shown how necessary it is to have appliances in these buildings for dealing with outbreaks. At the new station of the Chelsea Electricity Supply Company Messrs. Merryweather have just supplied hydrants, hose, and fittings similar to those fitted at the Company's head establishment at Cadogan-gardens.

Leamington and Warwick Tramway Company.—At the annual general meeting of this Company the Chairman remarked that they had lately received applications from several quarters with regard to electric traction. They had looked forward to this for some time. The overhead system, he thought, was the most suitable, but the Corporations of Warwick and Leamington would object to that system.

Llandrindod Wells.—The lighting of Llandrindod Wells by electricity is now an accomplished fact, the works having been practically completed. The installation for house lighting has been proceeding since Easter, and on Saturday night the whole of the street lamps, about 70 in number, were experimentally lighted for the first time with the electric current. The installation was perfectly successful.

Personal.—At a special meeting of the Morecambe District Council, Mr. Parkinson, who is at present electrical engineer at the Lancaster Wagon Works, received the appointment of resident electrical engineer. There were 122 applicants.

— At the meeting of the Gas and Electricity Supply Committee of the Bradford Corporation it was decided to recommend the City Council to increase Mr. Dalton's, the assistant electrical engineer, salary from £200 to £250.

Glasgow.—At the last meeting of the Telephone Committee of the Glasgow Corporation a letter was read from Sheriff Jameson, Perth, announcing that he had been appointed by the Treasury to conduct an enquiry into the efficiency and the cost of the working of the telephone on September 23. The enquiry is also to cover the report which was laid before the Postmaster-General for the municipal telephone system in Glasgow. The enquiry is expected to last some days.

Hampstead.—Active progress is being made with the installation of electric arc lamps up Haverstock-hill and through High-street, Hampstead, and, by an arrangement made with the Vestries of Hampstead and St. Pancras, the whole of the main thoroughfare leading from a point a little north of Oxford-street to the top of High-street, Hampstead, will shortly be lighted by electricity. This length of roadway, one of the most important main thoroughfares in the Metropolis, extending to a distance of considerably over three miles, will be the longest in London entirely lighted by electric arc lamps.

Grimsby.—The Chairman of the Town Council has stated that at a meeting of the full Council in committee it was resolved to recommend to the Urban Sanitary Authority that they carry out the electric lighting provisional order, and that the Public Lighting Committee be empowered to employ an expert if considered necessary. He said it was very likely that next week there would be a meeting of the Council, and if they passed that resolution the committee would then be able to take steps, but at present they would not be in order in moving in the matter. He further stated that there was no Electric Lighting Committee at the present time A discussion followed, but no action was taken.

Cardiff.—At the last meeting of the Cardiff Chamber of Commerce, the Secretary read a letter from Mr. James Hurman, superintendent at the Bute Docks, stating that arrangements had been made by Messrs. J. B. Saunders and Co. for providing telephonic communication at different points of the docks for the convenience of freighters and traders, but a little difficulty had arisen over the connection with the exchange. As soon as this was got over he would write further. The reading of this communication gave great satisfaction to the meeting. It is intended to have a box on the Cardiff Exchange if the directors will extend this concession to the Cardiff Railway Company.

Kingswood.—The Lighting Committee of the Urban Council have submitted a report recommending an extension of the lighting area so as to include Soundwell main road, Bath-buildings-road, Park-road, Tower-road, and Church-road to the cross roads, New Cheltenham, Black Horse-road, Taylor's-road, Reformatory-road, Wood-road, Bank-road, and Court-road to John Fry's-road, Jefferies-hill-road, to be extended as far as Lovell's-lane, and from T. Anstey's to Martin's-lane. The lighting of London-street, South-road, West-street, Laura-street, and Bright-street was deferred for future consideration. After an animated discussion the report was adopted, and it was agreed not to apply at present for a provisional order *re* underground wires.

King Cross.—This year being the jubilee of St. Paul's Church, King Cross, the congregation have decided to commemorate the same in a special manner. With this view it has been decided to light the church throughout with the electric light, which, when completed, will consist of about 100 lights. The nave of the church will be lighted with massive five-light standards of brass, relieved with scroll work, whilst the chancel will be lit with ornamental suspension drop lights of five and seven lights, which will not only add to the beauty of the interior, but will show to advantage the splendid coloured east window, which has been so long hid by the large gas corona. The installation, we learn, has been entrusted to Messrs. Edward Foster and Son, electricians.

Yarmouth.—The electric light undertaking, which is in the hands of the Corporation, does not appear to be as successful as was anticipated when the scheme was first brought forward. Already £30,328 capital expenditure has been incurred, sanction has been given for the outlay of £35,200, and the balance is required to pay outstanding debts and other items. Since 1895 about £1,500 has been furnished from the rates to make up a deficiency which is continually and regularly occurring, and altogether the business is very disappointing to the ratepayers, who expected, after two years' trial, that the undertaking would at least be self-supporting. The only crumb of satisfaction that can be extracted from the business is that if calls are being made upon the ratepayers to help the undertaking, they are paying off capital charges and interest, payments for which will cease in 20 or 25 years.

Motherwell.—Some time ago the Commissioners wrote to the Board of Trade asking for an extension of the town's provisional order, which was in danger of lapsing; and in reply it was stated that the Board of Trade had no power to extend the order, and that unless the works were proceeded with within 12 months the order would be revoked. In the interval a private electric lighting company offered to purchase the town's provisional order and to lay down an installation, at the same time guaranteeing to give the town street-lighting, etc., at a price nearly the same as the present price for gas, the Commissioners to have the option of taking over the works after 10 years. The committee at their last meeting considered the whole question, and unanimously decided to decline the offer of the private company, and go on with a scheme of their own, the committee to visit several installations in different parts of the country before deciding on a particular scheme.

Coatbridge.—A report laid before the Town Council on the accounts of the Scottish House-to-House Electricity Company, Limited, in connection with their works in the burgh, summarised the statement as follows: "(1) Capital account.—During the year a sum of £1,909. 19s. 8d. has been expended, making the total expenditure on capital account as at December 31 last, £20,414. 2s. 6d. (2) Revenue account.—The expenditure for the year amounted to £1,633 14s. 1d. as against £2,014. 8s. 8d. in the preceding year, a saving in total costs of £380. 14s. 7d.; whilst the revenue received amounted to £833. 1s. 2d. as against £552. 18s. 9d. in the previous year. The loss on the year's working amounts to £800. 12s. 11d., which, with the interest paid on mortgages and bonds, of £940. 7s. 3d., in all £1,741. 0s. 2d., as against £1,741. 0s. 2d. The amount has been carried to a suspense account. The total losses, etc., at the debit of suspense account as at December 31, 1896, amount to £5,092. 0s. 8d." The report was approved by the Council.

Leeds.—The Yorkshire House-to-House Electricity Company are making extensive preparations to meet the demands for current expected during the coming winter. Their new buildings are now rapidly approaching completion, and the additional generating plant, consisting of four new Lancashire boilers and four combined engines and dynamos, each of 500 i.h.p., have been obtained. It is stated that not less than £10,000 is being spent this year in improving the means of distribution in a part of the centre of the city, and the new system will be extended to other central thoroughfares as quickly as circumstances permit. It may be explained that hitherto all the company's cables have conveyed electric current at high pressure, and the conversion to low pressure is done by a separate transformer on the premises of each consumer. Under the new system transforming sub-stations are constructed at various points in the centre of the city, at which the conversion of the current from high to low pressure will be effected by means of large transformers to be there installed. Up to the present four of these underground structures have been built, two in Albion-street and two in Briggate.

— A large deputation from the Manchester City Corporation, including the Lord Mayor, has visited Leeds for the purpose of inspecting the electrical department of the Corporation tramways. The deputation expressed their approval of all that they had seen, and appeared favourable to the introduction of a similar system in Manchester.

— The Markets Committee of the Corporation, at a meeting held on 25th inst., decided that the open space at the Kirkgate Market which is now being covered in, the alleys, and the old fish market should be lighted by means of electricity, and it was resolved to ask the Council at its next meeting to grant the sum of £2,000 for the necessary plant.

The Holderness Light Railway.—At the last meeting of the Beverley Town Council it was resolved "that application be made to the Light Railway Commissioners for an order, under the Light Railway Act, 1896, authorising the mayor, alderman, and burgesses of the borough of Beverley to advance to the North Holderness Light Railway Company, when constituted by way of loan, for the purposes of their proposed line from Beverley to Beeford, or as part of the share capital of the said company, or partly in one way or partly in the other, such sum, not exceeding £5,000, as the said mayor, alderman, and burgesses may determine; the amount so advanced to be secured in a manner provided by the said Act;

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and, further, that application be made to the Board of Trade for power to make such advance, without the concurrence of the Council, of any area outside the said borough." This resolution does not commit the Council to the expenditure of any money whatever; it simply gives the Corporation a right to ventilate their opinions when the clauses of the Bill are under discussion.

Godalming.—The following particulars of the recently finished electric installation at the Godalming sanitary steam laundry may be of interest. The specifications were drawn up by Mr. F. Fanta (London) and the contractors were Messrs. Carling, Gill, and Carling, of Godalming and Guildford. The requisite power is obtained from the steam-engine which drives the other machinery, and is transmitted to the dynamo by means of a strong link belt, the smoothness in running of which is well known. The dynamo is built upon the latest improved principles, and is capable of supplying sufficient current to light 121 lamps, which are fixed in various parts of the building. The main switchboard, which also carries the ammeter and voltmeter, is placed over the dynamo in such a position that the engineer, standing in any part of the room, can tell at a glance how many lamps are being used and the pressure of the current. An apparatus mounted on the same board enables him to regulate the pressure of the current, independent of the speed of the engine, without loss of energy. The lamps used are a speciality of the Improved Electric Glow Lamp Company. They are spherical in shape, and the top half, being nickel-plated, takes the place of a shade, and concentrates the light upon the work or machine, as the case may be. The wiring is carried out on the "centre of distribution" system, the wires being of the quality used for high-pressure currents, so that there is no danger from fire. Owing to the safety of the electric light it has been found possible to introduce it into the airing-rooms, where the dry inflammable material is closely stored. This has proved a great boon, as the sorters can now use the rooms as freely at night as in the daytime, the work thus being considerably facilitated. The whole of the work has been examined and approved by the technical advisers of the fire insurance offices.

Parliament and the Electric Light.—The *Daily Telegraph* says workmen are busily engaged in completing the installation of the electric light at the Houses of Parliament. The scheme has really been in process of development for a dozen years or more. Instead of finishing the thing right off the reel, successive First Commissioners of Works have been content to proceed by instalments. There has not been a pin to choose between the Radicals and Unionists—between Mr. Shaw-Lefevre and Mr. Herbert Gladstone on the one hand, and Mr. David Plunket, now Lord Rathmore, and Mr. Akers-Douglas on the other. At present, however, unusual activity prevails, owing to the desire to reach something like finality before the retirement of Mr. Prim, the resident engineer in charge of the lighting, warming, and ventilation, under whose auspices the installation began. The House of Lords adopted the new light in their legislative chamber a couple of years ago. But in this matter the House of Commons is more conservative, and still retains gas in the apartment devoted to the affairs of the nation. Illumination and ventilation, in fact, are there dependent the one upon the other, the heat generated by the gas jets between the glass ceiling and the roof being utilised in removing the vitiated atmosphere below. Electricity, nevertheless, reigns supreme in the dining-rooms, lobbies, and corridors, and its use is gradually extending in the committee-rooms. On the Peers' side the Royal Gallery is being treated in a similar manner, and the dining-room and grand committee room will be attended to in due time. Throughout the entire building there are no fewer than 5,000 lights, and it will be scarcely credited that the electric current is supplied from outside, although it could probably be produced at half the price inside. Not long since it was proposed to substitute electricity for gas in Westminster Hall, but the project was abandoned, it is said, from the notion that the fumes of the older light tended to preserve the huge timbers supporting the ancient roof.

Darwen.—The surveyor will be instructed to prepare plans for erection of a central station. Permission to borrow £20,000 is to be applied for at an early date in order to carry out the provisions of the Darwen Electric Lighting Order, 1897. The appointment of an electrical engineer, who will be on the scene to superintend the whole of the works, has been agreed to. Mr. E. M. Lacey, electrical engineer, has stated that "the undertaking will yield a profit in the second year, and from that time forward will be an exceedingly profitable concern, even after allowing for a reduction in the current charges to consumers." The following are the particulars of the recommendations adopted by the Electric Lighting Committee: (1) That the direct driving system be adopted; (2) that the distribution be made by a direct current on the three-wire system at a pressure of 440 volts, with a 220-volt service to consumers, with suitable accumulators; (3) that the town clerk forthwith advertise for a borough electrical engineer, at a salary of £200 a year, who will be on the scene during the whole progress of the works from the start to the finish; (4) that after the specifications have been drawn up for the electrical work they be submitted to such consulting engineer as the committee should select, for him to report upon the same prior to the contract being let; (5) that the surveyor be instructed to prepare the necessary plans for erecting the central station in order that no time may be lost in applying to the Local Government Board for their sanction to the borrowing of money for carrying out the undertaking. In the report which Mr. Lacey submitted in October of last year, and which, it is thought, will influence the Corporation in their proceedings, he estimates the expense of an electrical plant to efficiently serve the area specified in the order, as follows:

Buildings, inclusive of overhead traveller	£3,100
No. 2 steam dynamos, each 120 kw.	3,200
Balancing apparatus, switchboards, electrical connections, instruments	800
Accumulators	900
No 2 boilers, condensers, feed pumps, etc.	1,900
Mains, etc	4,100
Service connection to consumers	900
Contingencies, 5 per cent.	745
Total estimated outlay	£15,645

This is for a service of 6,000 lamps, and on this basis the system at Blackburn has cost £18,000 per 6,000 lamps, Bury and Burnley £19,000, and Bolton £24,000. For an extension to supply an additional 6,000 lamps Mr. Lacey would add £6,100, making for 12,000 lights £22,000 roughly. It has not been decided for how many lamps provision will be made, but the total cost of the works will be about £20,000.

Manchester.—This week a special committee of the Manchester Corporation have decided by a large majority to recommend the City Council to municipalise the tramways. The exact terms of the resolution, which was carried by 12 votes to 1, are that the Council should consider at once the desirableness of the Corporation working the tramways. The tramway system serves a population of quite a million of people, if its ramifications into Salford, to the suburbs, to Oldham, Stockport, and to other places be taken into account. And the matter is of great moment also to the tramways company; they have capital at stake of nearly £600,000, including £210,000 (according to their last balance sheet) for buildings, tramways and machinery, and £153,000 for rolling stock, horses, and so on; their reserve fund amounts to £85,000, and their stocks stand at a considerable premium in the market, in consequence of dividends averaging 10 per cent. having been paid for the last two years at least. The Corporation receives now £23,000 per year from the company; this leaves, after payment of certain charges, a net profit of £16,000. It is anticipated that that sum will be doubled in the future. A committee is at present visiting Bristol, Birmingham, and other places where the motive power is electricity. It is anticipated that their report will be strongly in favour of overhead electric traction. It is also suggested that the difficulty between the tramway company and the Corporation as to the renewal of the leases might be, and possibly will be, got over by the Corporation granting an extension of the leases on the condition that the company should supply the trams and the Corporation the motive power.

— We learn that the number of promises to take telephones in the New Mutual Telephone Company has now reached 2,000, this being the number considered necessary for commencing a remunerative telephone exchange for Manchester and the district. The syndicate and committee have been working in accordance with the terms of the Treasury minute dated May 23, 1892, in which it is stated, as a matter of general policy, that competition "will not be excluded" in the telephony of the United Kingdom. There are, however, laid down certain conditions with a view of preventing companies being formed "whose sole object it is to force the existing licensees to buy them up," and the energies of the syndicate and general committee have up till the present moment been concentrated in the endeavour to bring about a compliance with these conditions. The first step was to find gentlemen to provide the money necessary for organising a sufficient amount of support to ensure the financial success of the undertaking Both, we are informed, have been accomplished. The second step was to obtain formal votes in favour of the new company by the municipal authorities. This has also been effected, resolutions in favour of the company having been passed by the Corporations of Manchester, Salford, and Eccles, and the Stretford District Council. With regard to the capital required, it is estimated that £100,000 will be ample to provide a telephone exchange capable of supplying upwards of 5,000 subscribers, and leaving a margin of unused wires along the lines for future development. With a view of getting the telephone users to be, as far as possible, the proprietors of the company, it is arranged that anyone holding £25 in shares in the company shall be entitled to a reduction in the price of the telephone of 15s., whilst holders of £50 in shares will obtain a reduction of 25s. in the annual charge. The latter is equal to 2½ per cent. on the capital invested, which would then stand to earn the ordinary dividends of the company. If each of the 2,000 applicants for telephones in the new company would invest £50 in shares the whole capital necessary for producing an exchange of upwards of 5,000 would be provided; but as this is hardly to be expected, it will be necessary for many to take a larger number. The charge per telephone is fixed at £6. 10s., but an annual reduction on this price will be made to persons who apply before the registration of the company.

PROVISIONAL PATENTS, 1897.

AUGUST 16.

18887. Improved means for the production of gases for explosive purposes and propelling mortar-cars, cycles, and other vehicles and discharging ammunition by electricity. Thomas Herbert William Parnell and Ernest Bailey, Congleton House, Scarborough.

18905. Electric warning apparatus for mine cages. Alix Florentin, 8, Rue des Princes, Brussels.

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18926. Improvements in apparatus for interrupting or starting an electrical discharge for the production of ozone and other purposes. Marius Otto, 46, Lincoln's-inn-fields, London.

18941. Improvements in and relating to electric alarm and registering or controlling apparatus. Charles Junge, 75, Chancery-lane, London. (Max Vester, Germany.) (Complete specification.)

AUGUST 17.

18957. Method designed to facilitate the coupling of wires for conveying an electrical current on railway trains. George Rennie Powell, Rosebank, Ashley Down, Bristol.

18994. Improvements in the superheating of steam by means of electricity. John Henrique Dunn, 34, Parkhurst-road, Wood Green, London.

19017. An improved method of and apparatus for advertising by electric light. John George Dixon, 70, Palace-chambers, Westminster, London.

19035. Improvements in electrolytic apparatus. Herbert Sefton Jones, of the firm of W. P. Thompson and Co., 322, High Holborn, London. (Edward Balbach, jun., United States.) (Complete specification.)

19037. Improvements in anodes and vats for use in the electro-deposition of nickel. James Steel Morrison, 6, Lord-street, Liverpool.

AUGUST 18.

19057. Improvements in or relating to brakes for electric cranes. William Henry Vaughan and Thomas Foster, 17, St. Ann's-square, Manchester.

19066. An improved mechanical electric apparatus for producing currents for intermittent use. Meyer Hart Goldstone, James Henry Ward, Henry Oliver Farrell, and James Moores, York-street Electric Works, Manchester.

19117. Adjustable tension device for phonograph diaphragms. Philipp von Wouwermans, Theodor Fischer, Max Raphael Kohn, and Ignaz Pulay, 46, Lincoln's-inn-fields, London.

19118. Improvements in dynamo-electric driving apparatus especially suitable for propelling vehicles. Paul Léopold Goldschmidt, 46, Lincoln's-inn-fields, London. (Complete specification.)

19123. Improvements in electric tramways or railways. James George Willcox Aldridge, 40, Chancery-lane, London.

AUGUST 19.

19180. Improvements in and relating to electric heating coils. Robert Hacking, 78, Fleet-street, London.

19229. Improvements in electric railway systems. Louis Edward Walkins and Francke Walden Dickinson, 40, Chancery-lane, London.

19230. Improvements in a system for the electrical protection of safes. Isaac Freed, 40, Chancery-lane, London. (Complete specification.)

AUGUST 20.

19289. Improvements in incandescent electric lamps, etc. John Sheehan and George Thomas Hutchison, 1, Cottage-grove, Bow, London.

19307. Improvements in or connected with electric arc lamps. Frederick Stanhope Worsley, 47, Lincoln's-inn-fields, London.

19317. Improvements in phonographs. Frederick Walter Baynes, 24, Southampton-buildings, Chancery-lane, London.

AUGUST 21.

19334. A new or improved wireless telephone. Robert Johnstone, 31, Southampton buildings, Chancery-lane, London.

19380. Improvements in or connected with conduits for electric or cable tramways or railways. William Griffiths, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

19381. Improvements in recording and speaking apparatus for phonographs. Philipp von Wouwermans, Theodor Fischer, Max Raphael Kohn, and Ignaz Pulay, 46, Lincoln's-inn-fields, London.

SPECIFICATIONS PUBLISHED.

1896.

16326. Apparatus for obtaining silent electric discharges Golby. (Vosmaer.)

16502. Electric clocks. Whitehead.

17088. Electric batteries Headland's Patent Electric Storage Battery Company, Limited, and Headland.

17557. Continuous-current dynamo-electric generaters and motors. De Ferranti.

17558. Dynamo-electric generators and motors. De Ferranti.

19469. Means of surrounding electric or other lights with a vessel or lining of glass or other material containing liquids. Macready.

19767. Methods of and means for controlling electric motors. Belfield. (The Westinghouse Electric and Manufacturing Company.)

20419. Electric suspension railways. De Romanoff.

20881. Means for jointing and protecting electric conductors specially applicable for use in the wiring of buildings. Middleton.

21009. Construction of low-tension dynamo-electric machinery. Elmore.

21617. Electric heating devices. Heys. (Chedville.)

24472. Frames for electric accumulators. Leitner.

24473. Primary and secondary galvanic elements. Leitner.

24475. Plate carriers for secondary batteries. Leitner.

1897.

12435 Electric conducting cords and means for connecting them to walls and other supports. Perci and Schacherer.

12933. General switch for groups of electric lamps. Imray. (Kissling and Sohn.)

12936. Electric furnaces or electric heating apparatus. Newton. (Cowles.)

13970. Dynamo-electric machines and rotary converters. The British Thomson-Houston Company, Limited. (Rice.)

13974. Lightning arresters. The British Thomson-Houston Company, Limited. (Ekstrom.)

14476. Insulators for electric conductor rails and fooders. The British Thomson-Houston Company, Limited. (Libby.)

14477. Insulators for electric conductor rails. The British Thomson-Houston Company, Limited. (Libby.)

14804. Construction of electric alternating-current generators. Blathy.

15011. Brush-holders for dynamo-electric machines. Yearsley.

15411. Electric igniter for gas-engines. Bosch.

15488. Means or apparatus for charging accumulators. Cox and the Cox Thermo-Electric Company, Limited.

15490. Electric heaters. Fraley.

15510. Secondary or storage batteries or accumulators and the manufacture of the same. Johnson. (Clare, Hatch, and Taylor.)

15513. Process for producing peat charcoal by means of an electrical current. Jensen. (Jebsen.)

15609. Electrical switches. Swan.

15623. Mouthpiece for telephones, speaking-tubes, and the like. Bolz.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	£5	9½-9¾
Brush Company, Ordinary	£5	1-1½
—— Non. Cum., 6 per cent. Pref.	£2	1½-1¾
—— 4½ per cent. Debenture Stock	100	105-109
—— 4½ per cent. 2nd Debenture Stock	100	93-97
Callender's Cable Company, Debentures	100	108-113
—— Ordinary	£5	6½-7½
Central London Railway, Ordinary	10	9¾-10½
——	£6	5¾-6½
Charing Cross and Strand	£5	12½-13½
Chelsea Electricity Company	£5	9¾-10½
—— 4½ per cent. Debentures	100	110-113
City of London, Ordinary	10	23½-24½
—— 6 per cent. Cumulative Pref.	10	16½-17½
—— 5 per cent. Debenture Stock	100	130-135
City and South London Railway, Consolidated Ordinary	100	65-67
—— 4 per cent. Debenture Stock	100	139-141
—— 5 per cent. Pref. Shares	10	15½ 15¾
County of London and Brush Provincial Co., Ordinary	10	12¾-13½
—— 6 per cent. Cum. Pref.	10	15-15½
—— 4½ per cent. 2nd Debenture Stock	10	15-15½
Crompton and Co., 7 per cent. Cum. Pref. Shares	£5	1½ 2
—— 5 per cent. Debentures	—	89 94
Edison and Swan United Ordinary	£5	2½-2¾
—— 5 per cent. Debentures	£5	4-4½
Electric Construction, Limited	£2	1¾-2
—— 7 per cent. Cumulative Pref.	£2	2¾-3½
Elmore's Copper Depositing	£1	⅞-1
Elmore's Wire Company	£2	1¾-2
W. T. Henley's Telegraph Works, Ordinary	10	1-1-19½
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	109-114
House-to-House Company, Ordinary	£5	9-9½
—— 7 per cent. Preference	£5	10½-10¾
India Rubber and Gutta Percha Works	10	20½-21½
—— 4½ per cent. Debentures	100	105-108
Kensington and Knightsbridge Ordinary	£5	13-13½
—— 6 per cent. Pref.	£5	8-8½
London Electric Supply	£5	1¾-2
Metropolitan Electric Supply	10	16½-17½
—— 4½ per cent. First Mortgage Debenture Stock	100	118-122
National Telephone, Ordinary	£5	6½-6¾
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	15-17
—— 5 per cent. Non. Cum. Third Pref.	£5	6-6½
—— 3½ per cent. Deb. Stock	100	105-110
Notting Hill Company	10	15-16
Oriental, Limited, £1 shares	£1	1½-2
—— £5 Shares	£5	8½-8¾
—— £4½ shares	£4½	7½-7¾
Oriental Telephone and Electric Company	£1	⅞-1
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	103-105
St. James's and Pall Mall, Ordinary	£5	17-18
—— 7 per cent. Pref.	£5	10-11
Telegraph Construction and Maintenance	£2	37-40
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	£8	10½-11½
Westminster Electric Supply, Ordinary	£5	14½-15½
Yorkshire House-to-House	£5	8-8½

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NOTES.

Electric Lighting in Russia. — The Municipal Council of Cronstadt have decided to transfer to the firm of Heilmann, of Paris, the concession for the electric lighting of that town.

The Telephone in the Argentine Republic.—The Argentine Government have recently given to a private firm a concession for the establishment of a telephonic communication between Buenos Ayres, Rosario, Santa Fé, and Montevideo.

Water Power.—There have been many attempts made to use the power of the sea for generating electricity, but Londoners would be thankful if a designing genius would turn his gaze upwards and see if he could not collect and store the water that has fallen from the clouds on to the London streets recently.

Telegraph Extension in Scotland.—Three new telegraph offices are to be opened in Argyllshire—one at Lochhead, one at Ormsary, and one at Kilberry. This activity on the part of the Post Office Department is due to the persistence and energy of Mr. Nicol, the parliamentary representative of the county.

Street-Lighting in Philadelphia.—The cost of arc lighting in the streets of Philadelphia is decreasing. The Council now pay an average price of 1s. 4½d. per night per arc lamp, or, say, £25. 4s. per annum, as against £27 in 1896 and £31 in 1895. It will be noticed that these figures are not unlike those which obtained in London.

Electric Brakes on the Mont Cenis Line.—The Italian Mediterranean Railway Company have made a contract with the Electrical Company of North Italy to apply their electric brakes to both the passenger and goods trains between the stations of Bardonniche and Modane on the Mont Cenis line. Should the trial be satisfactory, the whole of the line between Modane and Turin will be similarly equipped.

The Laundry Exhibition.—The multifarious uses to which electricity can be applied has been abundantly illustrated at the Agricultural Hall this week. An exhibition has been held there of laundry machinery, and several enterprising firms had stands exhibiting electric ironing apparatus, air propellers, ventilating and heating apparatus, etc. Among our "Business Notes" will be found a brief description of the show. Electric cabs and motors were present in strong force.

The Trade of Great Britain.—The Board of Trade returns for July summarise the imports and exports for the previous seven months. During that time the imports have increased by £10,681,073, but the exports show a decrease of £1,592,975. We note, however, that yarns and textile fabrics are chiefly responsible for this drop, while the export of machinery has increased in value by half a million. We hope that our electrical manufacturers contributed their share to the above increase.

International Telephone Lines.—In performance of an arrangement concluded between the French and English Postal and Telegraph Departments, two new telephone cables have been laid down in the Department of Pas-de-Calais in North-East France. A third telephone circuit and two new telegraphic communications are in use between Paris and London. A fourth circuit, at present in construction, will be opened for working in the course of the present year. German papers say that it would be desirable to have a direct cable between England and Germany.

Peru.—The *Chamber of Commerce Journal* announces that a presidential decree of February last provides for the establishment at Lima of a permanent exhibition of machinery, which, the French Minister states, is to constitute neither a medium for industrial competition nor a sale bazaar, but the object of which is, from the point of view of Peruvian imports, to enable manufacturers to make their products and marks known on the Peruvian market. Such machines for exhibit will be admitted free of duty. We note that electrical machinery and telephone gear are particularly referred to by the Minister as likely to be admitted.

Dover Electric Tramways.—The official trial of the new electric tramways at Dover took place last Friday in the presence of Sir F. Marindin and Major Cardew. The working was exceptionally smooth, and as the trams passed up and down the street a good deal of interest was manifested. There was no hitch whatever in the trips, the roadway being in perfect order and the electric supply most efficient. There is said to be little doubt that the line will be promptly sanctioned by the Board of Trade, and it is hoped that a permanent service will shortly be established. We have in a previous issue given full details and illustrations of these tramways, which will be found interesting at the present stage of affairs.

The 1900 Paris Exhibition.—We understand that Colonel Jekyll has been appointed secretary of the Royal Commission for the Paris Exhibition, and that the commission will hold its first meeting at the Foreign Office this month. We also learn from a French source that the catalogue of the exhibition has now been closed. Mr. Mesureur has just deposited his last report, from which we see that the question of railway communication suggested 24 different schemes. M. Moran decided to retain two of them only. The first one emanates from Mr. Armengaud, jun., who proposed an electric platform on the Blot system, with two speeds, for the conveyance of visitors to the interior of the exhibition.

British Engineers in Spain.—It is interesting to note that a British firm has been given the contract for the electrical equipment of extensive tramway systems in Madrid and Barcelona. The *Railway World* believes that the total amount of the contract, including 160 motor equipments, is about £160,000, which makes it the largest contract for the construction of electric tramways that has been signed in Europe, and, with one exception, larger than any single contract made in America. This should make it clear to corporations or companies contemplating the construction of electric tramways that British firms and engineers are perfectly competent to construct any system of electric tramways that may be required. The contractors for the Spanish lines refered to are Messrs. Dick, Kerr, and Co., Limited, of London and Kilmarnock.

Vacuum Tubes for Street-Lighting.—We hear that Mr. D. McFarlan Moore has recently carried out some experiments in outdoor vacuum tube illumination, which leads him to the belief that this work is practicable. This method of illuminating has been found successful for indoor lighting, but the experiments did not show with any exactitude the amount of energy used. This difficulty will have to be completely overcome before the system can be generally adopted for outdoor lighting, and in addition to this, the difficulty of insulation will be much enhanced. We learn that Mr. Moore has already determined the fact that water on the tube interferes in no way with its action. The tube Mr. Moore uses for his experiments is about 7ft. long with a diameter of about 2in., and he suggests that these could be strung together between the trolley wires of an overhead railway, which is somewhat elementary, considering the enormous additional strain that would be put upon the poles.

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A New Lighthouse.—It is not often that monuments to illustrious Frenchmen take so practical a form as that which has just been inaugurated amidst the desolate rocks of Penmarc'h, on the Breton coast. Some little time ago Mme. de Blocqueville, a daughter of Marshal Davoust, Duke of Auerstadt, left the sum of £12,000 sterling to perpetuate her father's memory by the construction of a lighthouse. The Government approved of so excellent an idea, especially as at that moment the Penmarc'h light was getting obsolete, and trebled the amount of the lady's legacy in erecting the lighthouse. This is now the most powerful beacon that France possesses, quite outdoing the Hève light. Its electrical illumination is said to be of 10,000,000 c.p., and placed more than 180ft. above the sea it is visible at a distance of 60 miles. On the summit under a canopy stands the statue of the great soldier looking forth over the wide waste of water.

Motors as Dust Collectors.—The Chiswick Urban District Council have just commenced the collection of dust and house refuse by motors, the first of two "steam tip wagons" ordered for the purpose having been delivered last week and set to work immediately. The Chiswick Council is the first local authority to employ motors in this way, and the experiment has excited much interest among other sanitary bodies. So far it has proved very successful. Mr. Ramsden, the surveyor to the District Council, reports that a week's experience with one of the cars shows that they are very easily controlled, and far more economical than horse labour. The steam wagon does the work of three ordinary carts, and Mr. Ramsden estimates that the Council will save between £500 and £600 a year by the adoption of the new system. He says that the motor easily negotiated the steep incline of Kew Bridge at 150lb. pressure with a load of two tons. We should be glad to see electricity employed in this way.

The City Polytechnic.—We have received the syllabus of lectures in the engineering department for the fiftieth annual session, 1897-98. The professor is Mr. Henry Adams, M.I.C.E., M.I.M.E., etc., who is well known on account of the valuable text-books he has written on constructional subjects, and for the success which this department has achieved under his guidance. Classes are arranged for technical drawing, building construction, machine construction, and civil and mechanical engineering. There are also various courses for quantity surveying, valuations, land surveying, etc. The City Polytechnic is situated at the City of London College, White-street, Moorfields, E.C., and we learn that there are now 40 professors and lecturers upon the staff, giving instruction in upwards of 50 different subjects of science, art, language, and literature, divided into 130 classes, and the attendances for the session (seven to nine months) average 70,000. The secretary is Mr. David Savage, and all particulars can be obtained from him.

Accumulator Cars in Paris.—Experiments are being made in the use of accumulators on the tramlines in Paris, extending from the Madeleine to the suburbs of Courbevoie and Levallois, a total length of about three or four miles. It is proposed to charge the accumulators at the end of the line before the car makes its return journey. The trial cars are double-decked, and will seat 52 persons, weighing when fully occupied 31,000lb. In each car will be placed 200 Tudor accumulators, ranged under the seats, and it is proposed to charge them with a mean current of 120 amperes, the time required being from 10 to 12 minutes. In this way the car will be charged at the end of each journey, and the required capacity and weight of the cells is accordingly reduced. Each motorcar is equipped with two 25-h.p. motors running at 500 revolutions per minute when the car has a speed of 10 miles per hour. This method of rapid charging will not in our opinion tend to a good efficiency, but we shall be glad to hear the result of actual experience.

The Liverpool Case.—A fortnight ago we entered a strong protest in these columns against the proposed appointment of a foreign engineer to advise the Liverpool Corporation over their traction work. We are now glad to be able to state that the Tramway Committee of the Corporation have decided not to appoint Mr. Pearson as the engineer of the tramways, but to engage him in a "consultative capacity if so desired by the committee." Mr. Granville Cunningham and Mr. H. Graham Harris will probably be appointed as engineers, which seems a most satisfactory arrangement, and one likely to produce the best results. We are glad, not from any personal motives, as we have already stated, but because we feel so strongly that charity should begin at home—in other words, that while we have the men capable of doing the work there is no need to go out of the way to appoint men from foreign countries. We were sure that if the matter was placed before the Liverpool people in the proper light, they would agree with the justice of our view, and therefore we did not hesitate to speak plainly; and we are rejoiced to find that our view has prevailed.

Madras Electric Tramways.—Great objection is being made in Madras to the posts in connection with the overhead conductors. We remember something of the same kind at Islington, when the Vestry tried to save money by turning out at midnight an arc lamp placed in the centre of the street. A local Madras paper publishes the following letter: "I had occasion to drive over No. 1 section of the Madras tramways, after darkness had set in yesterday evening, and not having been on the road since the erection of posts in connection with the overhead system of power conduction, about to be adopted by the tramway company on this section, was able to realise what the change means to a stranger driving along Poonamallee-road after nightfall. Even, however, to those familiarised by regular driving over this route, the position of the posts down the centre of the roadway is dangerous in the extreme. In driving anything more spirited than a jutka tat it will sometimes be possible to pass carriages and avoid collision with the posts and at other times it will not." We trust that the posts in question are to be used as supports for the street lamps, as in this case the whole of the danger is got over.

The Management of Accumulators.—We give elsewhere in this issue an article on the subject of the "Management of Accumulators," by Mr. F. G. Ansell, F.C.S. The first part of the article deals in a general way with the theory of accumulators, and is open, as all such matter is, to a great deal of question. Whatever may be said of Mr. Ansell's theory, his determination to call the peroxidised plate the negative plate is to be deprecated. All the makers of accumulators have adopted the opposite procedure, and to instruct a young man to order negative plates when he requires the peroxidised ones will lead to endless confusion. Passing over the theoretical introduction, Mr. Ansell's communication will be found to contain a collection of useful hints to those in charge of accumulators. We note, however, that he has not included in them the systematic record of the acid density in each cell at frequent intervals. In our opinion such records are more useful than anything else in indicating incipient faults. Mr. Ansell claims to have kept 100 accumulators in good working order for the last three years with an annual expenditure of 2½ per cent. on the original outlay, but we feel sure this figure does not include labour.

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Electric Lighting in Gloucester.—The Gloucester Corporation are seriously setting themselves to work to establish an extensive electric lighting system for their city, and they have received an exhaustive report on the subject from Mr. Hammond. We give the gist of this report in another column. This is only another instance of the activity which is being displayed by all our larger municipalities, most of whom are the possessors of provisional orders, to keep those orders in their own hands for the benefit of the ratepayers. The enormous, but natural, success which has been achieved in most of the large towns of the kingdom where electric lighting operations have been carried on for a reasonably lengthy period is now having its effect on the less enterprising boroughs, who are beginning to awaken to the fact that if they do not hurry up their opportunities will be lost. For Gloucester, Mr. Hammond recommends the adoption of low-pressure continuous-current feeders, on the three-wire system of distribution, at a pressure between the outer conductors of 440 volts. The Corporation have adopted the report, they have engaged Mr. Hammond to prepare and carry out a scheme, and they have decided to apply to the Local Government Board for sanction to borrow £50,000 to carry out the work.

The Electrical Engineer Volunteer Corps.—The organisation of the Royal Engineers Volunteers (Electrical Engineers) Corps is going rapidly forward. The officers who have been recently appointed, as referred to in our issue a fortnight ago, will proceed to the Isle of Wight this week for preliminary instruction. Their headquarters will be in the submarine mining station at the Needles, where they will commence their training on Saturday, the 4th inst. (to-morrow). We are informed that anyone who has had practical experience, or has been engaged in engine driving, will be eligible, but all candidates will be required to pass a slight preliminary examination conducted by the adjutant. The enrolment will not be commenced until November, at the end of the financial year, but in the meanwhile applications for membership may be forwarded to Captain Brady, R.E., the adjutant, at 5, Victoria-street, S.W. The headquarters will be most likely fixed at Greenwich, and at first the operations will be limited to London. As soon, however, as the London corps have been organised other corps will be established in the provinces. Previous to the engineering strike, which has now upset the organisation of our large electrical factories, a great number of men had, we understand, given in their names as probable members. Full particulars of the objects of the corps and the duties of the officers and men will be found in our issue of June 8 of this year.

The London Cab Trade Council.—The above body views with suspicion the introduction of the electric cabs. Their chief objection is on the score of competition, and the fear that the new cabs being in demand may induce the drivers to compete for them to offer higher prices per day for these cabs than those pertaining under the Asquith award. We have not heard that the drivers who have been trained to drive these vehicles share the distrust of the council, but we are sure that the resolution recently passed will not retard the progress of this type of public conveyance.—Mr. Walter C. Bersey, general manager of the London Electrical Cab Company, has addressed a letter to Mr. Fred White, general secretary of the London Cab Trade Council, in which he says: "I fail to see how it can be contended that the introduction of electrical cabs can be against the interests of the cabdrivers. We have spoken to hundreds of cabmen on the subject, and have always understood they were most anxious for the change, as it would shorten their hours (by saving the time wasted in changing horses), and also save them the unpleasantness of frequently having to drive tired and undesirable horses. I may add that we have no intention of charging the drivers more than the prices they now have to pay. However, if our electrical cabs possess the objections you mentioned the question will solve itself; but, so far, our experience is that the public are extremely pleased with them."

The National Electric Fire Code.—We have before referred to the fact that the National Board of Fire Underwriters in America have issued a set of rules which they have mutually agreed to adopt. Since our announcement of this fact the Institution of Electrical Engineers have issued their rules, and it is interesting to note that the requirements of the American code are in several cases much below those in force in England. As an example of this, we may mention that the rule for insulated wires only requires an insulation resistance of one megohm per mile. The wire before testing must be immersed for two weeks in water 75deg. F. and for three days in lime-water. The insulation resistance is to be taken after three months' electrification at 550 volts. Rule No. 12 in the National Electric Code deals with the electric tramway, and lays it down that the earth return wires must be so arranged that the difference of potential between the earth-plate at the central station and any point on the return circuit shall not exceed 25 volts. The same limit in the English practice has been fixed by the Board of Trade at 7½ volts, and the comparison is very striking. It is suggested in connection with this rule that the positive pole of the dynamo should be connected with the trolley wire, and then whenever pipes are found to be electrically positive to the rails or surrounding earth that they should be connected to the return conductor, so as to prevent as far as possible current flowing from the pipes to the ground.

Wireless Telegraphy.—Active preparations are now being made by the Post Office engineers for a most important experiment in wireless telegraphy. The *Daily Chronicle* announces that the above paragraph refers to the scheme for connecting Sark with Guernsey by the new means of communication. This has been talked about for some time, so that anticipation will give an added interest to the practical experiment. It remains to be seen how thoroughly the thing can be done. Necessarily it will have to be proved in a satisfactory way before permanent apparatus is laid down. There is not anywhere, at this moment, any telegraphic link of the communication between Sark and Guernsey. The people of Sark, although they hardly form a large community, are naturally anxious to be placed in telegraphic communication with the outside world. It happens that the bottom of the sea between the little island and its larger neighbour, Guernsey, is very rough and rocky. This fact means that a marine cable would be difficult to keep in repair, that its maintenance would involve considerable expense. Hence the idea of applying wireless telegraphy. The name of Mr. W. H. Preece is very familiar in relation to signalling through space without wires. His plan is based on the utilisation of electromagnetic induction. On the other hand, Signor Marconi utilises electric waves of very high frequency. It may be taken for granted that both methods will be tested during the experiments between Guernsey and Sark. The one thing that remains is to fix a date for these, and that will be done within the next week or two.

Electric Traction.—Mr. G. Gerry, jun., has recently read before the American Institution of Electrical Engineers a paper on this subject. He deals particularly with application of electric power to passenger traffic on elevated and suburban roads where rapid transit is required. He details the difficulties to be met in this class of line, where

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the traffic is irregular and exceedingly heavy at certain hours. The practical information given in the paper relates to the Chicago elevated railway, which had about 24 miles of such lines. The third-rail system is used, the conductor rail being placed about 20in. outside and 6½in. above the running rails. It is of the common T section, bonded with leaf copper. The insulation of this railway consists chiefly of hardwood blocks, and mounted on small iron chairs fastened to the ties. On recent extensions, however, stoneware insulators have been employed to give higher-class insulation. Steel rails are used for feeders, the feeder system being divided into six sections, which are tied together at the junction points through the circuit breakers. The author gives a series of curves as to the power required by the motors for running a 100-ton car at an average speed of 15 miles per hour. From this the following main figures are deduced: A train on a ·5 per cent. up grade takes from the line 106 h.p.; on a level line it takes 76 h.p.; and on a ·5 per cent. down grade 46 h.p. The author divides this power as follows: for accelerating the train, 60 h.p.; for ascending grade, 30 h.p.; and for train resistance, 16·5 h.p. These figures, of course, do not include losses in applying the power. The author also gives a large series of curves of the power required by the trains on different parts of the line, and says that the low current of the feeders has proved to be a sensitive indication of the traffic. A fault on the opposite line, necessitating delay, causes an increase of passengers, which can be observed in the load curves. As regards the cost of energy, he found that in the vicinity of Chicago power can be produced for traction purposes at ¼d. per unit, and the equivalent amount of energy on the car axle costs about ½d. per hour. From a table of eight different runs, we see that the average speed, without including stoppages, varies from 12 to 17 miles per hour. The kilowatt-hours per car mile supplied by the station vary from 1·2 to 1·8. To anyone interested in traction this paper is well worth reading.

Associated Chambers of Commerce. — The autumnal meeting of the above association will be held at the Oddfellows' Hall, Bridge-street West, Middlesbrough, on the 14th and 15th of this month. The chair will be taken each day at 10 o'clock precisely by the Hon Sir H. Stafford Northcote, Bart., C.B., M.P. The following, amongst others, are subjects on which resolutions will be moved: Canadian tariffs, consular reports, commercial education, the Imperial penny postage. The fourteenth and sixteenth resolutions are worthy of reproduction on account of the mutual contradiction. The fourteenth, moved by the Newcastle and Gateshead branch, is: "That this association is of opinion that the Post Office is looked upon too much as a revenue-earning department; whereas, whether as regards the carriage of letters, circulars, newspapers, etc., or the arrangements connected with the telegraph and telephone services, the first duty of the department should be to give the public the greatest reasonable facilities, even if in some cases no profit should arise therefrom. That copies of this resolution be sent to the Premier, the Chancellor of the Exchequer, and the Postmaster-General." The sixteenth, moved by the Wakefield branch, is to the effect: "That in the opinion of this association it is unfair to the public that the telegraphic department of the Post Office should for financial purposes be treated as a separate establishment, thereby causing unwarrantable delay in carrying out urgent and much-needed reforms. That, inasmuch as the postal establishment and its various departments are in their entirety a financial success, the time has arrived when the address of not exceeding four words should be allowed free of charge in all telegrams, and that telegraphic communication should be extended to rural districts where practicable. That a deputation wait upon the Postmaster-General to urge upon him the desirability of adopting this suggestion." There is also a resolution to be moved "That the Executive Council be requested to call the attention of the Postmaster-General to the irregularities and delays on the trunk line telephone service throughout the country with a view to speedy remedial measures." As a finish, there are four resolutions dealing with the metric system, which range from a proposed compulsory date for enforcing the system, to the teaching of the same in elementary schools.

The Durham College of Science.—This college forms one of the most imposing buildings in Newcastle-on-Tyne, and since its establishment in 1871 has done enormous work in the advancement of the study of science, philosophy, literature, and the fine and mechanical arts. The calendar for the ensuing session has just been issued, and forms quite a large volume in itself. Courses have been arranged, each consisting of about 24 lectures, to provide a continuous course of instruction in electricity, and, in conjunction with the laboratory work, to meet the requirements of students intending to become electrical engineers. The lectures will be illustrated by experiments, lantern slides, commercial instruments, etc. The course for electricity and magnetism will be conducted by Mr. Patterson, and is intended for students commencing the study of electricity, and the junior and senior courses for technical electricity will be conducted by Prof. Stroud. Laboratory classes will be held in connection with each of the lecture courses in electricity. Students can take up any particular branch of the subject in which they may be specially interested, provided they possess the necessary qualifications. The department of technical electricity is at present provided with ammeters, voltmeters, and other electrical measuring instruments, arc and incandescent lamps, different types of motors, specimen secondary batteries, etc. Direct currents are provided from the college dynamo, and alternating currents from the city mains. Courses have also been arranged for, amongst other things, telegraphy and telephony, general inorganic and organic chemistry, and the chemistry of fuel, iron and steel, besides the ordinary engineering courses. This calendar is a most useful book to have by one, and at the end are given several series of examination papers.

The Engineering Dispute.—The federated engineering employers have issued a statement in reply to a recent letter by Mr. Barnes, who spoke of wages being higher and the working hours fewer in America than in Great Britain. It is affirmed by the employers that wages are not higher relatively to the cost of living in America, and that work is done there at much higher pressure and with fewer holidays. Figures are quoted from the statistics compiled by the Government Labour Bureau to show that in the State of New York numbers of engineers, blacksmiths, machinists, and patternmakers work from Monday to Friday 10 hours and on Saturday nine hours, or 59 hours per week, iron-moulders 59 to 60 hours per week, and machinists 53 to 60 hours per week. In Connecticut, New Hampshire, Indiana, and North Carolina machinists work on an average 58·18 hours per week, ironmoulders 57·9, patternmakers 59, and engineers 60 hours per week. The Amalgamated Society of Engineers, it is added, "has about 2,000 members in the United States working continuously and contentedly from 57 to 60 hours per week. It is not probable that they will be willing to contribute to the support in idleness of men who want to work only 48 hours." An official statement, which has been issued on behalf of the Employers' Federation with reference to the extension of the lock-out by engineering firms in all parts

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of the country, shows that upwards of 100 additional firms have joined the federation since the first list of firms who had locked out was published two months ago, bringing the total up to 318. In the Manchester district 29 firms have locked out, in Bolton five, Liverpool and Birkenhead four; and the other districts which have followed the same course are Barrow, Leeds, Leicester, Hull, Halifax, Sheffield, Oldham, and Belfast. The most important extension was in Oldham, where 20 firms, including Messrs. Platt Bros., Limited, and Messrs. Asa, Lees, and Co., have joined the movement. In the Keighley district, too, 20 firms have decided to co-operate with the federation. A Leeds correspondent telegraphs that, in addition to the announcement made on Monday that a Hunslet firm of engineers intend to introduce German workmen, it was stated last evening that one of the leading engineering firms in Leeds is contemplating the erection of works in Germany. Should such a step be actually taken, the firm will remove three-fourths of its business there, and the remaining fourth will go to Russia. The latest returns show that 951 engineers, society and non-society, are out of employment in Sheffield, in addition to several hundred labourers, for whom there is a gloomy outlook, as they receive no strike allowance of any kind. The armour plate and projectile manufacturing firms are still at work, but the prospect is not hopeful.

Electric Cabs in New York.—The *Electrical World* has published an article on the electric motor cab service in New York, from which comparison can be made with the electric cabs now running in London. The electric cab service has been started in New York for five months now, and, although no attempt is made to compete in rates with other cab service, yet the demand for electric motor cabs has, we are told, assured the success of the enterprise. The essential differences we note at once in comparing the vehicle with those described recently in our columns, are as follows: The New York cabs have two separate driving motors, each driving one wheel; the front wheels are driven, while the back wheels are used for steering. The wheels have pneumatic tyres. The batteries are carried in the body of the vehicle, being slipped into place. On the other hand, the London electric cabs drive the rear wheels by means of a single duplex-wound armature. The wheels are differentially geared, but not absolutely independent; the tyres are of solid rubber. The front wheels are used to steer, and, finally, the batteries are carried under the cab, and can be more readily detached. From what we gather, the weight of the New York electric hansom is 4,200lb. when complete, while the London electric cab weighs 3,300lb. The numbers actually in use appear to be about the same in the two cities. The best results obtained in New York with these vehicles show that about 1·25 h.p. is necessary for the propulsion of 2,000lb. over ordinary approximately level roads at 10 miles per hour. This consumption of energy, which is only two and a third times that necessary for similar work on rails, can only be obtained by the reduction of all mechanical losses to a minimum, the use of an excellent motor and transmission, and a battery of only sufficient size to afford a practical travelling capacity, thereby bringing the weight within a reasonable limit. Careful deduction and the result of experiments and trials have enabled the designers to approximately state as follows the limiting figures: hansoms, maximum weight of vehicle 3,000lb., weight of battery 1,200lb., maximum distance in miles 25, maximum speed 12 miles per hour, average speed 6 miles; victorias, maximum weight of vehicle 2,000lb., weight of battery 800lb., maximum distance in miles 35, maximum speed 15 miles per hour, average speed 8 miles. To propel a vehicle weighing about 2,000lb. with passengers, at a speed of 10 miles per hour, it is found to be necessary to have a battery output of somewhat over 1½ h.p. The essential output would, however, be far exceeded ordinarily and approach nearer 3 h.p. It has therefore been found that about 9,000lb. of battery are needed to give a travelling capacity of about 30 miles at this rate, or about 1,350lb. with a vehicle weighing complete about 3,000lb. The steering gear of these hansoms, etc., is particularly interesting. The two hind wheels do the steering, and are mounted on pivoted hubs, the angle of which can be readily controlled by the driver.

Electric Blasting.—An interesting and lengthy paper has been written on this subject by Mr. Wm. Maurice. The first portion was read at the annual meeting of the Chesterfield and Midland Counties Institution of Engineers at Chesterfield last Saturday, and the remainder will be read at later meetings. We wish we could give a portion of our space to Mr. Maurice's remarks, but *Official Proceedings* are inexorable, and the paper is not yet at liberty to be reproduced. We have, however, obtained the following synopsis, which will indicate the exhaustive nature of the paper and make the reader wish for more. Part I. deals with: Invention of gunpowder—Introduction of gunpowder as a blasting agent in mines—Invention of first electric machine—Early attempts to ignite inflammable material by electric sparks—Ignition of sulphur ether by Ludolf, 1744—Ignition of gunpowder by Dr. Watson, 1745—Franklin's electric cartridge, 1751—Wolff the first to devise means ensuring certain ignition, 1787—Discoveries of Volta, 1800; Oersted, 1819; and Faraday, 1831; and their influence on the development of electric exploders—Early examples of electric blasting. Causes which have led to the extended application of electric firing in mines—Early blasting apparatus: (*a*) Leyden jars; (*b*) primary cells; (*c*) frictional machines; (*d*) induction coils; (*e*) magneto machines. Part II. (to be read at a later meeting): Evolution of the electric fuse—Platinum and iron wire coil fuses—Origin of the terms high and low tension as applied to fuses — Definitions of "high" and "low" tension fuses—The fuses of Beardslee, Shaw, Statham, Abel, von Ebner, Abegg, Gaiffe, Mackie, Scola, Siemens, McNab, Brain, Dumas, Bornhardt, Smith, Nobel, Pettinger, Linke, etc.—Detonators for (1) gunpowder; (2) Sprengel explosives; (3) nitro-explosives containing nitro-glycerine, and nitro-explosives not containing nitro-glycerine—Sizes of detonators—Testing detonators. Part III. (to be read at a later meeting): *Résumé* of the various electrically-operated systems which have been devised with the object of lessening the danger of blasting in fiery and dusty mines—Modern methods of detonating high explosives—(*a*) Bornhardt and other Continental apparatus; (*b*) American "rack-bar" exploders; (*c*) English and Continental magneto and dynamo exploders; (*d*) secondary cells; (*e*) primary cells; (*f*) "dry" cells; (*g*) electric light, etc., mains. Part IV. (to be read at a later meeting): Shot-firing cables—Suitability of various insulators—Series and parallel connections for group firing—Blasting in (1) shaft sinking; (2) stone drifting; (3) coal—Objections to electric blasting—Temperature of detonation—Photographic determination of detonation flames (contributed by Mr. L. W. De Grave, A.M.I.C.E.)—Miss shots—Hang-fires—Accidents—Failures: their causes and remedies—Blasting statistics—Cost of electric blasting—Different systems compared—Electric blasting compared with powder and fuse—Diagrams showing (1) 12 months' firing with powder and fuse; (2) ditto electric firing in same coal seam; (3) life of batteries—Safety regulations in collieries.

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TWO GUINEAS FOR A LETTER.

On the 20th ultimo we offered the above sum for the best letter of advice to the parents of young men wishing to become electrical engineers. Such a number of letters have been received, and amongst them there are so many which show a careful appreciation of the subject, that it has been no easy matter to decide to whom to award the prize. Our final decision has been that the letter under the *nom de plume* of "An Electrical Engineer" is the best. The writer hails from the North, and informs us that he has given us in his letter a *résumé* of his own career, which has led to a good appointment. We have decided also to award a second prize of one guinea to Mr. Edmund J. Fox, because he has carefully considered the alternative financial status of the lad's parents as affecting his mode of procedure. The following are some samples of the letters received, the prize letter being placed first:

How to Become an Electrical Engineer.

DEAR SIR,—One great principle that is necessary to success in any trade or profession is that any person entering such should do so of his own free will. Far too many young men go into, or are sent into, the engineering trade when they would make better ministers or soldiers, but as engineers they remain failures, because the whole soul is not in the work. The young engineer must be strong and in fit condition to do hard work. He must be willing to get up regularly at 5 or 5.30 each morning, and above all he must be ready at all times to obey his superiors.

If a boy shows a desire to become an engineer, he should be kept at school till he is 16 or 17 years of age. The last few years should be spent at an ordinary commercial college, where he will get a good general education, which is absolutely necessary to success. On leaving college he should have a good knowledge of geometry, algebra, trigonometry, freehand drawing, physics, inorganic chemistry, magnetism and electricity, practical plane and solid geometry. He should at least have gone through the elementary stages of these. He may now be got into a general engineering shop, where from 20 to 30 hands are employed. Never start in a large shop. In a small shop a lad of the better classes will usually find his fellow-workmen of a lower grade than himself, but he will soon get hardened to that. He may get many odd jobs to start with, such as tending the boiler and engine, or hammerman to the blacksmith, but at such things he will learn a lot. After a few weeks he will get accustomed to his surroundings, and will have started on fitting and erecting. In small shops fitters learn to use all the machines—such as milling, planing, drilling, slotting, shaping, etc. One great advantage that a small shop has is that apprentices learn to make their own tools, and do all sorts of blacksmith work; small shops usually do a great deal of outside repairing work, where a great knowledge can be gained amongst all classes of machinery. This will be found of very great advantage afterwards. After about three years on the fitting he will get on to the turning. In small shops, from five to eight turners (usually apprentices) are employed, so he will have all classes of work to do, such as screw cutting, shaft turning, boring wheels, pinions, bearing blocks, turning crankshafts, and a lot of other jobs too numerous to mention, both light and heavy. Parents will say that the foregoing is not electrical engineering, but the electrical engineer first requires to be a thorough mechanical engineer. Four or five years might be spent in such a shop as the above, the pay ranging from 3s. 6d. to 16s., all depending on the shop, district, and experience of the apprentice. During the foregoing apprenticeship the following classes should be attended: mathematics, machine drawing and design, steam, applied mechanics, inorganic chemistry, mechanical engineering, statics and dynamics, physics. He should also learn to use the slide rule, which is now in constant use in all offices where calculations have to be done.

The young engineer should now have little difficulty in getting into an electrical works, where he should remain for one or two years. His training would now depend on the circumstances of the parents, but it is not advisable to pay a premium, as it is apt to induce laziness and insubordination in the apprentice. Before starting in an electric shop the apprentice should consider which branch he is to take up, for it is necessary to make a speciality of one branch and stick to it. Different branches are the manufacture of dynamos, motors, and electric power plant generally; also high-speed engines. Another branch is the manufacture of electrical fittings. A speciality is also made in wiring and lighting buildings and vessels. After a year or two in an electric shop the young engineer should get into an office where a speciality is made of the line he wishes to take up. It is rather difficult to get into an office, and if the parents can pay a remuneration it will make matters easier. Several electrical firms in this country do not take premiums, and the best men in their shops usually get into their offices. These firms also pay as least a living wage on starting in their offices. In the office a start will have to be made on tracings and easy pieces of design, and as the man progresses he will get dynamos and motors to design; also high-speed engines, switchboards, and resistances, all depending on the firm he has started with. He should also learn to estimate and draw up specifications, both for light and power installations. The great object aimed at nowadays is to produce the best results with the least cost, and this has usually to be done in a specified time.

In conclusion, I cannot do better than quote from Southam's "Electrical Engineering as a Profession and How to Enter it." The management of works, organisation of factory and men, negotiations, the part taken by the Board of Trade, the local board, and municipal authorities in helping or restricting engineering work, the outlooks in various branches of industry in various countries, the cultivation not only of knowledge but sharpness and the sense of responsibility, all these are learnt, not at college, but by apprenticeship with a firm. This is also the view held by all the leading electrical engineers of to-day.—Yours truly,

AN ELECTRICAL ENGINEER.

How to Make a Lad of 16 an Electrical Engineer.

SIR,—Borough electrical engineers are continually being asked some such question as the above, and I, for one, invariably give the following answer. Let me first say, however, that I know no better method of being thoroughly grounded in the elements of the profession, and while it is as inexpensive as possible, in my opinion is not to be improved upon, even if a more expensive way is permissible.

At 16 the youth in question presumably has a knowledge of the rudiments of electricity, and magnetism, chemistry, and mechanics, and has received a good sound elementary mathematical education. I take it he will be able to devote five years to his apprenticeship, so that when he is 21 he will be able to earn enough to keep himself. The five years should be divided into three years in a mechanical shop and two years in an electrical one. In England, I believe, it is difficult to put a lad into a mechanical shop without paying a premium, but the majority of Scotch shops refuse to take premiums, all lads starting alike, and, being paid from the day they enter. They have to work from 6 a.m. to 5.30 p.m., and probably get about 5s. a week the first year, 7s. 6d. the second, and 10s. the third. By that time the lad has learnt how to use his tools, and even if he is not a first-class craftsman, has gained valuable ideas how to proceed to set out work, and the time to allow for it. He will now be able to get into an electrical factory by only paying a very reduced premium, or, indeed, may be taken on as an improver, if he is fortunate, and receive a small weekly wage. During the whole of the five years he ought to attend a technical college in the evening, taking up, say, two subjects a year, one of which should be drawing. At 21 years, a year, or even two, on some ocean liner, will be of invaluable good, giving him confidence in his own powers, and at the same time he will receive as good a lesson as can be had of his own insignificance—a lesson one has to learn some time, and the earlier the better. He will receive, say, £84 a year, together with

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board and lodging. With such training a lad ought to have no difficulty in obtaining a situation on shore at, say, £120 a year. He is now at the foot of the ladder, and it remains in his own hands as to what his future will be.—I am, etc.,

JOHN J. STEINITZ.

Town Hall, West Ham, E.

The Education of an Electrical Engineer.

SIR,—Although in a single letter it is rather difficult to point out the many sides to be taken into consideration in planning out a course of training for the profession of an electrical engineer, I have endeavoured to show below what in my opinion are the best ways of dividing one's time.

An electrical engineer, as far as general practical work goes, is simply a sound mechanical engineer who has acquired electrical knowledge. This being the case, the course of training for an electrical engineer is complicated by the fact that he should first qualify as a mechanical engineer, and as this, if carried out to the letter, would mean a longer period of training than the majority of future electrical engineers are able to give up to it, the question is, how can he best acquire a thorough practical knowledge of both in a reasonable time?

I propose taking two cases—the first that of a youth, say, the son of a tradesman; and, secondly, that of a gentleman's son—and enumerating as shortly as possible two of the best courses for each case. The youth is not supposed to be in a position to pay premiums to the same extent that the gentleman's son is, although I have assumed that he has at his command sufficient means to keep himself for a few years, as well as to pay small fees for technical college lectures, etc. I have assumed that the youth's school education is finished at 16, and that he is then ready to commence his training for the profession. He should, I think, in five years be in a position to take on a job and earn his livelihood, and I think that these five years should be divided in either of the two following ways, preferably the first: (1) *three years* as an apprentice in a mechanical engineering works, and *two years* as an improver in an electrical manufacturing firm; (2) *two years'* course at a technical college, and *three years* as an apprentice in the shops of an electrical engineering firm.

Course (1) offers facilities to the youth for acquiring a thorough knowledge of mechanical engineering, and if the firm he is apprenticed to is well chosen—such as a firm of engine builders and general engineers—he will become thoroughly conversant with the parts of engines, boilers, pumps, etc., which are certain to play an important part in his future career. He would not have any difficulty in getting apprenticed for a period of three years, at from 3s. to 4s. per week for the first year, with from 1s. to 2s. per week rise each year. At the age of 19 he would be ready to go to an electrical engineering firm, and although at this age he would be rather old to go as an ordinary apprentice, he should find no difficulty in going as an improver for two years at from 5s. to 6s. per week, provided he made some agreement to stay for two years. He should choose, if possible, the electrical shops—such as the armature-winding shop, test-room, lamp-shop, etc.—and if he found difficulty in making arrangements for being moved on from one shop to another, which in some cases he would do, I think that the two years spent in the test-room alone would be very well spent, as with his eyes open he would always be having opportunities of seeing what was going on, and, as a mechanic, of grasping details without actually working at them. The one point which this course does not provide, and which would be desirable if another year or two were at the youth's disposal, is theoretic work. The youth must make arrangements for this himself, by doing a good deal of reading at home in the evenings, and, if opportunity presents itself, of attending college lectures in the evenings. Great facilities are offered for this in all our large towns, and if the works are anywhere in the neighbourhood he will have no difficulty in doing this. If he has to depend on reading alone in the evenings, I think a keen worker will have no difficulty in keeping apace in theory, and although he would not cover so wide a ground as he would do by going to college for two years, he should during the five years be capable of acquiring quite sufficient. A little reading done in the evening, keeping pace with practical work during the daytime, is more keenly appreciated and easier remembered than a continuous flow of lectures from the professor's note-book.

I have only mentioned the second course as a possible way of getting over the objection of sending a youth straight into the shops after he has left school, without giving him an opportunity of associating with fellows of his own age for a year or two after leaving school. The second course may also be useful when the youth can live at home and attend college at the same time. Two years spent at a technical college will find the youth well grounded in the rudiments of engineering in general, in chemistry, physics, laboratory practice, and will have given him an idea of how to handle the ordinary workshop tools. He should be capable after this of entering a workshop as an apprentice, and of being capable of taking in details of the work going on around him, which he would in all probability not have grasped so readily without his college course. At this rate he would be ready to start his apprenticeship by the time he was 18, and he could expect from 5s. to 6s. per week for the first year, with a rise of about 2s. 6d. per week each year. Different firms make different arrangements with their apprentices, but the tendency among first-class firms is to start apprentices between 16 and 18 at higher rates than the younger ones, in order to encourage the older ones. In most shops apprentices are taken for three, four, and five years, according to their age. By the time the youth had finished his five years at this course (2) he would be thoroughly well up in electrical machinery, both in the theory and practice; but he would be found wanting in his knowledge of mechanical and general engineering, and unless he had opportunities for acquiring this (possibly his first job might offer these opportunities), he would miss it in after-life, and for this reason I would not recommend course (2) unless special circumstances of the case, such as the two mentioned above, strongly recommend it. A large number of youths after leaving school go to a technical college for a period of three years or so, and after finishing this course imagine that they are in a position to command salaries with manufacturing or contracting firms. This is the greatest mistake ever made, and I believe that the professors are to blame in a large number of cases for not telling the students at the beginning that without a further practical experience they are quite useless to any firm of practical engineers. Instead of this, students look forward to a salary at the end of their three years' course, and when they find that this is not forthcoming they become disheartened and discouraged. If the three years had been spent in the shops, instead of at college, they would have been in a far better position as far as earning any salary with a firm of practical engineers goes. I do not want to run the technical colleges down at all, as I think that they are most useful institutions, but to imagine that one can qualify as a practical engineer at one of these colleges is quite a fallacy.

To pass on to case 2. A gentleman's son will often not be satisfied, on leaving school at 19, to commence training at once for the profession. If he has an opportunity of going to either Oxford or Cambridge, he will in all probability take that opportunity. I have therefore made out two courses—the one for an individual who is prepared to start away on his training at 19, and the other for an individual who intends going to college for three years after leaving school. I think that if the subjects at Oxford or Cambridge are suitably chosen, and the individual takes his degree in either the science or engineering subjects, his three years will not be wasted, and, on the contrary, will be of considerable service to him in after-life. If a training such as one gets at Coopers Hill is substituted for the three years at Oxford or Cambridge, I think it will be far more useful to a future engineer, without at the same time losing any of the advantages of college life. It is, however, not everyone that can afford to prolong his training to this extent, and I have therefore prepared the two courses to meet the two cases. Course (*a*).—Leaves school at 19. *Three years* apprenticed in mechanical engineering works;

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one year a pupil at electrical engineering works; *two years* at technical college; and *one year* a pupil at electrical engineering works. Course (*b*).—Leaves school at 19. Three years at university or similar training; three years apprenticed at a mechanical engineering works; one year a pupil at electrical engineering works; one year a student at a technical college; and one year a pupil at electrical engineering works.

Course (*a*).—A pupil need not necessarily pay a premium at a mechanical engineering firm, and if he goes with an intention of working hard and keeping the men's hours he can, with a little trouble, get in as an ordinary apprentice, which at this part of his training would do him a great deal more good than if he were allowed to walk about, and not stick to his bench. For the two years spent at an electrical engineering works, with the two years' technical college sandwiched between, the pupil would do well to go as a premium pupil, and, in fact, would have to do so, to enable him to leave and come back again. The advantages, however, given to a premium pupil are so great that it is amply repaid. After three years in a mechanical engineering shop one would come to an electrical firm with an idea of going through the electrical part, and the advantage of being able to devote a portion of each day (or certain days in the week) to walking through the different shops and seeing what is going on, fully repays one for the premium paid. Possibly the two years spent at a technical college might be reduced to one year by anyone who has done a good deal of reading at home, or might be cut out altogether if able to attend classes in the evenings, in which case an extra year might be given to the electrical engineering works. The premium demanded for pupils by electrical manufacturing firms is about £100 per annum.

Course (*b*).—The three years spent at university make the training a very long one, and I do not think that even the one year given to technical college could be cut out, excepting for the same reasons as given in the last course.

Finally, the idea of spending part of one's training abroad, say in Germany, is a very tempting one, as not only are opportunities offered for learning an extra language, but experience can also be acquired which is bound to come in useful in after-life. My only views on this point are that if a part of the training *is* spent abroad, it should be the first part, and preferably the college part. The last years of one's training, in which organisation, discipline, and the art of dealing with men form important subjects for the practical engineer to study, should most certainly be spent in England, as experience in these cannot be acquired to the same extent abroad. I have no doubt that there are some cases where the courses given above can be somewhat modified or cut short, as after all some can learn in one year when it takes others two years to learn the same thing; but I do not think that for an average person that the courses are any too long.

I have not touched on central-station work and the experience gained by their pupils, because I do not think that anyone who has not gone through the above courses should take to central-station work until he has; and for a pupil to go straight to a central station from a college, as so many are doing now, will not qualify him as a practical man.—Yours faithfully,

EDMUND J. FOX.

The Training of an Electrical Engineer.

SIR,—In answer to your offer, the following is in my opinion the best course to be pursued by the not too well off parents of a lad of 16 who is destined to become an electrical engineer. I assume the lad to be able to write a good letter in correct English, to be well up in ordinary arithmetic, and to have some knowledge of elementary drawing, both freehand and geometrical. I also assume that his parents are not prepared to spend more than £50 a year on him for a period of six years.

The lad should, to begin with, be apprenticed for two years to a mechanical engineer, in whose shop he will learn how to use his hands. As his brains must be cultivated as well, he should in the evening attend the local science and art schools, taking during his first year plane and solid geometry and elementary mathematics, and during his second year elementary electricity and magnetism and elementary machine construction and drawing. His two years' mechanical apprenticeship ended, the lad should spend two years with a working electrical engineer, where he will learn how to apply the mechanical knowledge he has already acquired in one special direction. Whilst there he should attend during his first year evening classes in chemistry, heat and light, and advanced electricity, and during his second year classes in advanced mathematics, applied mechanics, and steam. His electrical engineering term over, the lad should be sent for one year to such an institution as the Finsbury Technical College or to Faraday House (if means permit) to attend a specialised course in electrical engineering, and this over, he should get a temporary berth on small wages at a central station.

No difficulty would be found in carrying out the programme indicated with the yearly sum named, and it would be safe to predict that the lad would, at the age of 23, be able to earn £150 a year, not at all a bad return for the capital spent on him. His first two years' apprenticeship would cost from £40 to £60, according to the standing of the firm selected, and this would be refunded in wages. At 18 the lad would be in a position to earn a small weekly sum whilst with the electrical engineer, and this judiciously laid by would tide him over his year at college. Once left college he would be a wage earner, although for the first year at the central station his wages would not suffice to keep him.

I would strongly recommend two years with a mechanical engineer and two with an electrical engineer, in preference to four years with an electrical engineer, for many reasons, the chief one being that it is sound policy to begin with *general* mechanical work and end with a specialised form of it. I would advise the parents of the lad to select a small town in preference to a large one in which to carry out this programme, as in a small town the temptations are fewer, and in the matter of science and art schools many of the smaller towns are now quite as well off as the larger ones. To the lad himself, I would say: Cultivate a taste for mathematics, as you will never be an electrical engineer worth the name unless you do, and be on your guard against prejudice and ignorance; those older and better off than yourself will try to persuade you that you will never attain to their standard, those worse off will try to make you believe that knowledge is not power because they have it not. No profession is so overstocked with knaves and fools: be on your guard against them both. The knaves, with their college or perhaps university education, will try to persuade you that their path is the only one to the goal. Read the life of Michael Faraday, and you will have an answer to that lie. The fools will try to make you one of themselves, but remember that though craftiness and worldly wisdom are good, knowledge is better, and knowledge can only be got by hard work. I may add, in conclusion, that I have purposely dealt with only one aspect of the question, as it is the only one on which I feel competent to give an opinion, and the only one which directly interests me.

Had I some thousands to spend on making my son an electrical engineer, I should probably write to one of your leading metropolitan lights for advice and enclose a ten-guinea fee.—Faithfully yours,

August 28, 1897. CLEMENT J. HEAPER.

The Best Way of Making an Electrical Engineer.

SIR,—As one who has only just passed through the mill, perhaps I am in a better position than many to give an opinion on this weighty subject. I think there is only one way to become a really good *practical* electrical engineer, and that is plenty of practical experience, together with a fair theoretical knowledge of the subject. I would like to specially emphasise the fact that these two must go together, and the following is, I believe, the best, quickest, and cheapest way to attain them. The would-be electrical engineer should first be sent to some first-class college, such as the Central Institution, South Kensington; the Yorkshire College, Leeds; and several others, and he should there take a first and second year course in the physics department; or, if he has had some previous physical

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training, he may possibly be able to take with advantage a one year's special course, which should be made to embrace the most valuable parts of the physics of both first and second years' courses at the college. This last will generally be found somewhat difficult to manage unless the student can get mathematical training outside the college, which, of course, is rather expensive, besides adding to the hours of work; the outside mathematical training should, of course, adhere as closely as possible to the college syllabus for first and second years. The student, after finishing his theoretical training, should then be sent to some well-known electrical works, preferably works which build their own engines, either as a student or apprentice for from two to three years. I should like to say here that I think it is safest to send a lad as an apprentice, but, nevertheless, if money is no object and the lad will work hard, a student has more opportunities to learn. He should here spend half his time at the fitting bench and half in the testing department, and when he has finished his three years he ought to come out with a very fair knowledge of his profession. Especially in his works course will the student find many opportunities of improving himself; many problems will from time to time come to him, for which he is at a loss for a solution, and it is by never letting such problems pass without tackling that success is insured. The cost of such a training might be made to cost anything from £100 to £400 —Yours, etc., STUDENT.

August 29, 1897.

Training for the Electrical Engineering Profession.

DEAR SIR,—In reference to the letter in your issue of August 20 upon the above subject, we will assume in the first instance that our friend is possessed of means which allow of his investing, say, £350 to £400 in five years of technical education. Having been brought up then at a good middle-class school, he should enter for at least a two years' course in the *day* classes of a technical college, of which many good instances exist in both London and provinces. The fees for the two complete sessions would be about £30. He will here acquire a very good grounding in the theory of electrical science and other branches of physics, and mechanics and mathematics. Thus equipped he should serve in the works of a responsible firm of manufacturing electrical engineers and contractors as an articled pupil for a period of not less than three years, during which time he will acquire by actual experience a practical working knowledge of his subject. The early portion of his articleship is well spent in the drawing office, the middle portion of his time in the works proper (workshops and outdoor), and the latter portion in the offices of the firm. The consideration for articled pupilage to a high-class firm would probably be about £300. In the second instance, we will assume that our friend is not in so fortunate a position as to be able to afford the course of tuition described above. In this case, in place of the two years of day-college training, he may obtain admirable *evening* courses, which are taken usually from 6 p m. to 10 p.m., according to the subjects and days. Regarding his *practical* training, he can gain admission to the workshops of any responsible firm as an apprentice, usually for a fee not exceeding 60 guineas. His evening work may, if desired, be taken up contemporary with his apprenticeship, though if this be done he must frequently be at work for perhaps 15 or 16 hours per day. The greatest efficiency will of course only be attained by the student not attempting too much, but what he does doing thoroughly. The fees for evening classes are always low, and are specially arranged for the benefit of apprentices and similar persons. As regards payment during pupilage or apprenticeship, various practices exist. In either of these two cases some firms return none of the premium paid, whilst others will return a certain proportion (and in some cases the whole amount) by an annual increasing salary extending over the term of the articles. Pupils are frequently the private pupils of one of the principals, whereas apprentices are articled to the firm.

Of the two courses indicated as suited to the different financial status of the student's friends, there are, of course, various modifications, the value of which can only be arrived at after thorough consideration of the circumstances holding in any particular case. Men will always be desirous of getting to the top of the ladder without the laborious process of starting from the very bottom, rung by rung, but it remains yet to be proven that the old (and perhaps expensive) system of pupilage or apprenticeship, coupled with the admirable theoretical college training now so readily obtainable, can be beaten. The writer's opinions, as herein expressed, are based upon personal experience extending over many years, and it is hoped may be of interest and service to enquiring parents and guardians.—I am, dear sir, yours faithfully,

August 31, 1897. A SUBSCRIBER.

THE MECHANICAL CONSTRUCTION OF ELECTRICAL MACHINERY.

BY F. M. WEYMOUTH.

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THE DYNAMO.

(*Continued from page 268.*)

Bearings (continued).—Thrust bearings and footstep bearings are very much the same in essence, although in practice the terms usually convey distinct ideas. Thus the latter of the two is virtually a thrust bearing put below the lower end of a vertical shaft, and the thrust it takes is that due to the weight of the shaft and other superincumbent parts that may be attached thereto, acting according to the laws of gravity. It happens, however, in electrical work, more especially perhaps in the case of portable motors used for the driving of tools, that the armature spindle may be in any position, horizontal at one time, and sloping or vertical another time. Thus, if a motor drives by gear—parallel gear, that is, not bevel or mitre—the end thrust of the armature spindle will simply be that due to gravity when the spindle is in any position other than horizontal. Should, however, the motor drive by a worm on its armature shaft, or by a bevel or mitre gear, there would then of course be always an end thrust in the shaft due directly to, such worm or gear, independent of, and in addition to, what might result from gravity. It is our purpose therefore, in discussing these types of bearings, to take them into consideration conjointly.

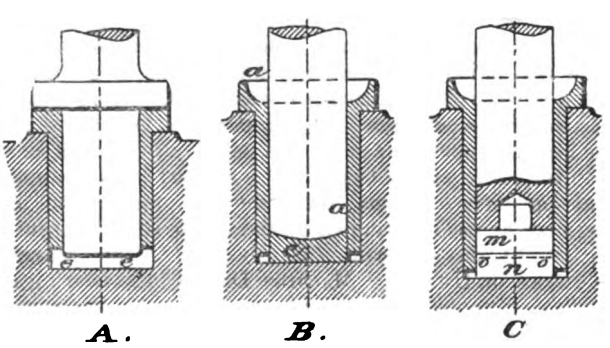

FIG. 275.

In Fig. 275 A, B, and C are shown three methods of meeting thrust in one direction only, of which the two latter are sometimes adopted for footstep bearings. The first of these, lettered A, is, however, though simple, a bad arrangement if the pressure of the shaft collar on the flange is at all other than very light. For the friction here, combined with the speed due to the large diameter, is apt to cause much heating. This method hence is used almost solely with horizontal shafts, wherewith there is no positive end thrust; and there is no duty on the collar and brass flange beyond merely keeping the shaft in place lengthways.

Fig. 275 B shows the shaft end included within a bush, *a a*, and stepped on a brass block, *c*, which bears all the weight: and the rubbing surface is dished as shown. It will thus be perceived that as compared with the last, the mean circular speed will be much less for a given number of revolutions per minute of the shaft. There will therefore be less tendency to heat.

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Under very heavy pressures, however, besides the liability of such blocks, *c*, to split, as pointed out in Unwin's "Machine Design," which might doubtless happen with a slow speed of shafting, when the speed is high there would be the further danger of seizing In connection with this latter point some experiments on the lubrication of bearings alluded to in a leading article in a recent issue of *Engineering* (August 6, 1897) may here be mentioned. A particular item therein brought out relates to the distribution of the pressure of the load within ordinary cylindrical brasses. Usually, such pressure is reckoned as so much per square inch of the longitudinal section of the journal. It would appear, however, from these experiments (by Mr. Beauchamp Tower) that the actual pressure per square inch along the centre of the brass, where alone the bearing surface is practically normal to the direction of the load, is double that reckoned for the longitudinal section as a whole; the explanation being of course, that towards the sides the brasses become less normal to, and more nearly parallel to, the direction of the load, until quite at the sides they are practically parallel thereto. Hence, though a mean pressure of, say, 300lb. per square inch may be allowed to the longitudinal section of the journal as a whole, it would seem to be a safe inference that along and about the centre of the brass the pressure will be more nearly 600lb. per square inch. Reverting once more to Fig. 275 A and B, we find the bearing surfaces opposed to the vertical load are practically or quite normal thereto; and so it would appear that, with efficient lubrication, 600lb. per square inch might possibly be allowed safely. This conclusion, however, does not seem altogether to agree with experience. At moderate speeds, 75lb. to 90lb. per square inch is given as a maximum load, and 40lb. or 50lb. as a safe load, on a collar. With a steel footstep, as in Fig. 275 B, on a white metal bearing, seizing has occurred at 240lb. per square inch (see *Proceedings* of the Institution of Mechanical Engineers for May, 0888, and March, 1891). It has to be noted that it is not so simple a matter, in Fig. 275 A, to maintain an efficient lubrication of the surfaces between the collar and the brass flange. Oil forced with sufficient pressure into the space, *e e*, beneath by pumping or other means, so that it could escape in a thin film beneath the collar, and would practically in a minute degree raise the shaft and prevent contact between the collar and the brass flange, would probably be the only means of getting such a design of footstep to work satisfactorily.

A further method, however, when the load is too heavy, and the revolutions are too high for a brass or gunmetal footstep block, is that illustrated Fig. 275 C. Here *m* and *n* are two hard-steel discs. The upper disc, *m*, has a pin formed on its upper side which is made a driving fit in a hole in the lower end of the shaft, as shown; and the upper or wearing surface of the lower disc has one or more oil grooves cut across it as shown dotted at *o o*, so as to insure the entry of the lubricant. In a bearing of this general type, shown in Unwin's "Machine Design," the bearing is shown much more roomy inside, so that the discs are immersed in a plenitude of oil; and by means of pipes leading to and from the interior fresh oil may be supplied as much as may be desired. By this means the parts may also be kept cool. With lubricant forced up beneath the centre of the footstep, and presumably with the groove *o o* absent, a pressure or load of one ton per square inch is safely borne (see *Proceedings* of Institution of Mechanical Engineers, May, 1888, page 197).

Two other methods of meeting end thrust which is in one direction only, are shown Figs. 276 and 277. In the former of these a hard cast-steel plug, *c c*, with an enlarged head as represented, is driven tight into a socket in the end of the shaft; and the outer or lower side of the head of this plug is smooth turned to a convex curvature as shown. A cast-steel disc, *d d*, with its upper surface also convex and smooth turned and polished, is placed beneath. The whole weight thus bears on the single central point of contact between the two convex surfaces. It will be observed that in such a bearing there is plenty of spare space: this latter may thus be filled with vaseline or other lubricant.

It might seem not a safe thing to put a great weight on a mere point. On the other hand, it has to be borne in mind that this is not a projecting point; but the actual contact surfaces in the steel both above and below, are immediately surrounded by other metal, forming a ring, which in the close vicinity of the contact may be considered to be in a state of tension tending to make it burst. Such an imaginary ring is, however, again surrounded and supported by other such rings of metal; and thus their united strength is sufficient to resist the tendency to burst, and a very heavy load is safely carried on the central point. Though not quite parallel in all circumstances, we find an instance in the case of a locomotive wheel resting on a rail, wherewith, owing to the contrary curvatures of the wheel tyre and the top of the rail, some 15 or 18 tons is supported on a mere point. It is not to be inferred, however, that it would therefore be safe to put anything like so great a load on a footstep of this type. For the locomotive wheel rolls on the rail, whereas in the bearing the one surface turns on the other, and there is friction. The actual safe load in this latter case will, of course, depend much on the quality of the steel. With ordinary cast steel, and a journal about 1¾in. diameter, a load of about half a ton may be carried safely, according to the writer's experience.

An advantage of this form of bearing is that even if the shaft rotates at a high velocity, and even if the actual point of contact be assumed as $\frac{1}{16}$in. or $\frac{1}{8}$in. in diameter, yet the maximum peripheral velocity will be very small: and the further such periphery extends from the centre, the less will be the load carried, on account of the convexity.

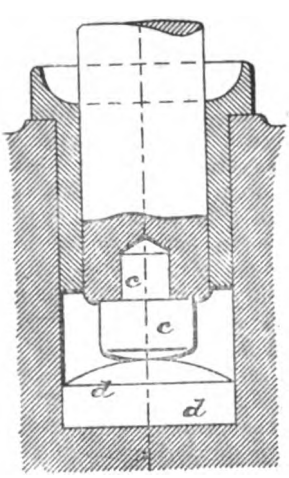

Fig. 276.

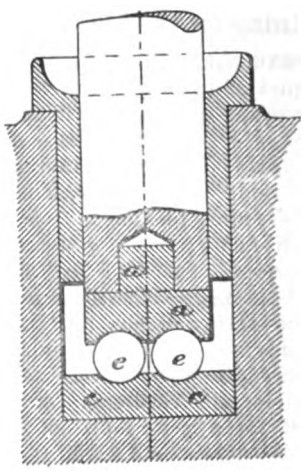

Fig. 277.

Although the steel blocks, *c c* and *d d*, may be immersed in lubricant, it is, of course, obvious that no lubricant whatever would remain between the actual bearing surfaces at the centre of the point of contact. As the pressure lessens in proportion to the distance from the actual centre, on account of the convexities of the surfaces, so will lubricant be more and more able to remain. But vaseline or other such substance also prevent rust.

Fig. 277 shows a further arrangement, which, like the last, has been, and is, used successfully for withstanding end thrust, whether due to gravity or any other cause. Here one, two, or three or more hard steel balls are supplied to take the weight and reduce friction. The end of the shaft is fitted with a hard, smooth-turned steel heel, *a a*, with a circular groove for the balls, *e e*, as shown; and a lower hard, smooth-turned steel disc, *c c*, has a groove to correspond.

Referring to our explanation of the free running of a ball bearing in connection with Fig. 274, it might perhaps appear here as though inasmuch as the balls may be all held under a constant heavy pressure, that any two or more of them may be grinding hard against one another. and so produce the friction they are designed to prevent. It has to be noted, however, that at the outset, when the parts are put together, the balls are all in loose contact with one another: and when in use there is nothing to make one catch up another; and with the least relaxation of load, balls that might be tight together would tend to spring apart once more.

The vacant space in this bearing also may be filled with lubricant: for not only does this prevent rust, but it

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minimises the friction that may be set up by the balls rubbing together.

It is to be noted with regard to the thrust or footstep bearings thus far discussed, Figs. 275 to 277, that they show no allowance for wear; and that consequently, as wears takes place, the shaft will gradually drop. Fig. 278 is a thrust bearing, which, unlike the foregoing, will take end thrust in either direction, as indicated by the arrows *x* and *y*. But here also there is no adjustment for wear. This latter is a design patented by Mr. James Blower (No. 15,492, 1886), and we illustrate it as being typical among various attempts to introduce ball bearings into the sphere of mechanical engineering generally. It is intended as a marine engine thrust block. The main bearing is indicated diagrammatically where lettered *a a*: *b b* are collars forged on the shaft: *c c* are hard-steel collars gripping the shaft and rotating therewith; and *d d* are fixed hard-steel collars attached to the bearing, *a a*. These steel collars are grooved as shown to receive the balls. They need to be split so as to get them on, as indicated in the end view of one of them shown at A, the two halves being held by bolts through the holes, *e e*. This necessitates running the balls over a joint: whereas ball races are usually and preferably designed so as to be without any joint. On the question of adjustment for wear, however, it is, of course, to be noted that the common expedient of packing up the parts with thin sheet metal, or even with paper, can be adopted to make up for wear. Thus the bush in Fig. 275 A may have some thin sheet metal placed under its flange so as to raise it a little, and similarly under the lower blocks or discs in Figs. 275 B to 277, and behind the collars *d d* or *c c* in Fig. 278. But these expedients, though common, none the less involve

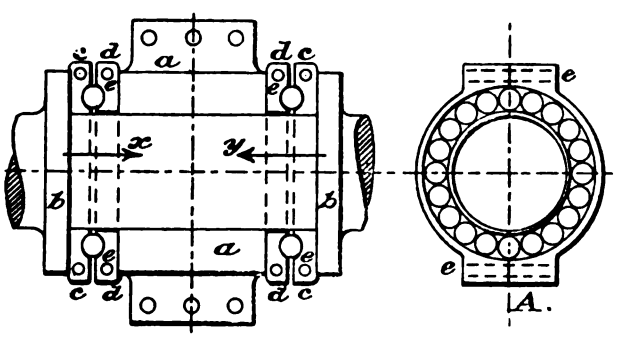

FIG. 278.

dismounting the machinery: or if such dismounting is not undertaken for the purpose, they can only be put into effect when such an opportunity offers.

(To be continued.)

MULTIPOLAR DYNAMOS.

We are glad to note that the firm of Easton, Anderson, and Goolden, Limited, has taken up the multipolar type of dynamos and motors, and that the machines made are finding a demand on the English market. There is no doubt that this type has been hardly judged by the profession in England, owing to faults in the early machines which were quite preventable. Mr. Valère A. Fynn is now responsible for design of the electrical generators and motors manufactured by Messrs. Easton, Anderson, and Goolden. This gentleman has had extensive experience with Messrs. Brown and Boveri, of Baden, and hence we must expect to see in his designs the traces of Continental practice. Mr. Fynn has kindly supplied us with the photographs from which the accompanying blocks were made, and which enable the construction of the dynamos and motors to be readily followed.

The frames and bed-plates of the machines consist of as few parts as possible. Up to 30 kw. the bed-plate and lower half of the frame are cast in one, together with the pedestals. The poles in these machines are cast with the frame; thus only two main castings are required. The frames of this series of machines are of specially prepared cast iron. The shape of the field is similar to that shown in Fig. 1, but the poles have not any extended pole-pieces. The exciting coils can thus be slipped on from the inside.

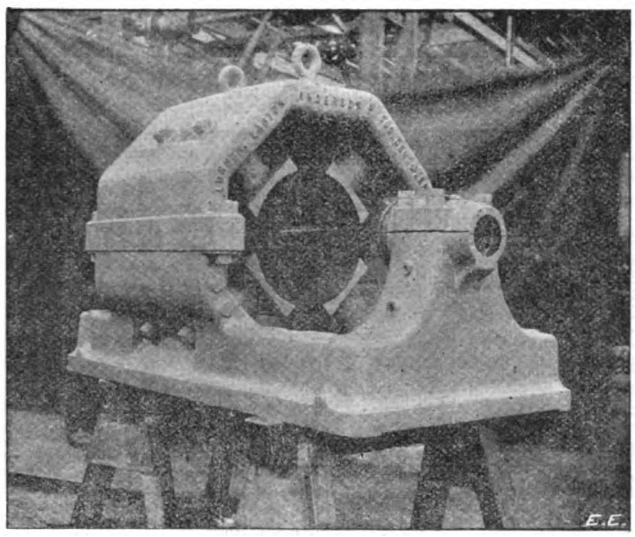

FIG. 1.—Carcase of the Four-pole Dynamo, with Steel Poles.

The next series of machines, extending up to the 110-unit size, are illustrated by Fig. 1. These machines are built much on the same lines, bed-plate, pedestals, and lower parts of frame being cast in one, and, together with the upper half of the frame, are made of special cast iron. The poles, however, which are bolted to the frame, are of best steel. The still larger sizes follow more closely the configuration of the first series, but on account of the size of the castings the lower half of the frame is not cast in one with the bed-plate, but bolted rigidly to it, and the poles are of steel. The general design is such as to give the very greatest stiffness and stability, avoiding at the same time a clumsy appearance. All the bed-plates are of box section. The frames are invariably provided with the necessary eyebolts for lifting purposes.

The excitation of the field is effected by means of a number of coils corresponding to the number of poles. These coils are wound on removable brass formers, which are securely fixed to the poles. The weight of these coils has been kept down to allow of convenience in handling. The upper half of the frame, with the poles attached, can in all cases be lifted off without in any way disturbing the magnet coils or cores. This allows of the easy removal of the armature, and gives ready access to every part of the machines.

All the armatures made for these dynamos are of the slotted-drum type. The advantages attached to that kind of armature have been fully recognised for some time past.

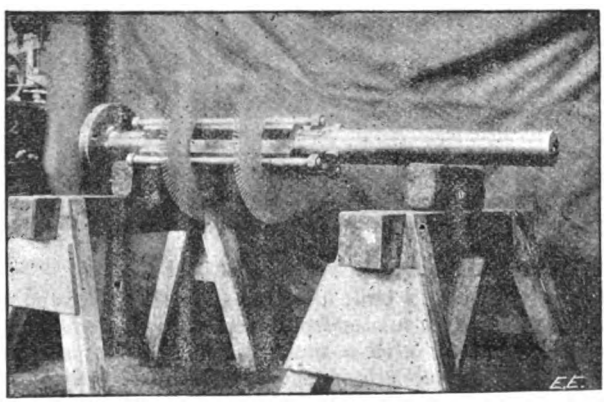

FIG. 2.—Armature Spindle, showing Discs and Keys.

At the same time, serious difficulties have been experienced with such armatures in obtaining a sparkless commutation and good regulation. On the other hand, large air-gaps in other types necessitate a large amount of copper, and therefore making the price prohibitive. Careful and prolonged

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study has been given to this question by the makers, and they claim the most complete success. They claim—and from what we have seen, they have reason to claim—to have obtained all the mechanical and other advantages of a slotted armature, together with perfectly sparkless commutation, with practically no "lead," and an extremely close regulation. Owing to the small air-gaps, it is also found possible to adopt prices which compare favourably with those of any other makers of dynamos.

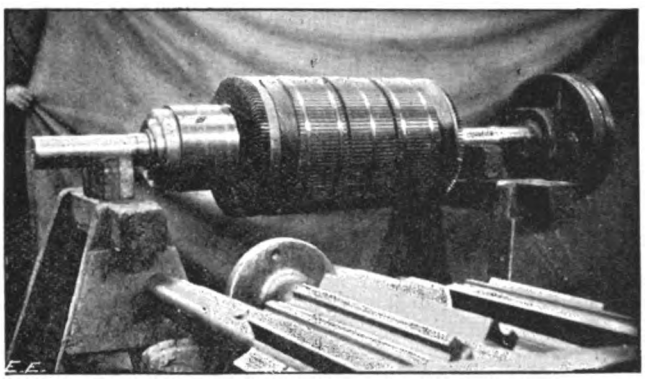

FIG. 3.—Complete Armature.

Much time and money has also been expended on the development of the best forms of winding, and the armatures are, with the exception of the very smallest, fitted with windings in which every single portion is easily accessible for repair or replacement, providing at the same time most liberal ventilation. Owing to their symmetry and ease of manufacture, these armatures present a very pleasing appearance.

on the mode of securing the armature discs to the shaft. The process adopted, and illustrated by Fig. 2, is one that will at once commend itself. The shaft in its middle is forged into the shape of a spider, thus securing stiffness at the very point where it is most wanted. A round hole is placed half-way in the disc and half-way in the spider arm; through this passes a bolt, which not only drives the discs, but is also used for clamping them tightly together. An effective system of ventilation, by means of openings in the armature core, continuously forces cool air through the whole system, greatly reducing the final temperature of the machine. Fig. 3 gives a general view of such an

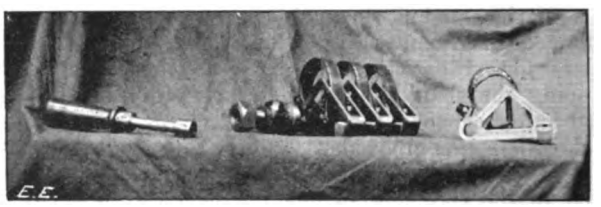

FIG. 4.—Details of Brush Gear.

armature when completed. In the foreground of the photograph several shafts with recesses for the key-bolts can be seen.

The actual method of winding these armatures varies with the range of voltage and current required, but usually two conductors are placed in each slot, one above the other. The inner wires are then bent in one direction, while the outer conductors are bent in the other direction. Each is carried round half the pitch of the winding and then joined. This gives the cylinder type of end connection, which is perhaps the neatest possible.

The bearings are all of ample length, and rest on

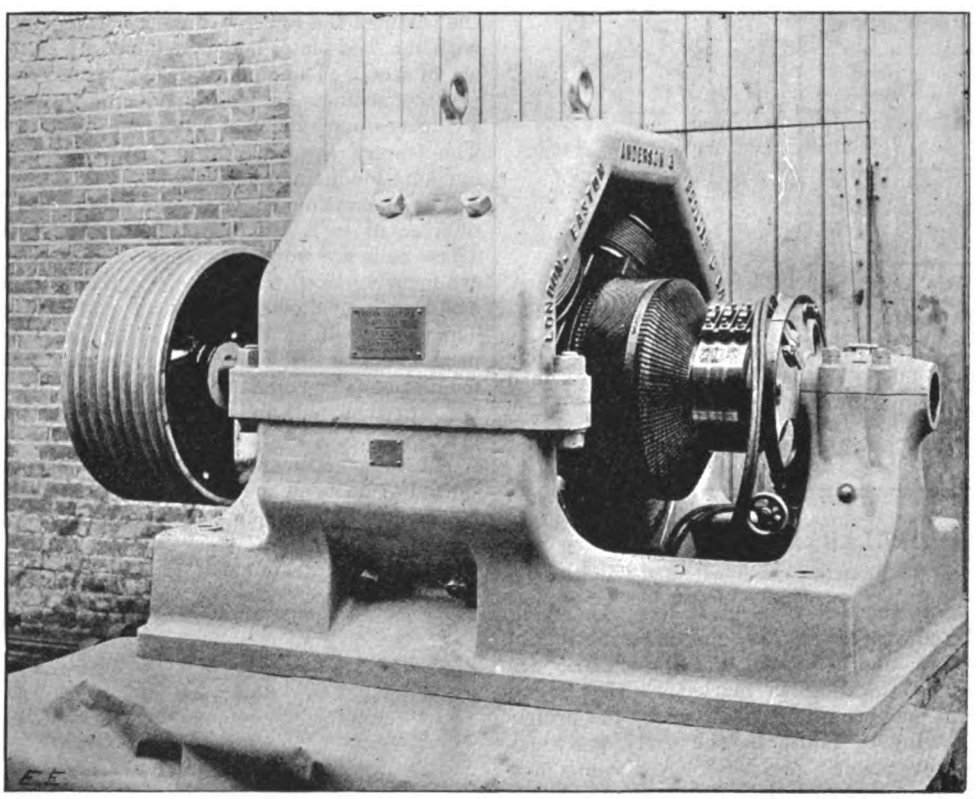

FIG. 5.—Complete Machine for Rope Driving.

The core (Fig. 2) is built up of the best annealed Swedish charcoal iron discs, insulated from each other by paper. These discs are provided with a number of slots stamped out before building, and subsequently annealed, thus avoiding the necessity of tooling these slots after building, a process always dangerous, as entailing a risk of causing subsequent heating and heavy losses. These slots are carefully insulated with the very best materials suited for the particular conditions under which the machine is to work. The conductors being embedded in the iron, they are most positively driven. Special care has been bestowed specially strong pedestals; usually the automatic chain or ring lubrication is provided. The commutators are made of best hard-drawn copper or of special commutator gunmetal, insulated with clear India mica; they are of specially large diameter, and the copper section throughout is on a liberal scale, ensuring perfectly cool running. The sections are so proportioned that after 1in. (radial) has been turned off, they are still able to carry the full current without undue heating. All the brushes are worked at low-current density and have a large margin; self-locking worm gearing is provided on all the larger machines for

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shifting the brush rocker, and each separate brush has a pressure adjustment spring, screw feed, and hold-off catch. Pointers are fixed to the holders to set the brushes by. Carbon brushes of high conductivity held in the specially-designed carbon brush-holders (Fig. 4) are strongly recommended by the makers. These provide ample contact surface between carbon and holder, and prevent any heating. The rocker itself is most carefully designed with a view to obviate all vibrations. Each machine is provided with large gunmetal terminals placed in suitable positions.

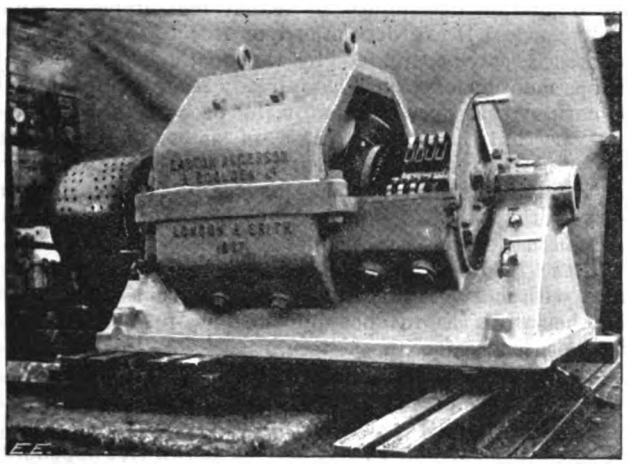

FIG. 6.—Dynamo of Enclosed Type.

Fig. 5 represents a large machine of the multipolar type as completed and ready for work, while Fig. 6 is a view of an enclosed machine for use in a damp place, or in a factory where inflammable dust may be expected. The upper part of the case is removed to show the end of the armature and the brush gear.

The efficiency of these multipolar dynamos is high throughout, ranging from 75 per cent. for the 750-watt size up to 96 per cent. to the largest sizes. The efficiencies for loads below and above the normal are also high. Fig. 7 gives a good idea of the general shape of the efficiency curve of the dynamos. This curve was obtained by Hopkinson's method off a 50-unit compound-wound machine. The

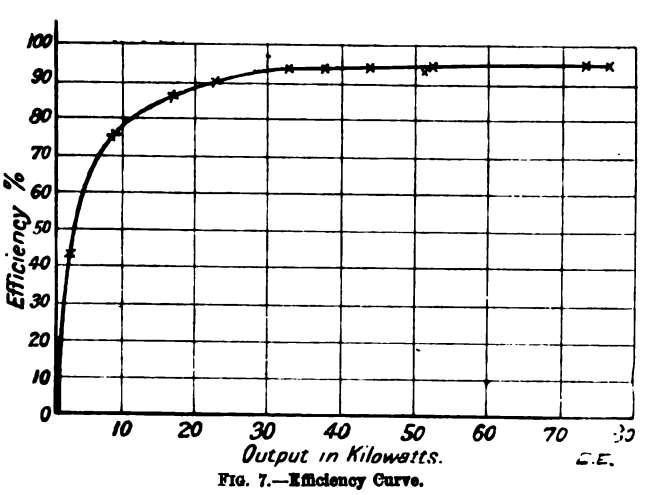

FIG. 7.—Efficiency Curve.

efficiency referred to above are the commercial efficiencies of the machines, all losses due to friction, ventilation, iron and copper losses being included. The dynamos designed for normal outputs at normal speeds all show very slight rises of temperature varying with the size of the machines. The amount varies from about 50deg. to 70deg. F. for the field coils, and 60deg. to 80deg. F. for the armatures. This rise above the temperature of the surrounding atmosphere occurs after six hours' run at full load. For special purposes, or to meet specified requirements, machines are made with still smaller rises, but as a rule this is not required.

We hope to see these machines represented on a large scale in our central stations at an early date.

THE PREDETERMINATION OF THE REGULATION OF A TRANSFORMER WITH NON-INDUCTIVE LOAD.*

BY F. BEDELL, R. E. CHANDLER, AND R. H. SHERWOOD, JUN.

In this paper it is proposed to give a method for determining the exact regulation of a transformer, without the necessity of applying a load. A corresponding method for obtaining the efficiency of a transformer without loading is in common use;† an accurate method for finding the regulation will, it is thought, be of equal service.

An approximate method (which we will call "Method C") for determining the drop in secondary voltage of a loaded transformer without applying a load has already been published‡ and has been employed by one of our largest electrical companies; but the regulation curve determined by this method (see curves C, which follow) are invariably higher than the true curve marked A, obtaining in the usual way by loading the transformer. Curves B are determined by the method to be described in this paper, and are seen to conform much more nearly to the actual regulation curves. The difference is commonly not over one or two tenths of a volt. This requires but two measurements, as will now be described.

For the sake of clearness, a transformer whose ratio is 1 to 1, and whose copper losses in primary and secondary are equal, will first be assumed. To determine the regulation of a transformer by this method, the secondary is short-circuited by means of a stout copper wire, and sufficient voltage applied to the primary to send any particular load current through the coils. A wattmeter, voltmeter, and ammeter are placed in the primary circuit as shown in Fig. 1.§ The reading of the wattmeter divided by the

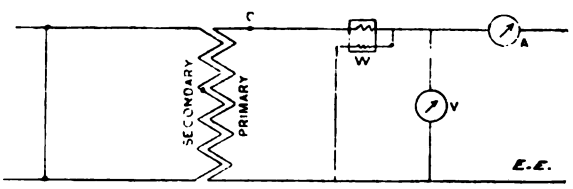

FIG. 1.

product of E.M.F. and current will give the power factor—that is, the cosine of the angle, θ, of lag between the impressed E.M.F. and the current. In Fig. 2 this angle is represented by N Q F. The line Q N is the voltmeter reading, being the voltage necessary to send the current corresponding to the desired load through the coils. The angle θ is then laid off. The line N F is drawn perpen-

* Paper presented at the Detroit meeting of the American Association for the Advancement of Science, August, 1897.

† In this method the transformer is tested by placing a wattmeter in the primary circuit; the secondary (low-potential coil) is short-circuited through an ammeter, and the primary pressure adjusted until the current which flows in the secondary equals the normal full-load current or any desired fraction of it. The wattmeter reading then indicates the copper losses. The secondary is then open-circuited and the normal pressure applied to the primary; the wattmeter reading in this case indicates the core loss. In this way the losses may be obtained and the efficiency calculated. In the open-circuit test, it is often convenient to use the low-potential coil as primary. This method was employed in an extensive series of tests made in 1895 at the University of Wisconsin by Prof. Jackson and Mr. Ford. See "A Complete Test of Modern American Transformers of Moderate Capacities," by A. H. Ford, Engineering Series, *Bulletin* University of Wisconsin, vol. ii., No. 1.

‡ See Kapp, "Transformers," p. 119.

§ After considerable experiment it was found that this manner of connection was most satisfactory. The instruments are all placed in the primary circuit and the secondary short-circuited as directly as possible. Where the voltage is too small to be measured by the ordinary voltmeter, an auxiliary transformer is used to step up the pressure for the voltmeter and voltage coil of the wattmeter. The reading of these instruments must, of course, be divided by the ratio of transformation of the auxiliary transformer. An approximate correction may be made in this case for the current taken by the auxiliary transformer. This is done by opening the circuit at "C" and measuring the current through the ammeter while the voltage is kept constant. This reading should be subtracted from the former reading of the ammeter to obtain a more accurate value for the current flowing in the transformer being tested.

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dicular to Q F and produced to the point M, making N M equal to $\frac{I_0}{I_1} E_1$, where I_1 is the reading of the ammeter, E_1 is the normal primary voltage, and I_0 is the magnetising current obtained by measuring the primary current when the voltage is normal and the secondary is on open circuit. With M as centre, and radius, M O, equal to the normal primary voltage, draw an arc cutting Q F produced at O. Lay off O L equal to half Q F; draw P L perpendicular to O F and equal to N F. Join P and M, and lay off P S equal to O L. Then S M equals the voltage at the secondary terminals. The difference between S M and O M equals the voltage drop. This is, as before stated, for a transformer whose ratio of transformation is unity.

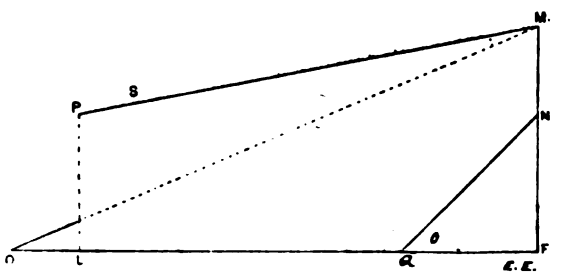

FIG. 2.

For a transformer with a ratio of transformation other than unity the construction is exactly the same, with the exception that the line S M must be divided by the ratio of transformation to obtain the pressure at the secondary terminals.

In this diagram M F is the total reactive drop, and N F that due to magnetic leakage. Q F is the sum of the ohmic drops in the primary and secondary. In transformers of modern design this drop is about evenly distributed between the coils, O L for the primary and P S for the secondary. Q N has been called the impedance drop, being the geometrical sum of the ohmic drop and the reactive drop due to magnetic leakage.

In order to show the facility with which this method may be applied, the following numerical example for the determination of one point on the regulation curve is given. In this instance a commercial transformer was employed, with 2,500 watts capacity, transforming from 1,000 and 100 volts. The primary voltage necessary to send the desired current through the coils with the secondary short-circuited was 54 volts. The reading of the ammeter was 2·42 amperes, while that of the wattmeter was 72 watts. We have then

$$\cos \Theta = \frac{72}{54 \times 2{\cdot}42} = 0{\cdot}554\,; \quad \Theta = 56^\circ\ 22'.$$

The magnetising current measured in the usual manner was found to be 0·058 ampere. The right triangle, Q N F (Fig. 3), is now constructed to convenient scale, the angle,

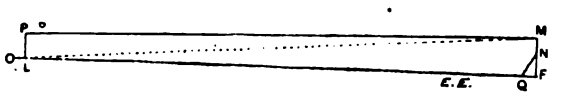

FIG. 3.

N Q F, being made equal to 56° 22′, and the hypothenuse, Q N, equal to 54 volts. We now proceed to calculate the length of the line N M from the formula already given:

$$N\ M = E_1 \times \frac{I_0}{I_1} = 1{,}000 + \frac{0{\cdot}058}{2{\cdot}42} = 24 \text{ volts.}$$

This line is laid off as shown in the diagram, and with point M as a centre and radius equal to 1,000 volts, on the scale selected, an arc is drawn cutting the line Q F produced at O. The length O L is then laid off equal to one-half Q F; and L P drawn equal and parallel to N F. The points P and M are then joined, and a length P S = O L laid off on this line. S M is then the secondary E.M.F. transferred to the primary; this, on being measured, was found to be 968 volts. Dividing 968 by the ratio of transformation, we have the secondary voltage—*i.e.*, 96·8 volts. The actual voltage of the secondary found by measurement was 96·75 volts, showing the great accuracy* of the method.

The curves given herewith show the method applied to seven transformers of various types. Transformers number (6) and (7) are small laboratory apparatus having a large amount of magnetic leakage. They are included here to show the applicability of the method to transformers varying widely in their essential characteristics. The remaining curves are taken from well-known commercial transformers of recent types. Curves marked A show the regulation determined by actual measurement, while those marked B are determined by this method. Curves marked C are computed by the method described by Kapp, mention of which has already been made. It will be noticed that curves taken by the proposed new method (B) vary but little from those of actual measurement. In fact, the regulation can usually be obtained more accurately by this method than by loading the transformer, the results being less influenced by errors of instruments and fluctuations in the source of supply.

If the readings are taken with accuracy, one measurement, with short-circuited secondary, as previously described, together with the magnetising current, furnishes all the data necessary for the determination of the complete regulation of the transformer. Suppose the diagram in Fig. 3 has been drawn for a load corresponding to a particular current, I′; it is required to determine the drop for any other current, I″. It may be shown (see appendix) that N F and Q F vary directly, while M N varies inversely with the current. Therefore, to determine a new point, it is simply necessary to enlarge or diminish the side of the triangle Q N F by multiplying each side by the ratio $\frac{I''}{I'}$. The line M N is to be multiplied by the inverse ratio—*i.e.*, $\frac{I'}{I''}$. The construction then proceeds exactly as before. The angle N Q F remains unaltered.

The principles upon which this method is based are rational rather than empirical. The more complete theory is discussed in an appendix. What has been given above, however, is sufficient for the practical application of the method. It is pleasing to note the verification of the accuracy of the theory in the actual results obtained are shown by the curves given.

If a wattmeter reading is taken when the magnetising current is measured, the iron losses are obtained, and the efficiency as well as the regulation determined. A transformer may thus be given a complete test for regulation and efficiency by making two measurements (without loading it), the source of supply being a lamp socket supplied from the house mains.

The data for tests on the seven transformers are given by the author, of which we reproduce the first only:

LOG OF TEST NO. 1.

Capacity of transformer, 1,500 watts.
Ratio of transformation, 10 to 1.
Primary pressure, 1,000 volts. Frequency, 126 ⌒.
Hysteresis loss = 55 watts.
Magnetising current = ·085 ampere.

Primary pressure.	Amperes in primary.	Watts	Cos θ	Drop method C.	Drop method B.	Actual drop A.	Load in watts.	Efficiency	K.
35	·755	7·2	·268	·7	1	·85	753	92·5	·0568
35	·76	7							
42	·887	10	·269	1·1	1·1	1·2	877	93·2	·0576
42	·885	10							
51	1·095	14·3	·262	1·34	—	—	1,010	93·6	·0567
51	1·08	14·1							
61·5	1·32	21·6	·264	1·84	2·2	2·4	1,268	94·5	·0577
61·6	1·30	21·6							
64	1·36	23·0	·262	1·85	2·4	2·6	1,315	94·5	·0579
64	1·34	23·0							
69·2	1·5	27·5	·265	2·1	2·8	3	1,455	94·9	·0562
69·3	1·5	27·5							
70	1·52	28·25	·265	2·2	3	3·1	1,483	94·8	·0561
70·2	1·53	28·1							

* In a long series of measurements, the difference between the observed secondary voltage and the predetermined voltage was rarely as great as 0·2 volt, and was commonly less than 0·1 volt.

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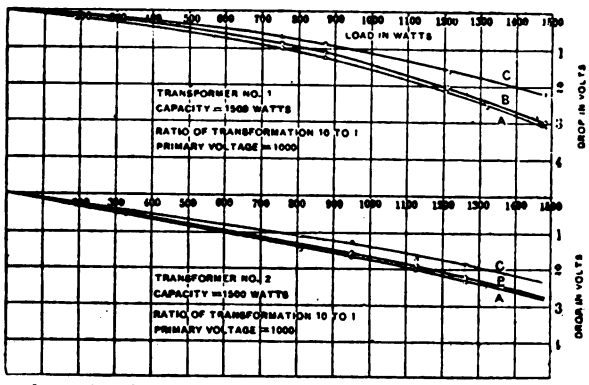
Appendix.

The above method may be rigorously established by employing the transformer diagram, as given in Bedell's "The Principles of the Transformer."



Transformer Regulation Curves: Curve A is Observed; Curve B, Computed.

In Fig. 4 let O F be the direction of the primary current in a transformer, and O M the direction and magnitude of the impressed E.M.F. necessary to send the current, O R, through the primary coils. As the resistance of the secondary is varied, the E.M.F. which would be necessary to maintain this primary current constant would vary along the semicircle, J T L, being O J on open circuit, and approaching the point L, when the secondary is short-circuited. If, however, magnetic leakage be present, the locus of the primary E.M.F. necessary to maintain a certain primary current will be the semicircle, J M P. Let O M represent the normal primary E.M.F. and O R the normal primary current. O P would be the E.M.F. necessary to send the current, O R, through the transformer, assuming that the secondary is short-circuited, and that its resistance is zero. This line will then be the impedance drop caused by magnetic leakage and primary resistance. Then it is evident that P M is the induced secondary E.M.F. transferred to the primary,* since when added in its correct vector position to the drop, P O, it gives the primary E.M.F., O M. In order to obtain the E.M.F. at the terminals of the secondary, it is now only necessary to subtract the drop due to the resistance of the secondary coil. This is to be done algebraically, since the secondary current and E.M.F. are in phase for a non-inductive load. If, therefore, a diagram, as shown in Fig. 4, can be constructed, and the length P M measured, it is only necessary to subtract from this the ohmic drop in the secondary and divide by the ratio of transformation to obtain the E.M.F. at the secondary terminals.

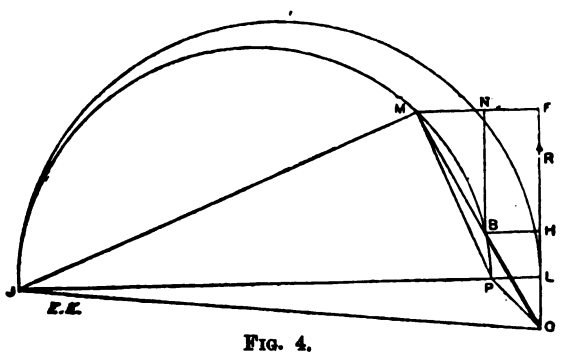


Fig. 4.

In order to construct this diagram proceed as follows: the secondary is short-circuited, and the voltage necessary to drive the current, O R, through the coils, together with the angle of lag, is measured. This data enables the E.M.F. triangle, B O H, to be constructed. In this triangle the line O H is the ohmic drop due to both primary and secondary, and may be represented by R I, where R is the combined resistance of the primary and secondary transferred to the primary; I is the current in the primary coil. B H will be the reactive drop caused by magnetic leakage, and may be represented by $k\ \omega$ I, where $\omega = \pi$ two times the frequency and k equals the self-induction due to leakage. O B is the impedance drop. It will be seen that the sides of the triangle vary directly with the load, and hence the angle θ is constant for any transformer for given frequency. This will be noted in the tabular data.

In most commercial transformers the ohmic drop is equally divided between the primary and secondary coils. Therefore, by bisecting the line O H and making P L = B H, the triangle P O L is obtained. Theoretically, P L is not quite equal to B H, but the semicircle, J M P, is so large that the error is inappreciable. O J would be the E.M.F. necessary to drive the current, O R, through the transformer when the secondary is on open circuit. This line is purely theoretical, and may be obtained from the simple proportion:

$$O J : E_1 :: I_1 : I_0 ;$$

whence

$$O J = \frac{E_1 I_1}{I_0}.$$

Here E_1 is the normal primary voltage, I_1 the normal current, and I_0 the normal magnetising current. In other, words, if a magnetising current I_0 is produced by an E.M.F., E_1, a magnetising current I_1 would be produced by O J. Sufficient data is now available for the construction of the complete diagram. Since the line O J is very large, compared with the other lines of the diagram, a large scale would be necessary for accurate work. The necessity of constructing the large semicircles may be avoided as follows: from the measurements made, B H or N F may be determined, as already explained. If M N can be calculated, the point M becomes fixed, and the essential parts of the diagram may then be constructed.

The triangles, P N M and J M P, are similar; hence we have

$$J P : M P :: M P : M N.$$

Therefore,

$$M N = \frac{M P^2}{J P}.$$

Now, J P may for this purpose be taken equal to J O, since they are both very large as compared with P L or L O, and M P may be assumed equal to the primary voltage. It has been proven by trial that this latter approximation does not affect the result. On substitution of these values the equation becomes

$$M N = \frac{E_1^2}{J O}.$$

Substituting the value previously obtained for J O,

$$M N = \frac{E^2}{\frac{E_1 I_1}{I_0}} = E_1 \frac{I_0}{I_1}.$$

The line M N is the drop due to self and mutual induction. This added to the drop caused by leakage (B H = $k\ \omega$ I) forms the total reactive drop of the transformer, M F.

The point M having been fixed, M O is drawn equal to the primary voltage, and the point O therefore determined. The rest of the diagram is constructed as previously described, and the secondary E M.F. determined.

* That is, the secondary E.M.F. multiplied by the ratio of transformation.

Excessive Mechanical Stoking.—The *Electrical Review* of New York describes a curious case of plenty in time of scarcity which is worthy of a notice. It announces the fact that Paterson, New Jersey, is in darkness, as an indirect result of the coal-miners' strike. Not an electric light is burning in the city. The residents are going about at night armed with revolvers, and are beginning to realise the old axiom that "an arc light is as good as a policeman." The management of the local Edison Company in Paterson feared that there would be a shortage in the coal supply owing to the miners' strike, so the company's coal bunkers were hastily filled to their utmost capacity. The other day the bunkers gave way and let the coal down into the boiler-room, completely burying the boilers. The boilers are now being rescued by gangs of men digging out the coal.

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All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

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OUR STUDENT'S NUMBER.

The letters we publish in this issue will be of great service to parents who wish their sons to become electrical engineers. The perusal of the letters in question, which are nearly all written by men actually engaged in the profession, shows that the writers nearly all prefer a strictly practical course of training. It is also not surprising to us that so few words of commendation of the articled-pupil system are to be found in the letters. This is due to the fact that several small firms in the past have been run wholly as pupil nurseries. That such firms have usually failed is what must be expected, as justice could not possibly be done by them, either to their clients or their pupils. Before leaving this subject, we must record our opinion that some firms do give the articled pupils exceptional advantageous returns for their premiums, and that to be articled to certain prominent consulting men makes an excellent start for a pupil who has had previous workshop experiences. On the other hand, we endorse most emphatically the opinion of the majority of our correspondents that the best possible start for a lad is to put him in the shops as an ordinary apprentice, and so let him there find his own level. The more directly he is under the control of a good foreman, the better, and a diligent lad will find little difficulty in getting moved to new departments if he has proved to his foreman that he means to work his way up. As so many letters recommended the shop course in general engineering, we had to distinguish between them as to the choice of the shop. In this we hold with the writer of the prize letter, that a small shop is much the best. Nearly all the young men we know who are now rising in the manufacturing branch of the profession have started in small shops, where they gained most general experience, and often had to be responsible for work which was quite new to them. Such experience puts the lad on his mettle, and tends to give him much greater resourcefulness in after-life than if he had been in shops where the extreme division of labour so necessary in large firms is in force. Another great point emphasised in the first letter is that of specialisation after a mechanical training has been obtained. Special knowledge only is well paid, except in the case of managers of factories, and of these posts there is not a superabundance. If the lad decides on central-station running as his speciality, he should most certainly follow Mr. Steinitz's advice and obtain experience as a sea-going engineer. This will wean him from the practice of looking always to the manufacturers in case of breakdown, which the telegraphic facilities on shore is apt to lead to. He may also, as suggested, at the same time learn the truth of the fact, that although a man may be very useful, it does not follow that he is necessary. The third letter, to which we award a special prize, certainly states the remuneration a lad may expect as an apprentice at too low a figure. We also think that the writer rather overdoes his pupilage time allowance for the young man leaving college at nineteen. It is difficult for such a one to conform to the

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apprenticeship system, as he will be so much older than the other lads round him. We think, too, that in such a case the foreign travel and experience advice is most useful, and that its effect in broadening the character cannot be overestimated. The summer vacations at the technical colleges usually extend over three months, and should, when financial means allow, be spent abroad. We do not wish to minimise the good done by the technical colleges now established and being established in England, but the student is more capable of taking the fullest advantage of them after workshop training than before. On the other hand, as mentioned above, the student leaving such a college after a three years' course is, as a rule, too old to derive the full benefit from apprenticeship in a workshop. To such a one the workshop drudgery of doing well a certain amount of work which requires no great mental exertion is wearying, and he is apt to forget that such drudgery is the only way to success. Finally, the value of the training must not be judged by the maximum salary obtainable in a minimum time. The thorough knowledge derived from varied experience in a given branch will, in the long run, command the best salary.

CRICKET—A LEAGUE OF CENTRAL STATIONS AND FACTORY CLUBS.

We have been asked to help on a good work, which at first sight may seem a little outside our programme, but it is one we gladly place within the borders of that programme. It is proposed to inaugurate a cricket league next season and to have inter-club matches—the league to consist of clubs belonging to central stations and electrical factories. A few such clubs have already been formed and matches have taken place this year. As a commencement, we may state that Mr. Minchin (St. Pancras), Mr. Goslin (Wandsworth), Mr. Gibbs (Chelsea), Mr. Brooking (Shoreditch), among others, are willing to do what they can to make this league a success. We should be glad if our readers would consider the matter during the next week or two, and if those willing to assist would send in their names, either to us or to any of the above-named gentlemen, a meeting could be arranged to formulate plans and arrange matters by the end of September. It is necessary to be thus early, as most of next year's matches are arranged in October or November, and the inter-league matches would be arranged so as not to clash with the ordinary matches.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

QUESTIONABLE ELECTRIC LIGHTING IN EDINBURGH.

SIR,—There is a tendency here at present among the cheaper class of contractors to the use of lead-covered wires for indoor purposes. These wires are used without any attempt to protect them from mechanical injury, and are simply laid in bunches throughout a building, conveying the idea that they are so many pneumatic bell tubes. Between joists they of their own weight sag down, and present a spectacle of a system of electric wiring which, however easily and cheaply installed, can hardly be said to be substantial or safe. It would be interesting to know, in view of the fact that this system of wiring has no special mention made of it in the latest wiring regulations, whether such a method of wiring is legitimate and admissible, and that at a voltage of 230, which is the case here.—Yours, etc., FINEM RESPICE.

[We cannot tell quite what system our correspondent refers to, but perhaps the Free Wiring Syndicate, who use a lead-covered concentric system, could enlighten him as to its legitimacy.—ED. *E. E.*]

THE GENERATION OF STEAM.

SIR,—My attention has been drawn to the rate of evaporation given for the "Economic" boiler in the recent paper read before the Municipal Electrical Association. I shall be glad to point out that the figure given was taken from the week in-and-out evaporation of those boilers at a large London station, and therefore included the banking losses, etc., and is obviously an unfair figure to place beside the test figures and other boilers; an evaporation of over 12lb. per 1lb. of coal from and at has been obtained on tests taken by a most reliable authority. I shall be much indebted to you for inserting this in your paper, and beg to remain, yours, etc., JOHN F. C. SNELL.

Sunderland, September 1, 1897.

SHOREDITCH DESTRUCTOR.

SIR,—Perhaps Messrs. Manlove, Alliott, and Co., Limited, would not mind answering the following queries: (1) If there is any gain at all by using the very inferior town's rubbish, as stated, why use coal at all? Surely a yard could be obtained in which sufficient rubbish could be stored for Sunday's use, either at the depôt or within a cartable distance? During the daytime the temperature of the gases, judging from the appearance of the refuse on the grate, does not look capable of generating much steam.

Perhaps Messrs. Manlove will give, and from an absolutely unprejudiced, independent, and competent source, the following information: (2) What is the weight of steam generated, from and at 212deg. F., from 1lb. of refuse burnt in the daytime? (3) What is the cost of steam generation and hot-water storage apparatus per horse-power actually developed per hour? (4) Is the same quantity of refuse used throughout the day, or is it a fact that a kind of refuse is employed at night of so special a character that its like could not be easily procurable elsewhere? Steam has been generated by the burning of selected town's refuse for nearly 20 years, but it is pretty well agreed that the calorific poverty of the rubbish, in addition to the very great extra cost of plant for a given power output, is such as to make its rival coal by far the most economic fuel, except in places where the road and rail cost of bringing the coal is excessive.—Yours, etc., ENQUIRER.

[We insert the above letter as requested by the correspondent, but do not like the tone of the same over a *nom de plume*, although we have his name by us. Many of the questions are absurd, and the writer could not but admit it if he will reason them out. He looks at the matter as a question of fuel only, but must remember that there is also the sanitary and cheap destruction of refuse to be considered.—ED. *E. E.*]

VOLUNTEERS.

SIR,—Would you kindly tell me through the next issue of the *Electrical Engineer* what are the qualifications required to join the new corps of Electrical Engineers, where are its headquarters, and who have you to apply to for enrolment, and is it restricted to London only, or throughout the country? I know by the back numbers of the *Electrical Engineer* its requirements as regards duty.—Yours, etc.,

H. G. ANDREWS.

[The full details required by our correspondent will be found in one of our notes this week.—ED. *E. E.*]

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ALTERNATING-CURRENT MOTORS TO START UNDER HEAVY LOADS.

The following is a translation of the paper read by Mr. A. Heyland at the fifth annual meeting of the Verband Deutscher Elektrotechniker at Eisenach:

Everyone knows that the alternating-current motor does not start from the position of rest when used in its simplest form as a single-phase motor. The multiphase or revolving field motor does so with great power, but necessitates the generation of three currents, and, therefore, its use is precluded in many cases in consequence of the somewhat complicated arrangement of the conductors required. Soon after the successes obtained with the multiphase system, endeavours were made to build an alternating-current motor for the ordinary alternating-current system which would be the equal of the multiphase motor. Following closely upon the theory of the multiphase motor, various means were employed to artificially create a revolving field in the motor. But the results were not favourable. As a rule the motors can only start either without or against a very moderate load.

Starting from the question how a turning moment is created in the single-phase motor when work is being produced, I will demonstrate that the turning field in this case is only of secondary importance, since the proper turning moment of the motor is only caused through a component of the turning field—*i.e.*, an alternating field vertically to the axis of the coil.

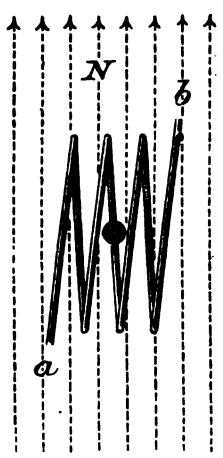

FIG. 1.

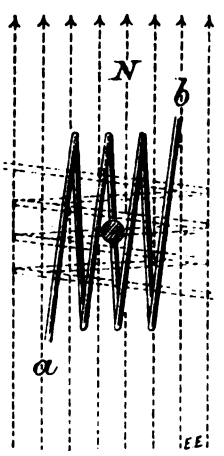

FIG. 2.

If coil *a-b* in Fig. 1 represents the winding of a single-phase alternating-current motor, then there is required to cause a turning moment a magnetic field, N, the direction of which lays vertically to the axis of the coil. Also, in order to cause a constant turning moment, this field must reverse its direction simultaneously with the induced alternating current of the coil—that is to say, it must be an alternating field in phase with the alternating current of the coil.

In the single-phase motor the impressed exciting power gives only one field in the direction of the axis of the winding (in Fig. 1 horizontally), and the motor cannot start because it has not got a field vertical to the coil The impressed exciting power, only when the motor is in motion, induces currents in the winding of the short-circuited armature, which causes a field vertical to the coil—*i.e.*, the field shown in Fig. 1. The short-circuited armature is in this case to be considered as the field magnet of the motor. The excited core and armature field then produce the revolving field. Only the field created in the short-circuited armature vertical to the coil of the exciting core is the proper working field of the motor, and only when this field is created (that is, only when the motor is in rotation) can it develop torque. This power developed depends upon the strength of that field.

The conclusion to be drawn from the above is that it is possible to provide an almost unlimited starting power in the motor, if in some way a field of corresponding power is created in the short-circuited armature vertical to the exciting coil.

In the single-phase motors with artificially-created turning field, this starting field is produced by changing the phase of a part of the current. This phase shifting of the current is shown in Fig. 2 by the coil indicated by the dotted line. The reason that this method does not produce great starting power in this instance is that the field produced does not reach a large value in these motors. Now, it is known that the passage of an alternating current through the windings produces a field which induces an E.M.F. in the winding approximately equal to the pressure at the terminals—that is to say, the field is proportional to the quotient $\frac{\text{pressure}}{\text{number of turns}}$.

If a strong field is required from this auxiliary or field winding, then the voltage of the same has to be great, and the number of windings small. It is of interest to note that this leads to the creation of an artificial revolving field on a principle directly opposite to the usual practice. The winding for a small difference of phase of the current consists of many turns, while the winding for a current with greater displacement of the phase, which in the usual arrangement contains as many turns as possible, in the case treated only contains a few turns.

Fig. 3 shows an arrangement chosen by me as one serving the purpose well, and which I have selected after many trials made in the workshops of the Elektricitäts Actien-

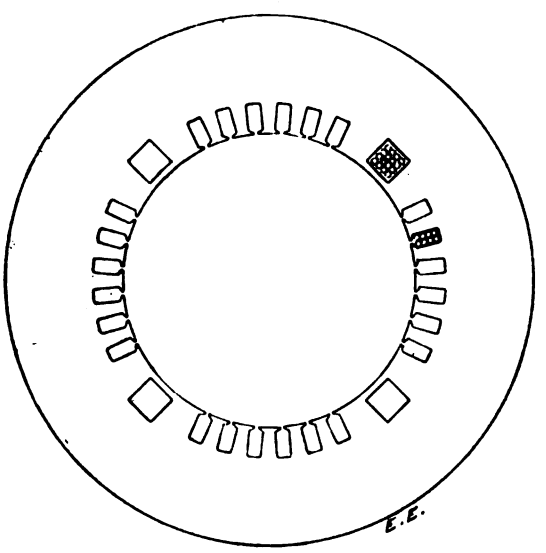

FIG. 3.

Gesellschaft vormals W. Lahmeyer und Co., to whom I am indebted for the use of the same. The ordinary winding of the motor is carried out in the way usually applied in single-phase windings, and is distributed in the small notches at the circumference. The field winding which cases the starting field is located in the remaining intervals in each of the big notches. The latter contains but few turns. Nevertheless, a larger displacement of phases does occur here, because the magnetic relation of this winding in only one notch with that of the short-circuited armature is unsymmetrical, and therefore causes great magnetic displacement.

This field winding causes in the short-circuited armature a powerful starting field at right angles to the exciting coil. The starting field and starting force are increased, and are inversely proportional to the number of the turns in the field winding. Therefore one may adjust the motor to any starting power required. A special advantage of this construction is that the arrangement of the single-phase motor is entirely retained, and that the mode of winding does not change the dimensions in any way. The motor does not require any resistance in the circle of the principal current, or a choking coil, or a condenser, etc. It is started by a resistance in the short-circuited armature, which latter is furnished with three contact rings for that purpose. If the motor is meant to start without these connections, a starting resistance is placed in principal coil in order to avoid too large a current when starting. This weakens the field of this winding, but as the turning moment is caused by the field of the other coil, this fact is of sub

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ordinate importance. The curves in Figs. 5, 6, and 7 describe the action of a motor built upon the principles just described.

I am indebted to Prof. Kittler for these exact tests, as the motor has undergone searching trials by him at the institute in Darmstadt. The motor shown in Fig. 4 has a core diameter of 9¼in. and a length of 4½in.

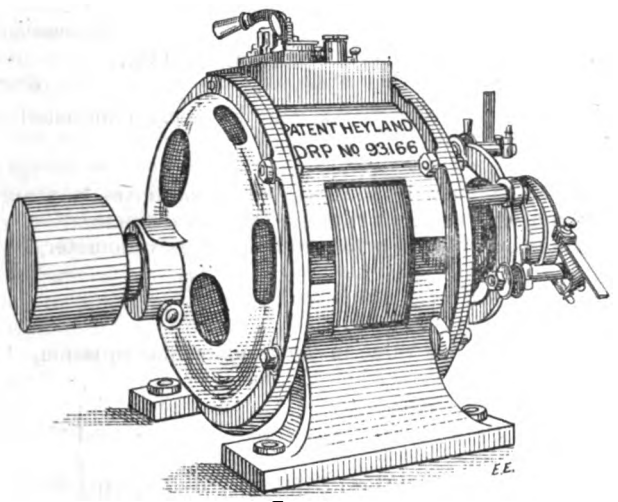

FIG. 4.

As seen by the curves in Fig. 5, it has a normal output of 4 h.p. at 1,500 revolutions per minute and 50 frequency. It then takes at 120 volts some 43 amperes. Its efficiency is 74 per cent., and the cosine of the angle of lag is ·77. The motor has at full load 6 per cent. slip. It may be overloaded by about 60 per cent. before falling out. The normal output of 4 h.p. with 6 per cent. slip—that is, at 1,410 revolutions per minute—corresponds to a turning moment of about 14·6lb. at a radius of 1ft.

Figs. 6 and 7 show that a motor starts against a force corresponding to 10 h.p., therefore, with 2½ times the overload, while a motor of the normal type built for moderate overload stops with an overload of 1·6.

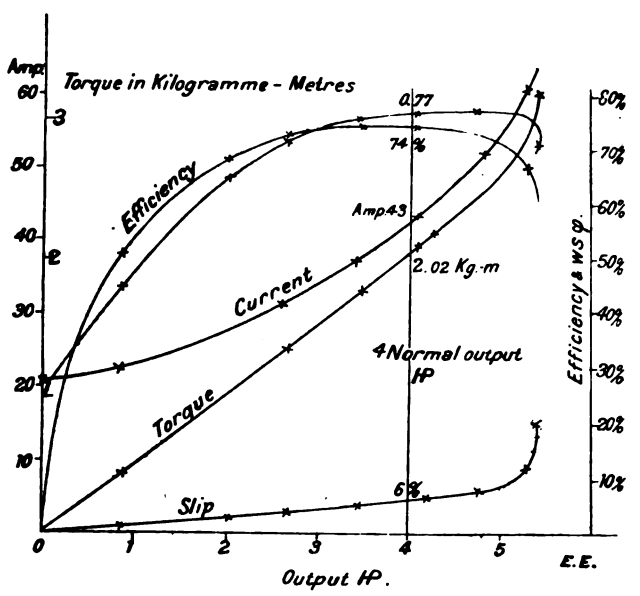

FIG. 5.

The interesting part of this result is that, by the employment of the arrangement just described, it is possible to obtain a higher starting torque than that which corresponds to the maximum capacity of the motor while running. This is an important point when we consider that, without complicated switch-gear, even a multiphase motor can never reach a larger starting torque than that of its maximum power when running. The amount of current used to start against a load equal to 1·5 of the full load torque is only about 1·7 times that of the current used at full speed under equal load. The fact that the motor can start against a torque greater than that at full load, may be explained by the fact that the starting current has the high power factor of ·61.

Naturally all these figures are considerably reduced when the proportion of the maximum starting power to the working output of the motor is not driven to excess. If the starting force is increased too much, a point is arrived at where it appears not feasible to increase the

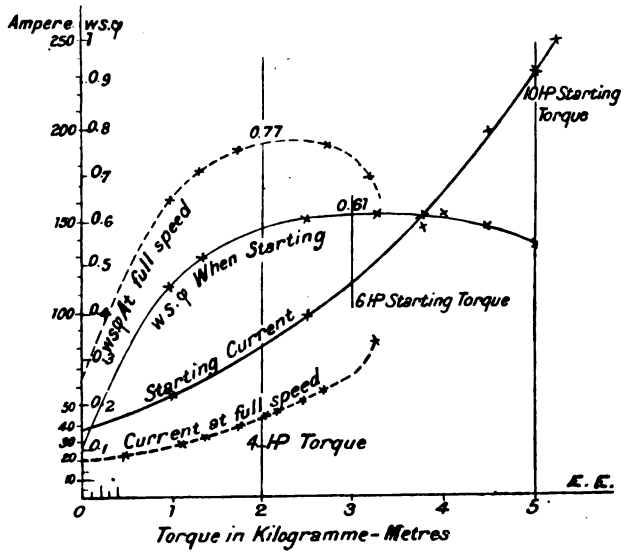

FIG. 6.

starting field on account of the over-saturation of the iron. Nevertheless, even with a high starting force, the percentage of current and energy used per unit of torque is still considerably more favourable in this motor than in any motor with a revolving field artificially produced. The motor shown in Fig. 4 is a trial motor, and must not be considered as the best producible. It was built for me by the firm mentioned, and we may expect many improvements through further trials.

In conclusion, to sum up the advantages of the alternating-current motor. There is the applicability of high pressures, and in consequence the transmission of electric energy, to any distance, however great, and also a large starting torque. These advantages are now shown to belong to both the single- and the multi-phase motor. To sum up, we may count as a gain the fact that the motor requires only the ordinary alternating current.

The alternating-current motor may be used in connection

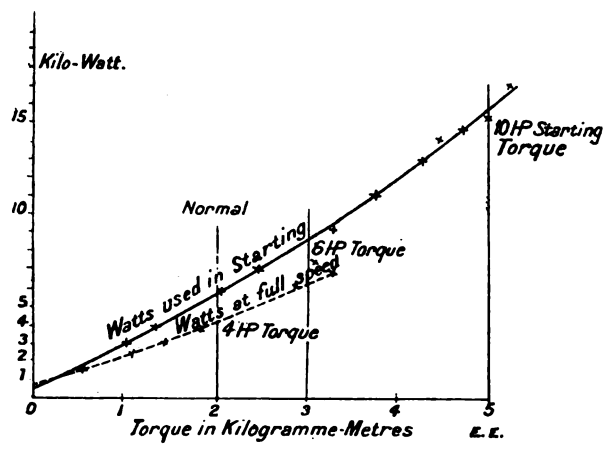

FIG. 7.

with any alternating-current installation, in installations where both light and power is distributed at the same time, in municipal central stations, where for rational reasons the multiphase system could not be applied previously.

A large field is open for the employment of this motor in the construction of electric railways, where the multiphase motor cannot be used on account of the impracticability of three contact conductors, while the alternating motor had not the necessary starting force, so that continuous current only could be used. The alternating-current motor would have many advantages there, such as permitting unlimited extension of the railway system, a simpler construction of motor, as no collector is necessary, etc. A very important feature is that

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a normally-built motor—that is to say, one of ordinary size—can give a very great starting torque without complicated switching arrangements. Although in consequence of the simple arrangements of the coils, regulations are easily made, as, for instance, the alteration of the number of poles to change the speed of the motor.

Speaking of a variable speed, the author observed a curious phenomenon lately. He found that an alternating-current motor built in a certain way is able to start at once, without any starting switch-gears, at one-third of its full speed. He had in time to go deeper into the matter, but states that it may be considered as a secondary synchronism, coming to the conclusion that there must be several of these speeds which would be theoretically one-third, one-fifth, or one-seventh, etc., of the full speed.

This reminds us of the phenomenon of Görges, according to which a revolving-current motor with only two brushes on the short-circuit armature starts at half speed. If this can be applied to the alternating-current motor, then it would be able without switching-gear to run with 50 per cent., 33 per cent., and 20 per cent. of its full speed; at any rate, it is not improbable that we may hear very shortly some interesting news about this subject.

[NOTE.—We reproduce this article as an interesting one, but our readers must not take the statements as to the multiphase motor as quite correct. Our special correspondent at Eisenach informs us that in the discussion several makers of these multiphase types proved that they obtained much better starting torques than those mentioned by Mr. Heyland. Also it seems that Prof. E. Arnold stated that he had designed a single-phase motor with much better results, but in this case a commutator was used when starting.—ED. *E. E.*]

THE BALLISTIC GALVANOMETER IN THEORY AND PRACTICE.

BY ELLIS H. CRAPPER, A.I.E.E.

(Continued from page 266.)

§ 6. *Calibration of a Ballistic Galvanometer.*—Since the accuracy of the results obtained in experimental work depends so largely upon the exact calibration of the instruments used, it is obvious that the determination of the working constant of a ballistic galvanometer is an essential and important prelude to the actual practical work with that instrument. Now, from previous considerations it is evident that of the factors which enter into our calculations (see formula 5), H, G, and T are independent of the quantity of electricity passing through the coils of a ballistic galvanometer. A moment's consideration will show that they depend upon the construction of the instrument, and also upon the magnetic field in which the needle is placed. Of these, only G is a constant quantity, and its value depends upon the size, disposition, and winding of the coils of the galvanometer, whilst H and T are variable quantities depending upon the earth's magnetic field and the field due to the controlling magnets. It is therefore clear that the working constant of a particular ballistic galvanometer is not an absolute constant for that instrument, but is a quantity, sometimes called the *ballistic value of the galvanometer*, varying with the conditions under which it is used, and is a constant for that time only. Consequently the working constant may have to be determined for each experiment, and for this reason special attention is called to the methods of calibrating a ballistic galvanometer.

The following methods of measuring the constant of a ballistic galvanometer will be considered in the order given here:

1. By determining (*a*) the working constant when used as a tangent galvanometer, and (*b*) the periodic time of the galvanometer needle.

2. By measuring the throw of the galvanometer needle when a condenser of a known capacity and charged to a known difference of potential is discharged through the galvanometer.

3. By measuring the throw of the galvanometer needle when an induced current is sent through the instrument.

§ 7. *Working Constant when used as a Tangent Galvanometer.* Our fundamental equation (equation 5),

$$Q = \frac{H}{G} \times \frac{T}{\pi} \times \sin \frac{\alpha}{2}, \text{ or } \frac{H}{G} \times \frac{T}{\pi} \times \frac{\alpha}{2},$$

may be written

$$Q = K \sin \frac{\alpha}{2}, \text{ or } K \times \frac{\alpha}{2} \quad . \quad . \quad . \quad (12)$$

in which form, $K = \frac{H}{G} \times \frac{T}{\pi}$ = working constant.

Now $\frac{H}{G}$ is a factor which may be easily eliminated as follows:

Let C = the steady current which produces a steady deflection, β, when sent through the galvanometer.

Then, from the theory of the tangent galvanometer,

$$C = \frac{H}{G} \tan \beta \text{ and } \frac{H}{G} = \frac{C}{\tan \beta}.$$

Substituting this value in our fundamental equation,

$$\left.\begin{aligned} Q &= \frac{T}{\pi} \times C \times \frac{\sin \frac{\alpha}{2}}{\tan \beta} \\ &= \frac{T}{\pi} \times \frac{C}{2} \times \frac{\alpha}{\beta} \text{ (approx.) if } \alpha \text{ and } \beta \text{ be small,} \end{aligned}\right\}$$

so that $$K = \frac{T}{\pi} \times \frac{C}{\tan \beta}, \text{ or } \frac{T}{\pi} \times \frac{C}{\beta} \quad . \quad . \quad . \quad (13)$$

In this form K is expressed in terms of T, C, and β, which may be determined experimentally. The method of obtaining K is obvious, and is as follows:

A constant cell, whose E.M.F. is known—an ordinary Daniell cell, E.M.F. one volt will do nicely—is connected in series with the galvanometer and a large resistance, to reduce the deflection to a convenient amount, and the resulting steady deflection is observed. Then, by Ohm's law,

$$C = \frac{E}{G + R + B},$$

in which G is the galvanometer resistance which is known, R the resistance inserted, and B is the battery resistance. This latter quantity, if very small compared with G + R, may be neglected, or if once obtained may be used in future tests. If the mirror of the galvanometer be concave the scale will, of course, always be set up at a fixed distance from the mirror, and observing *d*, the deflection, and knowing L, the distance of the mirror from the scale, the angle, β, may be calculated. T, the periodic time, is easily found by taking the time required for the needle to make a certain number of swings of small amplitude and dividing the time observed by the number of swings. The constant, K, thus becomes:

$$K = \frac{T}{\pi} \times \frac{E}{(R+G+B)} \times \frac{1}{\beta}.$$

Should a shunt of resistance S be used with the galvanometer as is the case when the amplitude is too large to read easily, the current through the galvanometer is

$$C_g = \frac{S}{G+S} \left(\frac{E}{R + \frac{GS}{G+S} + B} \right)$$

and our constant becomes

$$K = \frac{T}{\pi} \times \frac{S}{G+S} \left(\frac{E}{R + \frac{G.S}{G+S} + B} \right) \times \frac{1}{\beta}. \quad (14)$$

Example (III.).—A ballistic galvanometer of resistance 9,313 ohms gave a steady deflection of 92 divisions to the right and 87·5 to the left when the current was reversed. The galvanometer was shunted with a wire of 25 ohms resistance, and the current was supplied by one Daniell cell, E.M.F. one volt, and a resistance of 2,000 ohms was connected in series with the cell and the shunted galvanometer. The resistance of the cell and connecting wires was 2·4 ohms. When the needle was made to vibrate,

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18·5 complete oscillations were made in one minute. The scale divisions are given in millimetres, and the mirror was 914·4mm. from the scale. Determine the working constant of the galvanometer.

Solution.—The periodic time $= T = \frac{60}{18·5} = \frac{120}{37}$.

The mean deflection $= \frac{1}{2}(92 + 87·5) = 89·75 = d$, and distance of mirror from scale $= 914·4\text{mm.} = L$,

then $$\frac{d}{L} = \tan 2\beta,$$

since, as in all cases with mirror galvanometers, the angular velocity of the reflected spot of light is, by the laws of reflection, twice that of the mirror, when the mirror is deflected. That is, the position of the spot of light on the scale gives 2β when the mirror is deflected through an angle β.

$$\therefore \tan 2\beta = \frac{89·75}{914·4} = 0·0981$$

$$\therefore 2\beta = 5° 36' \text{ (from table of tangents)}$$

$$\therefore \beta = 2° 48'$$

and $\tan \beta = 0·049$ (from table of tangents).

It may be pointed out here that the circular measure of 2° 48′ is 0·0488692, from which it is obvious that the circular measure of a very small angle may be substituted for the tangent of that angle without introducing any serious error. This also applies to the sines of very small angles.

Substituting the known quantities in equation (14)

$$K = \frac{120}{37 \times 3·1416} \times \frac{25}{9,338}\left(\frac{1}{2,000 + 24·9 + 2·4}\right) \times \frac{1}{·049}$$

$$= \frac{120 \times 25}{37 \times 3·1416 \times 9,338 \times 2,027·3 \times ·049}$$

$$= 0·0000278.$$

A very useful modification of this method is to find the steady current which produces unit deflection, on the scale, in terms of which the quantity of electricity passing through the coils of the galvanometer and producing a deflection, d, may be readily expressed.

Let C_1 = steady current producing unit deflection on the scale;

d = throw of galvanometer when Q units of electricity are discharged through the galvanometer;

then, from the theory of the tangent galvanometer,

$$C_1 = \frac{H}{G}\tan\beta;$$

but $$\frac{1}{L} = \tan 2\beta \quad \therefore \frac{1}{2L} = \tan\beta \text{ (approx.)}$$

$$\therefore 2L \times C_1 = \frac{H}{G}.$$

Again, since the angular displacement of the needle of a mirror galvanometer used ballistically is usually *very small*, we may express $\sin\frac{\alpha}{2}$ in terms of the scale divisions and the distance of the mirror from the scale as follows:

$$\tfrac{1}{2}\tan 2\alpha = \tan\alpha = \sin\alpha = \frac{d}{2L};$$

also $$\tfrac{1}{2}\tan\alpha = \tan\frac{\alpha}{2} = \sin\frac{\alpha}{2} = \frac{d}{4L};$$

And by substituting these values in

$$Q = \frac{H}{G} \times \frac{T}{\pi} \times \sin\frac{\alpha}{2}$$

we get $$Q = 2L\,C_1 \times \frac{T}{\pi} \times \frac{d}{4L} = \frac{T}{\pi} \times \frac{d}{2} \times C_1.$$

In this equation, C_1 is of the nature of a constant which may be found in the same way that C_g was determined in the method explained above. Thus, in the example given, 89·75 scale divisions were obtained, when the current passing through the galvanometer was

$$\frac{S}{G+S}\left(\frac{E}{R + \frac{GS}{G \times S} + B}\right)$$

$\therefore$ current per scale division $=$

$$C_1 = \frac{1}{89·75} \times \frac{S}{G+S}\left(\frac{E}{R + \frac{GS}{G+S} + B}\right)$$

(To be continued.)

ON THE MANAGEMENT OF ELECTRIC ACCUMULATORS.

BY F. G. ANSELL, F.C.S.

The proper management of the ordinary lead accumulator is a matter of considerable importance, because upon its treatment depends its efficiency and also its length of service; and, as most of us know, a battery of these accumulators is a very costly item in an electric installation. Its study is now an important branch of electro-chemistry, a subject claiming comparatively few devotees—in fact, so few that I have often found men in charge of accumulators without the least notion of the chemical changes going on in the cell during charge and discharge. For my present purpose I do not intend to enter into these changes at all deeply, and will therefore content myself by stating for the benefit of the younger members of our profession, that the cell consists of two sheets of lead immersed in a solution of sulphuric acid of about 27 per cent. strength. When the electric current is passed, the hydrogen and oxygen of the water are separated by the chemical power of the electricity, the hydrogen going in the direction of the current through the liquid or electrolyte, and the oxygen going in the opposite direction. Oxygen converts the surface of one plate into oxide of lead, and hydrogen seems to have the power of thoroughly cleansing the other plate. This action goes on until the one plate is oxidised as far as possible, when it is said to be peroxidised or coated with peroxide of lead, and the other plate is said to be thoroughly reduced—*i.e.*, to the metallic state. This simple cell is typical of the well-known lead accumulator invented by Planté about 1859. Anybody not well acquainted with electricity would not consider this a battery until it was charged and capable of giving out electricity, and I am much disposed to agree with this view of the matter, but unfortunately all people do not seem to have regarded it thus simply. Hence we find some confusion as to what is meant by the positive and negative plate. If the above simple proviso is accepted—viz., that the accumulator is not a battery until it is ready to discharge—then all difficulty vanishes, and the cell at once bears comparison with a primary battery, and nobody would hesitate to say that the zinc is the positive plate. Everybody who has had much to do with primary batteries knows that the zinc is always the plate to be eaten away by the acid. Just so with our example of Planté's cell, when discharging the sulphuric acid of the electrolyte attacks the reduced lead, converting it into a sulphate of lead, and the hydrogen set free by this chemical decomposition goes to the peroxide of lead, which being able to part with some of its oxygen receives the hydrogen, and immediately water forms by the union of these two gases, and so the electrolyte is weakened by these two causes—viz., the addition of water and the loss of sulphuric acid by union with the reduced lead, as stated above. We now see that the chemical action starts at the surface of the reduced lead plate, which is attacked by the sulphuric acid just as the zinc would be, except that it is not dissolved into the electrolyte as sulphate of zinc is. This, then, makes it clear that the reduced or grey plate is the positive plate, and hence the brown or peroxide plate must be the negative plate, the electrolyte being a conductor of electricity. The positive pole is, of course, attached to the negative plate, as in any primary battery. Having dipped so far into the chemical

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actions of the cell, I will not go into the further consideration of the various sulphates which have been supposed to form under different circumstances, as I have already said enough to show that the density of the electrolyte varies during charging and discharging, because the sulphuric acid which it contains is alternately set free and combined with the positive or grey plate. It is found by experience that the best density to use is 1,190deg. specific gravity at starting, and not to allow it to rise above 1,210deg. or to fall below 1,180deg. A good hydrometer should be supplied with every battery, and every cell should be frequently tested. If the density suddenly falls off, a short-circuit must be looked for and immediately removed, or, at all events, before recharging, and in the course of a day or two the density of the electrolyte will generally regain its old and proper value. In my own experience, which extends over a good many years and a good few batteries, I have found it a good plan to keep a thin small lath of deal handy, and to put it occasionally down between the plates. This will often remove little obstructions which escape being seen, and will often restore a cell to first-class working order. I also make it a rule to keep a portable electric lamp in each battery-room, and to move this lamp about each cell so as to allow a thorough inspection to be made. This I generally do as soon as I begin to charge, and whenever I find a thick deposit of droppings from the plates I invariably remove it, because in time it is sure to give trouble by rising up to the plates, and so causing a short-circuit. This deposit has a great capacity for holding the gases given off by the plates, and often calls attention to its existence by sending to the surface large bubbles, so these large bubbles must be regarded as a danger signal by all who wish to show an exemplary efficiency at the end of the year. It must not be forgotten that often some sulphate of lead is found in this deposit, and so the electrolyte is robbed of some of its sulphuric acid. Therefore, after cleaning out a cell, I always keep a sharp eye on the density of the electrolyte for a few days, and if it does not rise to its proper figure after two or three good charges, then I add a sufficient quantity of fresh acid to restore it. I generally find about once in two years enough for this, or if working under adverse circumstances, once a year. I have also tested the atmosphere of the battery-room on several occasions, and found it to contain sulphuric acid, so that with these two sources of loss a little fresh acid may reasonably be added once a year. It is important to use pure acid, because impurities in the acid such as hydrochloric acid or nitric acid tend to dissolve the lead plates, and one common result of this is the formation of "lead trees," which form across the liquid from one plate to the other, and so short-circuit the battery.

The battery should always be carefully and fully charged before attempting to discharge, and 50 cells should give at least 110 volts when disconnected from the dynamo. I have also found it advisable to charge with as low a current as time will permit in the winter, and to keep a low current on for a good long time during the summer days. In fact, I have obtained a good result with a charging current of one ampere to each 100 square inches of lead plate, counting every inch submerged, whether grey or brown plates, and both sides of each plate. And generally speaking, I have found it easier to get satisfaction from a battery during the winter, when at full work, than during the summer, when the work falls lightly on the battery. I have often observed that the good, steady discharge of the autumn evenings does the battery a lot of good, but the very heavy discharge of a long winter night I do not admire. I am disposed to think that the discharge current is best limited to the same amount as the charging current, or, say, about one ampere from each 100 square inches of plate, although this is often exceeded, and some of my experienced friends allow a maximum discharge of one ampere from 80 square inches. If I see a plate bending at all close to its next neighbour, I invariably have it bent straight, or put a strip of glass down to prevent contact; and I always advise mixing the acid with distilled or soft water, because hard water always contains lime, etc., which combines with the sulphuric acid and makes part of it useless for the battery purposes. The whole of the plates must be kept well covered by the liquid—in fact, at least ½in. below the surface, because if this is neglected, obviously part of the plate by being out of the electrolyte escapes the chemical action of the charging current, and consequently is in a different state, and the result of this would be local action on the plate itself, which would waste the charge and in time destroy the plate. A slight inspection of a plate sticking up, say, ½in. above the electrolyte, will show that it is never dry, and so it is not beyond the reach of the electricity. Again, if the plates are just touching the surface of the electrolyte, then any dust or insects settling on the top may form a short-circuit, and the short-circuit is one of the worst things to happen to a secondary battery. Many years ago it used to be the practice to take a short length of thick copper wire and apply the two ends of it to the two poles of the battery in order to ascertain whether it was fully charged, the rule being that if this process gave a sharp crack and a tremendous spark the battery might be considered fit for work, but electricians soon discovered that this shattered the plates, and very soon rendered the best battery useless; so now, and, in fact, for a good many years past, nobody would dream of using this barbarous method, because we can tell far better by a voltmeter the exact state of the cell at any time without doing any damage, and without interrupting the circuit. This little voltmeter should read from 0 to 2½ volts by a good open scale divided into tenths, and no cell should ever be allowed to discharge after its E.M.F. falls to 1·8 volts. When the discharge is first started, and a good current is passing, each cell should show a good two volts, and should maintain it for the greater part of the time of discharging. When nearly fully charged, and while still connected to the charging circuit, each cell should show 2·5 volts, or even a shade more, say up to 2·6 volts, under the most favourable conditions, but this is a top figure. If the cell fails to give these E.M.F. readings (except the 2·6) it is a sign that the cell is not in proper order, and the defect should be sought out and cured immediately. This involves a little work I know, but it is well worth doing because it makes the lights give satisfaction to those who depend upon them, and it keeps the maintenance charge low. In fact, by paying strict attention to this line of conduct, I have found no difficulty in keeping the maintenance charge for new plates down to 5 per cent. per annum on the original cost of the battery, which is as good as can be expected, and is not to be easily beaten. I have obtained this result although the battery has not been working under ideal conditions, owing to the discharge being occasionally excessive. A daily charge and discharge keeps the cells in good order, but undoubtedly standing idle soon deteriorates them, and also an excessive charging current is not advisable. It seems that more than a given quantity of electricity cannot act upon the plates properly, and so is wasteful, and, further, I am disposed to think that it also does harm by generating heat and so disintegrating the plates. I have observed that a slight rise of temperature always accompanies the charging, but under normal circumstances, such as I have suggested above, I have not seen a rise of more than 2deg F. I always keep my batteries locked up to prevent mischief from amateur experiments of various sorts, and in one case found a most marked improvement immediately follow this obvious precaution. I also keep the ventilation under reasonable control, and so far as possible maintain an equal temperature all the year round. It is, of course, very important to keep the cells all well insulated from the earth, and a careful test should be made several times a year to ensure the insulation being thoroughly good in this respect, otherwise a large leak may be going on day and night unobserved, and the battery blamed for doing too little work, while in reality it is doing too much.

My experience is that a secondary battery is a very valuable adjunct to an electric installation, especially for lighting, because it ensures a good, steady light all night and enables the machinery to cease running, thereby saving a great and constant expense, and proving itself a true commercial economy.

The Durham College of Science, Newcastle-upon-Tyne.—The twenty-seventh session of this college begins September 27, 1897. Full particulars appear in our advertisement columns.

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THE ALTERNATING-CURRENT INDUCTION MOTOR.*

BY CHARLES PROTEUS STEINMETZ.

(Concluded from page 277.)

§ 3. *Regulation and Stability.*

In the preceding, the load curves and speed curves of the polyphase induction motor—that is, the dependence of the electrical and mechanical features upon the output and the speed—have been discussed under the assumption of constant voltage at the motor terminals.

In practice, however, this condition is usually only approximately fulfilled. In general, the voltage in any alternating-current system is maintained constant, or approximately so, at the centre of distribution or at the primary terminals of the transformers. Thus, between the motor terminals and the point of constant voltage of the system, a certain impedance exists in the circuit.

If now, as it is reasonable to expect, the distribution voltage, ratio of transformation, etc., are chosen so as to bring the rated voltage at full load at the motor terminals, at light load the voltage at the motor will be high, and thus the exciting current greater than at the rated voltage. Inversely at overload the voltage at the motor terminals will drop below the rated voltage, and thus the maximum torque and the maximum output of the motor be decreased in proportion to the square of the reduced voltage—that

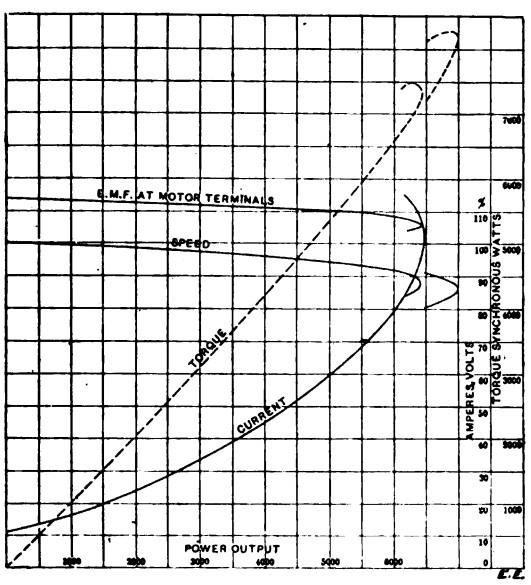

FIG. 14.—Induction Motor. Load Curves. $Y = \cdot 01 + \cdot 1\,j$. $Z = \cdot 1 - \cdot 3\,j$. Operated from Transformers of Impedance, $Z = \cdot 04 - \cdot 08\,j$, at Constant Primary Potential of 114·1 Volts, corresponding to 110 Volts at Motor Terminals at 5,000 Watts Load.

is, the more, the greater the impedance of lines, transformers, etc., is.

Thus, when operated under these conditions of practice, the induction motor does not give the same margin of overload as when operated at constant impressed voltage.

This at once shows the desirability of designing the induction motor with sufficiently large margin of overload, and the necessity of choosing the supply circuit, and especially the transformers, of as low impedance as possible.

As an instance are shown, in Figs. 14 and 15, the load curves of the motor discussed in the preceding, of the constants—

$$Y_0 = \cdot 01 + \cdot 1\,j,$$
$$Z = \cdot 1 - \cdot 3,$$

rated at 5,000 watts per circuit full load, corresponding to 59 amperes at 110 volts impressed, when operated:

(1) At constant impressed voltage of 110 volts. (Fig. 3.)

(2) Operated from transformers of 2 per cent. resistance drop and 4 per cent. internal reactance—that is, transformers representing about the best make on the market of very close regulation. (Fig. 14.)

(3) Operated from transformers of 2 per cent. resistance drop and 15 per cent. internal reactance, or about the average type of cheap transformers at constant primary voltage corresponding to 110 volts at full load at the motor terminals. (Fig. 15.)

In these cases, the impedance interposed between motor and point of constant voltage is:

$Z = \cdot 04 - \cdot 08\,j$, with best regulating transformers.

$Z = \cdot 04 - \cdot 3\,j$, with transformers of poor regulation.

In Figs. 14 and 15, the load curves of the motor, the limits of speed and torque curve at constant voltage of 110 are plotted also, showing that the maximum output is reduced under these conditions from 7,000 watts per circuit to 6,450 and 5,780 watts respectively, and the maximum torque from 8,250 synchronous watts to 7,500 and 6,460 respectively.

That is, even with the best make of transformers inserted in the circuit, at constant voltage at their primaries and rated voltage at the motor terminals at full load, the margin of overload power is reduced from 40 per cent. to 29 per cent., or by 11 per cent. in the instance chosen here, and the margin of overload torque from 55·5 per cent. to 41·5 per cent., or by 14 per cent., while an inferior type of transformers, of poor regulation, reduces the margin of power to 15·6 per cent., and the margin of torque to 22 per cent.—that is, more than twice as much as transformers of close regulation. In consequence thereof, with transformers of poor regulation the motor is at full load

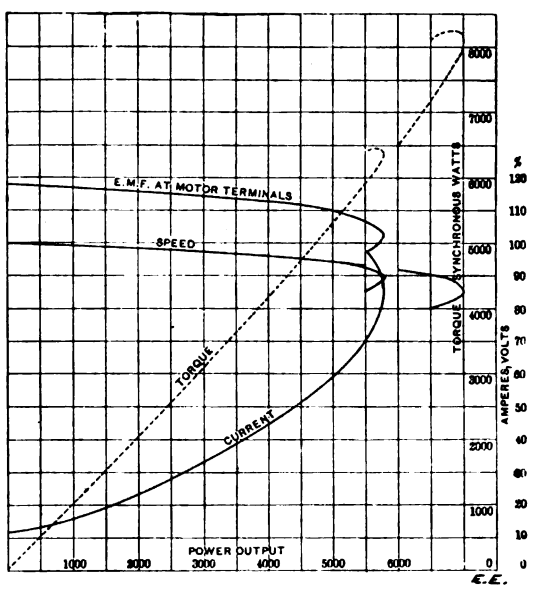

FIG. 15.—Induction Motor. Load Curves. $Y = \cdot 01 + \cdot 1\,j$. $Z = \cdot 1 - \cdot 3\,j$. Operated from Transformers of Impedance, $Z = \cdot 04 - \cdot 3\,j$, at Constant Primary Potential of 121 Volts Corresponding to 110 Volts at Motor Terminals at 5,000 Watts Load.

already dangerously near the maximum output point, although at constant impressed voltage it has ample margin to carry any reasonable overload.

Still greater is the decrease of voltage, and thus of torque, in starting, especially with low-resistance armature, due to the large currents consumed under these circumstances. With an armature containing a variable resistance of sufficient size, limiting the starting current, the starting torque is less affected by the transformer. Thus, with short-circuited armature, in the motor chosen as instance, the starting torque and starting voltage drop from 2,950 synchronous watts at 110 volts to 2,420 synchronous watts at 99·5 volts with good transformers, and only 1,635 synchronous watts at 82 volts with poor transformers, while the starting current is correspondingly decreased from 176 amperes to 139 and 131 amperes respectively, but the exciting current, or current, when running light, increased from 10·7 to 11 and 11·45 amperes respectively, due to the increase of voltage at light load.

In consequence thereof, the characteristic constant, which is approximately equal to starting current divided by current at standstill, is increased from 6·1 per cent. at constant impressed voltage to 6·9 per cent. with good and 8·75 per cent. with poor transformer, with the result that

* *Transactions* of the American Institute of Electrical Engineers.

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the motor becomes inferior in every respect in correspondence with the increase of the characteristic constant, δ, as discussed in the preceding. For instance, the exciting current rises from 17·4 per cent. to 20 and 24·7 per cent. of the current at two-thirds maximum torque.

If in the installation of the motor the mistake is made not to allow for the drop of voltage taking place even in the best transformers on inductive load, but the ratio of transformation is chosen so as to give the rated motor voltage at the secondary terminals of the transformers at open circuit, output and torque of the motor are still further reduced, and even with the best transformers the margin of overload is only 19·4 per cent. in power and 31 per cent. in torque, while with transformers of poor regulation no margin of torque is left, and the motor cannot carry full load any more—that is, at constant primary voltage corresponding to the rated motor voltage at open circuit at the secondary terminals the motor can be operated successfully only with the best type of transformers. This fundamental importance of transformer and line impedance on the operation of the induction motor has frequently been overlooked. It is, however, analogous to the dropping of torque and output of a continuous-current motor if the impressed voltage drops.

The curves are calculated thus:

Let at slip, s, the current in the motor $= i$ at the impressed E.M.F., e, and the angle of lag $= \phi$. It is then the apparent impedance of the motor in absolute value:

$$z_m = \frac{e}{i},$$

or in compress expression:

$$Z_m = \frac{e}{i}(\cos\phi - j\sin\phi).$$

If

$$Z = r - j\,x$$

equals the impedance of the transformer, etc., the total impedance of the system of motor, transformer, etc., is:

$$Z^1 = (r + \frac{e}{i}\cos\phi) - j\,(x + \frac{e}{i}\sin\phi),$$

or, absolute:

$$z^1 = \sqrt{(r + \frac{e}{i}\cos\phi)^2 + (x + \frac{e}{i}\sin\phi)^2}.$$

At full load it is $e = e_0$, $i = i_0^1$, hence

$$z^1 = Z_0^1 = \sqrt{(r + \frac{e_0}{i_0^1}\cos\phi_0)^2 + (x + \frac{e_0}{i_0^1}\sin\phi_0)^2},$$

and

$$e^1 = i_0^1 z_0^1 = i_0^1 \sqrt{(r + \frac{e_0}{i_0^1}\cos\phi_0)^2 + (x + \frac{e_0}{i_0^1}\sin\phi)^2},$$

the constant primary impressed voltage of the system; thus, if at slip s and voltage e_0 the current $i = i_0$, the motor impedance is

$$z_m = \frac{e_0}{i_0},$$

and the voltage at the motor terminals:

$$e = e_0^1 \frac{z_m}{z_1},$$

and the motor current has to be changed in the proportion:

$$\frac{e}{e_0};$$

the motor output and torque in the proportion:

$$\left(\frac{e}{e_0}\right)^2.$$

Appointment Vacant.—As seen by an advertisement appearing in this issue, the Government of Straits Settlements require a telegraph inspector to supervise maintenance of open lines, erect new lines, supervise telegraph offices, etc., who should have theoretical and practical knowledge of telegraphy, and understand location of faults, and setting up of batteries, electric bells, and telephones.

THE ECONOMY AND UTILITY OF ELECTRICAL COOKING APPARATUS.*

BY JOHN PRICE JACKSON.

The tests of electrical cooking apparatus detailed in this paper were made with the hope of obtaining a method of cooking that would be satisfactory with a minimum risk of fire. During the past winter a serious fire, which might readily have become disastrous, occurred in one of the buildings of the college with which the writer is connected, caused by the use of an alcohol stove. As this institution is lighted and furnished with power by electricity, it was naturally felt that such a danger should be avoided if possible by the use of electrical appliances. It was also desired to find out whether at least a portion of the cooking in the women's department of the college could not be done satisfactorily by electricity.

To settle these points, I procured from the American Electrical Heating Corporation, of Boston (through the courtesy of Mr. Sayles), the following pieces of apparatus: one oven, 12in. by 9in. by 15in., having three heats, 3, 10, and 17 amperes respectively; three stoves of 2, 4, and 5 amperes respectively; two flatirons, of 1·5 and 6 amperes capacity; one broiler, of 12 amperes capacity. The pressure used by these is 110 volts.

The stoves are round discs of iron, on the under side of which the heating wires are embedded in a non-conducting, non-combustible compound. The oven is a box so thoroughly heat-insulated that the outside metal covering never reaches a temperature uncomfortable to the hand. The broiler is made of a corrugated metal surface, slightly tipped from the horizontal, with a drip groove at the lower edge for catching the meat juices. The flatirons are similar in construction to the stoves, the larger one having a low-heat switch, which enables the operator to control the heat. In all these appliances the heating coils are so arranged that the energy is largely concentrated at useful points. They are also supplied with supports and cases which will not conduct heat.

The efficiencies of the two larger stoves were obtained by heating 2lb. of water to the boiling point, and measuring the power supplied by a calibrated wattmeter. The cooking vessels used were ordinary stewing-pans, with the bases nearly the same size as the tops of the stoves. The efficiencies, considering the ratio between the amount of heat absorbed by the water and the amount received by the stove, were: for the larger or No. 1, 48·9 per cent.; for the next size, No. 2, 43·1 per cent. These efficiences could be increased by having the pans made to fit the stoves exactly, and still further by carefully covering the pans, lids, and exposed portions of the stoves with a non-conductor of heat.

When it is desired to boil water, the best plan is to place an immersion coil in a properly heat-insulated pot; such an arrangement should give an efficiency of from 90 to 100 per cent. We unluckily did not have such a coil at our disposal. It was impossible to measure the cooking efficiency of the oven, but as it was merely warm on the outside after potatoes or bread had been baked and "done to a turn," the efficiency is high. In baking, the current was turned on and the oven allowed to heat for five minutes before the articles to be cooked were placed within, and the current was turned off from 10 to 20 minutes before the baking was done, when the heat of the oven was sufficient to complete the operation. The broiler was manipulated in much the same manner, thus utilising the greatest possible amount of heat. This electrical apparatus was used in cooking most of the meals for a family of six for several weeks.

The following table indicates the amount of cooking done for the first breakfast, dinner, and supper respectively, and may be taken as a fair average of the whole period. All costs have been estimated on the basis of 10 cents per kilowatt-hour, the average rate charged for residence electrical supply in a nearby town. The foods were not measured, as it was believed more desirable to determine whether in a long period of cooking the apparatus would prove satis-

* A paper read at the fourteenth general meeting of the American Institute of Electrical Engineers, July 26-28, 1897.

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factory in a family of given size. The largest stove is designated No. 1; the next size, No. 2; the third size, No. 3; the broiler, B; and the oven, O.

BREAKFAST.

Time.	Utensils.	Food.	Watts.
6.55	No. 1, on	Rolled oats	—
6.55	2, on	Coffee	844
7.45	2, off		
7.45	B, on	Beefsteak	1,505
7.55	2, off		1,150
8.05	B, off		

Kilowatt-hours, 1·355. Cost, 13·55 cents.

DINNER.

10.25	No. O, on	Beef, roast...	
10.35		Potatoes	1,610
11.14		Pie	
11.46	1, on	Asparagus	1,990
12 05	O, off		
12.05	2, on	Coffee	1,180
12 11	B, on	Toast for asparagus	2,200
12.29	1, off		1,835
12.32	B, off		
12.32	2, off		

Kilowatt-hours, 29·8. Cost, 29·8 cents.

SUPPER.

4.59	No. 1, on	Cocoa	630
5.15	2, on	Potato cakes	1,010
5.10	B, on	Omelet	2,100
5.22	2, off		1,700
5.26	B, off		
5.26	2, on		1,130
5.43	2, off		
5 44	1, off		640

Kilowatt-hours, 8·39. Cost, 83·9 cents.

Four pies can be baked in the oven at an expenditure of ·62 kilowatt-hour and a cost of 6·2 cents, or 2·05 cents per pie. Two large loaves of bread were baked with the current on the oven 50 minutes, at an expenditure of 1·22 kilowatt-hours, a cost of 12·2 cents, or 6·1 cents per loaf. Four rather small-sized loaves could have been as readily baked. Biscuits with about the same expenditure of energy as in the case of pies. The broiler utilised about the same amount of energy for all kinds of meat. The result of the whole series of meals was a cost for electricity of 13·1 cents per meal. The heating of water for washing the dishes took an additional ·35 of a kilowatt-hour per meal, which raises the cost to 16·6 cents per meal.

To determine the relative cost of cooking with electricity and coal, the same foods were cooked on the No. 8 Othello coal stove ordinarily used by the family. The coal was carefully weighed. The results gave an average of 12·6lb. per meal, which at 5dol. per ton gives a cost of 3·15 cents per meal. The results shows the cost of cooking by coal about 19 per cent. of the cost of cooking by electricity.

Ironing was done for the same household a number of times. The heavy articles were done with the large iron; while for fancy dresses and small articles the small iron was used. The average time taken was four hours, and the expenditure of energy in kilowatt-hours was 2·27. This made the cost of the ironing 22·7 cents. An equal number of tests was made using the coal range, the fuel being carefully weighed. For the same size wash, the ironing took five hours at a cost of 12·25 cents. This shows the cost of energy by the use of coal to be 54 per cent. of that by electricity. The results of the cooking tests seem to indicate that for the ordinary cooking of a family for the whole year the expense would be larger than would be ordinarily acceptable, notwithstanding the great advantages in other respects. However, in the following classes their utility should be great:

1. For light housekeeping, such as is practised in small city apartments, or in many large houses during the summer months, no other method presents so many desirable features. The dirt of coal and ashes, disagreeable gases, and abnormal temperatures due to a coal stove are entirely obviated. For such housekeeping a disc stove using 500 or 600 watts and a broiler using about 1,200 watts would be sufficient for a small family, and would cost from 20dol. to 30dol. A tea-kettle or immersion coil might be added at a cost of from 6dol. to 10dol. A special pair of wires would of necessity have to be run into the cooking-room from the house or apartment supply mains. The latter would ordinarily warrant the extra call that would be made upon them in this way. For similar purposes coal, oil, gas, or gasoline are frequently used, but with the inherent disadvantages of greater heat in the room, offensive odours, comparative uncleanliness, and danger.

2. This form of cooking apparatus could be used with facility in boarding-houses and restaurants for purposes which require an even temperature, such as is needed in baking griddle cakes, boiling eggs, etc.

3. Where electricity is available, nothing could be more convenient than a small electrical stove, requiring 300 or 400 watts, for the many uses to which at present the alcohol flame is put, such as the afternoon tea-kettle, chafing-dish, toaster, etc. This use of alcohol is most unsafe as regards danger from fire, and could well be discarded for electricity, which is absolutely safe when properly installed, as well as being more convenient and better in other respects.

4. In the shop the glue-pot, solder-pot, brazing-iron, etc., can be heated advantageously by electricity, and one of the most gratifying consequences of our experiments has been the decision to put such an equipment in our college shops.

5. The test of the electrical flatirons showed them more economical than the old form, when the saving of labour is taken into account. Not only is there a saving in time, but the severity of labour is much lessened. Our experience was that a laundress who had used an electrical iron would be exceedingly unwilling to go back to the old form.

A small flatiron of two or three amperes attached to the ordinary lighting fixture in a dressing-room is a great convenience, and with an electric tea-kettle and curling-iron are destined to become essentials in the modern home. Concerning the questions whether the use of electricity had proved satisfactory in its operations in the cooking tests described, the housekeeper in charge said: "The instruments were excellent in every respect. We were able to cook more rapidly, to keep the heat at just the right point, and could readily prevent over-cooking or under-cooking. While we were using electricity every dish was perfect. When I think of these advantages, and of the cleanliness and convenience of the utensils, I sincerely hope that some of them at least may be retained in the house permanently."

The general results of the tests were of such a nature that the writer is warranted in the belief that if central-station managers would more generally introduce exhibition equipments of these domestic utensils a new call on their station capacity would develop, of which the larger proportion would be during the light-load periods. I wish to acknowledge my indebtedness to Mr. Rudolph F. Kelker, of Harrisburg, Pa., for his valuable aid in carrying out the work briefly described above.

PROPOSED ELECTRICITY SUPPLY AND DUST DESTRUCTOR WORKS FOR GLOUCESTER.

At the meeting of the Gloucester Corporation on Tuesday the Council had under their consideration an exhaustive report, prepared by Mr. Robert Hammond, M.I.E.E. (of Ormond House, London, E.C.), on proposed electricity supply and dust destructor works for Gloucester. The Gloucester Corporation have on several occasions tentatively demonstrated their adhesion to municipal control by opposing the grant of provisional orders to trading companies, and securing such orders in their own name. Mr. Hammond stated in his report that there are now in the United Kingdom 242 provisional orders and licenses of the Board of Trade in force. Of these 171 are held by local authorities and 71 by companies, showing that 70 per cent. are under local public control. The bulk of the pioneer work was done by private enterprise, whilst almost all the newer works have been undertaken by local authorities. Taking the 13 undertakings which have been owned by local authorities for three years and upwards, it is found that, with three exceptions (which are satisfactorily explained), in every case there has been a sufficient return of revenue to cover the expenses, plus the interest and sinking fund charges, and to leave a surplus available for the reduction of the rates. In addition, many of the works set aside large sums to a reserve fund as a provision for depreciation and renewal of plant. The total net profits earned by the 25 companies that had been in operation three

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years and upwards amount to £119,021, after providing for interest on debentures and for depreciation. Local authorities have shown an increasing disposition to acquire the established undertakings of companies. There were five instances of such acquisition last year. Among considerations which make it desirable that the business, if a sound one, should be retained in the hands of the local authority, may be named the following: ratepayers as consumers would be better supplied by the local authority rather than by a company, who have to consider the cost of administration by directors and the provision of a substantial dividend; ratepayers realise that electricity works laid down by the local authority represent public money, are their own property, and that the larger the demand for electricity the more economically will it be "generated," meaning either increased profit to the city or a lessening of rates charged to the consumers; the municipality would aim to develop the business on an extended basis as rapidly as possible, and could afford to make small "capital extensions" without waiting for a 5 or 6 per cent. dividend upon the work in the pioneer area, and the principal object with due regard to permanent profitable results would be to extend the benefit of electricity supply to the ratepayers throughout the whole of the city; the Corporation would themselves be good customers in the direction of public lighting, which would to a certain extent provide for a prolongation of the "load," thus assisting economical working. Meeting the possible objection that electricity cannot compete with gas at 2s. 6d. per 1,000 cubic feet, Mr. Hammond remarks that one great boon in the introduction of electric light is the almost simultaneous reduction in the price of gas, and quotes the example of Leeds, where phenomenal success has been attained by the electric lighting undertaking, in spite of gas at 2s. per 1,000ft. Mr. Hammond has come to the conclusion that electricity supplied at 6d. per unit will usually equal a gas bill for the same premises at 3s. per 1,000 cubic feet, but money will be saved by choosing the electric light, even if its metered cost be 50 per cent. more than gas, for several reasons, the most forcible of which appears to be: the facility with which it can be switched off and on; the advantage in health, as compared with gas and oil; the absence of damage to tradesmen's goods, ceilings, decorations, picture frames, furniture, etc. Mr. Hammond, further, foreshadows substantial reduction of cost as the production for a given area increases, as improvements in the incandescent lamp are perfected, and as advantages accrue to electric lighting works through by-uses of the plant. With regard to the third possible objection, that by waiting it may be possible to obtain more efficient plant, Mr. Hammond retorts that such an argument applied generally to industrial machinery during the past 100 years would not have advanced England beyond the hand-power loom. "Of course," he says, "it is impossible in 1897 to secure plant with all the improvements that experience may supply by the year 1907, but it is sufficient to know that the capital sunk to-day in copper conductors will probably be spent as efficiently as it would be 10 years hence; and while the present types of generating plant are capable in other places of generating electricity at 1½d. and 2d. per unit, with a loss in the conversion from mechanical into electrical energy of only 5 per cent. to 7½ per cent., no great risk is run in embarking capital at the present time."

The provisional order at present in force in Gloucester, whereby the Corporation are empowered to undertake the supply of electricity for both public and private purposes within the city, stipulates, *inter alia*, that the Corporation shall, within two years from the commencement of the order (July 2, 1896), lay down sufficient distributing mains for the purpose of a general supply of electricity in the main streets. The total length of distributing mains for the city is 14,280 yards, or just over eight miles. Dealing next with the feeders connecting the generating plant with the distributors, Mr. Hammond points out that the alternative plans are those by which the feeders can be arranged to either: (*a*) deliver the pressure direct to the distributors, in which case they would be charged at the generating works with the pressure of the distributors, plus the percentage of drop of the E.M.F. on route; or (*b*) be charged with a high pressure, say 2,000 volts, in conjunction with an arrangement for transforming the 2,000 volts to 440 volts required by the distributors. In the first case the system would be the low-pressure continuous-current system, and in the other the (*a*) high-pressure continuous with rotary transformers, as at Oxford, or (*b*) high-pressure alternating, as at Cheltenham, Worcester, Bath, and Liverpool. For Gloucester, Mr. Hammond recommends the adoption of low-pressure continuous-current feeders, with the three-wire method of distribution at a pressure between the outer conductors of 440 volts. Having settled the systems of feeding and distribution, Mr. Hammond proceeds to submit an estimate for carrying out the mains in two schemes, costing respectively £3,150 and £14,200.

Coming to the generating plant, Mr. Hammond says in low-tension feeders the plant at the generating works must also be of the low-tension type. Whatever size be adopted, it will be necessary to provide duplication, so that in the event of one plant being laid off the other can continue the lighting. In making up his estimates, Mr. Hammond sets forth the respective costs of high and low speed engines, setting out the chief points of difference between them. In point of size, Mr. Hammond warns the committee against the mistake in adopting plant which has had to be cleared out in a year or two as being unequal to the demand, and recommends 300-kw. size for the permanent set. He suggests that in addition one, if not two, smaller sets are desirable at the commencement to secure economy in working. One set of 150-kw. capacity (5,000 lights) should form part of the first equipment, and (as the first step towards the provision of the permanent sets) it would be prudent to adopt 300-kw. as the size of the necessary reserve set. On the demand for lights extending, the installation of another 300-kw. set would bring up the generating plant capacity to 450 kw. (15,000 lights), with 300 kw. (10,000 lights) in reserve. Adding the accumulators, this would give available capacity for 17,500 8-c.p. lights, all burning at one time, which would, it is estimated, permit of 26,250 8-c.p. lights being installed on consumers' premises. These figures would be proportionately reduced if the reserve set were limited to 150 kw., and the only saving effected would be about £1,000. It was recommended that a set of accumulators be added capable of sustaining a load of 2,500 lights to meet the day and post-midnight demands. Should there be a heavy demand for motive power during the day, it would be more economical to supply the current direct from the engines.

The works estimates are as follows; For high-speed plant the estimated cost of generating works with engines and dynamos of total capacity of 300 kw. (two 150-kw. dynamos), capable of supplying 7,500 lights (with accumulators, 11,250) fixed on consumers' premises, works out as follows: buildings, £7,200; boiler-house plant (including two 30ft. by 8ft. Lancashire boilers in mechanical stokers), £1,500; engine-house plant, £5,650; miscellaneous, £1,250—total, £15,600. The alternative estimate for the same capacity of plant, but with slow-speed engines, comes to £18,150. The estimated cost of equipment of generating works with engines and dynamos of total capacity of 450 kw. would be: high-speed plant, £16,670; slow-speed plant, £19,920.

Mr. Hammond, in conclusion, gives details of the cost of public lighting, and of the dust destructor works. A two-cell destructor with all necessary brick buildings, tipping platform, suitable for dealing with 30 tons per diem, inclined roadway, 150ft. by 4ft. chimney, and water-tube boiler, is estimated to cost £6,000, but if the destructor is combined with the electricity supply works there would be an appreciable saving in capital outlay in the direction of the chimney, which is valued at £1,200, as a slight increase in the size would make it serviceable for both purposes. Mr. Hammond submits plans of his various proposals, and declares that if the combined scheme of electric lighting and dust destructor be adopted on the lines recommended, he is certain the city will possess a property which will prove a most valuable investment, and which will in the course of a few years contribute a handsome quota available for the reduction of the rates of the city.

The Council decided to establish electricity supply works with dust destructor works in connection therewith, and to engage Mr. Hammond to prepare a scheme for the same on the lines suggested in his report, and afterwards to prepare plans and specifications for and superintend the carrying out of such works; Mr. Hammond to be paid a fee of 5 per cent. upon the actual outlay in respect of the buildings, engines, and plant for the electric supply works, and a fee of 150 guineas in respect of the dust destructor works. The Council also decided to apply to the Local Government Board for sanction to borrow a sum not exceeding £50,000 required for carrying out the proposed work. A sub-committee of the Council was appointed to visit several towns that had adopted electric lighting.

BIRMINGHAM.

The programme of the evening classes at the municipal technical school for the forthcoming session has just been published. The session begins for workshop classes on Monday next, and for lectures and laboratory work on Monday, the 20th inst.

The list of classes held at the school is very comprehensive, and is divided into the following nine departments—viz., (1) chemical department, (2) metallurgical department, (3) electrical department, (4) classes in mathematics and physics, (5) engineering lecture classes, (6) mechanical drawing classes, (7) workshop classes, (8) miscellaneous classes, (9) women's classes. The fees for all classes are commendably low, and within the means of all intending students, being 2s. 6d. per session for lecture classes, and 5s. per session for a laboratory or workshop class. The latter fee, however, covers admission to a lecture class it being compulsory upon all students in practical or workshop classes to attend during the same session one approved lecture or drawing class.

Having regard to the number and variety of the metal trades of Birmingham, the next department, that devoted to the teaching of metallurgy, is a most important one. In addition to the ordinary lecture classes and laboratory work in the several grades

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of the subject, special courses are held in metallurgy for brass-founders, German-silver workers, and jewellers, and for iron and steel workers, the course in each case consisting of an hour's lecture and an hour and a half's practical work by the students themselves in the laboratory. Included in this department are also classes in electro-metallurgy, and metal colouring and bronzing. In the first named subject instruction is provided for electro-platers and gilders, brassfounders and nickel-platers. In the electrical, mathematics, and physics department ample provision is made for the teaching of magnetism and electricity, mechanics, and other important subjects connected therewith, while special classes are arranged for the teaching of telegraphy and telephony. The class for practical instruction in electrical jointing and fittings, established last year, was so successful that this year the course has been divided into elementary and advanced stages. The electrical laboratory will this session be open every night in the week, and the work therein will consist of a graduated series of experiments arranged to aid each student in becoming practically acquainted with electrical apparatus and methods of testing, and to enable him to more thoroughly understand the principles dealt with in the lectures he is attending in the electrical department. The laboratory is only open to those students who are attending the approved lecture course. On Mondays and Tuesdays they are arranged for the students attending lectures in the advanced and honours stages of electricity and magnetism, and in the honours stage of telegraphy and telephony. The Saturday course is reserved for students in the electrical engineering class, and will include work in the dynamo-room.

Under the head of engineering lecture classes there are courses of lectures on mechanical engineering, steam, and applied mechanics.

The workshop classes comprise instruction in plumbing, sheet metal work, carpentry and joining, patternmaking iron and steel work, brasswork, electrical instrument making, and electric jointing. In all these classes, priority of admission during the two first weeks of the session is given to persons engaged in the trade. The registers are kept open until the close of the second lesson for this purpose, but after that time, if there is room, admission will be given to all applicants in order of priority of application.

As an incentive to earnest study on the part of students who join the classes, a number of valuable scholarships and prizes are offered for competition as follows—viz., the Priestley scholarship, of the value of £50 per annum (and tenable for two years at an approved science school), and the Smith Memorial Prize of £4, each in chemistry; Mr. Howard Smith's prizes of two guineas and one guinea in metallurgy; Mr. W. W. Butler's prizes, amounting in all to five guineas, in electro-metallurgy and metal colouring and bronzing; Mr. John Wand's prize of six guineas in magnetism and electricity and electrical engineering; the Birmingham Association of Mechanical Engineers' prize of five guineas in machine drawing, iron and steel work, and patternmaking; and various other prizes

For the special benefit of students in the workshops, a course of 24 short lectures has been arranged on every evening except Saturday, and will be given between 7 and 7.40, the latter being the hour at which the shops are opened. Twelve lectures will be given in the winter term, and the remaining 12 in the spring. Each course of lectures will comprise four parts, and each part will consist of six lectures, given by one of the teachers of the school connected with the mechanical, electrical, chemical, or metallurgical departments. The lectures will not be devoted to any particular science, but will be arranged so as to form a connected course dealing in a simple way with a number of matters likely to be of use and interest to the students in the workshops. As far as possible the lectures will be illustrated by experiments. These lectures are not intended as a substitute for the regular courses in engineering and the other applied sciences. On the contrary, students are advised to join such courses in preference if they can possibly do so. Only students in the workshops will be allowed to join these special courses, and admission will be free. These lectures will not commence till the last week of September.

COMPANIES' MEETINGS AND REPORTS.

ALUMINIUM COMPANY, LIMITED.

The report of the dictors of the Aluminium Company, Limited, for the year ended June 30 last, to be submitted to the ordinary general meeting to be held at the Cannon-street Hotel on September 7, states that, while the result of the year's trading is not so satisfactory as last year, the Board still have every reason to feel entire confidence in the present position and future prospects of the Company. The accounts show a gross profit of £10,532 for the financial year. This sum together with the sum brought forward, and after providing for debenture interest of £4,739, and all other fixed charges, leaves a balance available for dividend of £7,447. Out of this the directors recommend the payment of a dividend of £10 per cent. for the year on the "A" shares, which will absorb £6,000, leaving a balance of £1,447. The transactions of last year enabled a large sum to be written off both the works and patents, and also the formation of a large reserve fund in shares of other companies; the directors, therefore, are of opinion that no further amount need be written off this year. The business at Oldbury has suffered materially this year owing to what the directors believe is improper competition, and suits have been instituted in Germany to restrict the manufacture of sodium carried on there by what is confidently expected will prove to be an infringement of the Castner sodium process. Upon the successful termination of these suits heavy damages may be secured, and the Oldbury business will be restored, it is believed, to its former level. The works of the Castner-Kellner Alkali Company, Limited, are now in operation, and the shares command a high premium, though standing in the books of the Company at par value. The dividends which may be paid by the Castner-Kellner Alkali Company will considerably increase the income of this Company in future years. The works being erected by the Mathieson Alkali Company at Niagara Falls are expected to be finished and started in October. The payment of the minimum royalty of £4,000 per annum by the Mathieson Alkali Company has now commenced to run. The works of the Niagara Electro-Chemical Company are also in successful operation, and if present indications continue, that company will be able to pay a substantial dividend at the close of their first full financial year.

YORK TRAMWAYS COMPANY.

The half-yearly meetingof this Company was held on September 1 at York, Mr. J. Kincaid presiding. The report stated that the gross receipts for the half-year ending June 30 had been £1,853. 10s. 4d. and the working and general expenses £1,381. 12s. 3d., showing a balance of £471. 18s. 1d, which it was proposed to appropriate as follows: Interest on 5 per cent. debenture stock (less income tax), £145; dividend at the rate of 6 per cent. per annum (free of income tax) on share capital, £266. 5s.; and balance carried to reserve fund (bringing the fund up to £450), £60. 13s. 1d. The number of passengers carried during the half-year had been 417,344.

The **Chairman**, in moving the adoption of the report, said that the provisional order authorising the use of electric traction had been confirmed by Parliament, and the Company was in a position of being able to make an arrangement for using electric power on the tramways when it was provided for the lighting of the city.

The report, having been seconded, was adopted.

CONTRACTS FOR ELECTRICAL SUPPLIES

CONTRACTS OPEN.

Dunfermline.—Tenders are required for fitting-up the electric light at Muirbeath Colliery, Dunfermline.

Switzerland.—Tenders are invited at Lausanne for a concession for erection and lease of electric works. Applications to be made to the Municipality before September 25.

Jassy (Roumania).—Contracts will close on September 18 at 4 p.m. for the electric lighting of the town of Jassy. Specifications, plans, and all particulars may be obtained at Paris, 80, rue de Varenne, at the Bureau des renseignements commerciaux.

Sofia (Bulgaria).—On September 10 tenders will close for the erection of an electric lighting and motor plant, together with the concession for working the whole of the urban and suburban tramways. Details will be supplied at the Municipal Offices, Sofia. Foreigners may compete.

Paris.—Tenders are invited for two large contracts for the supply of copper, iron, insulated wire, and other materials for telegraphs and telephones. The tenders close on September 12 and 17 respectively. Full particulars may be obtained at the office of the Under Secretary for Posts and Telegraphs, 103, Rue de Grenelle, Paris.

Epsom.—The District Council invite tenders for lighting the public lamps in the district (about 207 in number) with gas or suitable material for 12 months, upon the basis of a contract which may be seen at the office of Mr. E. G. Wilson, clerk, High-street, Epsom, from 10 a.m. to 3 p.m. Sealed tenders, marked "Tender for Lighting," are to be sent to the Clerk by 7th inst.

London, W.C.—The Guardians of the Strand Union invite tenders for the installation of electric light at their offices, 15, Henrietta-street and 29, Maiden-lane. Specifications of the work required may be obtained at the Guardians' Offices. 15, Henrietta-street, and tenders should be delivered to Mr. A. H. Maddocks, clerk to the Guardians, at the same place, on or before 14th inst., at 5 p.m.

Sydney (New South Wales).—Tenders are required by October 18, at noon, at the General Post Office, for supplies to the Telegraph, Telephone, and Post Office Departments, including iron, copper, and insulated wire, insulators, nails, screws, nuts, bolts, electric batteries with all accessories and chemicals, diaphragms, arc lamps, incandescent lights, 11,000ft. carbon for arc lamps, and various other appliances.

Sale by Tender.—We beg to remind our readers that to-day is the last day upon which the receiver for the debenture-holders of the Electrical Manufacturers, Limited (in liquidation), 223, Upper Thames-street, E.C., is prepared to receive tenders for the purchase of the stock-in-trade and furniture of the company. Particulars and conditions of sale and forms of tender can be obtained by application at 223, Upper Thames-street, E.C., and the goods will be on view there from 10 a.m. to 6 p.m. each day (Saturdays, 10 a.m. to 1 p.m.). Tenders will be received by the Receiver up to and inclusive of September 3.

Norway.—Her Majesty's Secretary of State for Foreign Affairs has received information from her Majesty's Consul-General at Christiania that tenders are invited by the Norwegian State

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Railway Administration for the supply of telegraph and telephone materials. Tenders will be received by the Administration up to 7 p.m. on September 22, 1897, and should be marked "Telegraf og Telefonmaterial," and addressed Tyrelsen's Expeditionskontor, Statsbanerne Christiania. Further particulars may be obtained on application at the Commercial Department of the Foreign Office between the hours of 11 and 6.

Russia.—Two concessions for the erection and lease of street railways are open for tender. These tramways may be worked either by electricity or any other means. Tenders for the works at Penza will close September 30. Particulars are to be obtained at the offices of the Municipal Administration. The second lot of contracts is for a similar undertaking in the town of Kontais, in the Caucasus. The municipal authorities will furnish applicants with particulars as to this work. For the benefit of intending contractors, we observe that they will save themselves time, and probably disappointment, if they will write their letters in French.

Leicester.—The Gas and Electric Lighting Committee of the Corporation invite tenders for the supply of sulphuric acid, made either from native Sicilian brimstone, or recovered sulphur, or pyrites (specific gravity in each case to be stated). The price to include free delivery by rail into elevated tanks, 27ft. high, at the chemical works, Ayelstone-road. Probable quantity, about 1,700 tons, to be delivered as required during the ensuing 12 months. Tenders, addressed to Alderman Lennard, chairman, and endorsed "Tender for Acid," to be delivered at the Gas Offices, Millstone-lane, Leicester, by 11 a.m. on 11th inst.

Ludlow.—The Corporation offers a prize of £20 for the best and most economical scheme of electric lighting for the borough. The scheme must deal exhaustively with the whole matter, and give definite information of the cost of steam and water power for the purpose of comparison with the total cost of the undertaking and working expenses. Schemes to be delivered at the offices of Mr. John Herbert Williams, town clerk, Ludlow, marked "Scheme for Electric Lighting," before 4 p m. on October 1. Should the Corporation employ the engineer whose scheme is awarded the prize to carry the work out, then the £20 will merge in the commission to which he would then be entitled to.

Whittingham.—Tenders will close on the 20th inst. for electric lighting and plant required at the new hospital and reception wards at the County Asylum, Whittingham, for the Lancashire Asylums Board. Plans and specification may be seen, and further information obtained, at the offices of Messrs. Simpson and Duckworth, architects, Richmond-chambers, Blackburn, and also at the offices of the consulting engineers, Messrs. Fawcus and Clirehugh, Temple-chambers, Brazennose-street, Manchester. General conditions, specification, and form of tender on deposit of £5. 5s., returned on receipt of bona fide tender. Tenders to Mr. J. P. Muspratt, County Offices, Preston, not later than first post on 20th inst.

Whittingham.—Tenders are invited by the Lancashire Asylums Board for electric lighting and plant required at the new hospital and reception wards at the County Asylum, Whittingham. Plans and specification may be seen, and further information obtained, at the offices of Messrs. Simpson and Duckworth, architects, Richmond-chambers, Blackburn, and also at the offices of the consulting engineers, Messrs. Fawcus and Clirehugh, Temple-chambers, Brazennose-street, Manchester, on and after 28th inst. General conditions, specification, and form of tender on deposit of £5. 5s., returned on receipt of bona fide tender. Tenders to Mr. J. P. Muspratt, County Offices, Preston, not later than first post on September 20.

Llandudno.—The Urban District Council invite tenders for the following work in connection with their electric lighting and dust destructor station: (Section A) water-tube boilers; (B) condensing plant, steam plant, etc.; (C) steam engines and dynamos; (D) switchboard; (E) battery; (F) travelling crane; (G) underground mains, arc lamps, posts, etc. Copies of the specification, with form of tender and general conditions, can be obtained at the office of Mr. A H. Preece, A.M.I.C.E., 39, Victoria-street, Westminster. Applications for any or all of the above must be accompanied by a cheque for £5. 5s., which will be refunded on receipt of a bona fide tender. Sealed tenders, marked "Electric Lighting Tender for Section —," must be delivered at the office of Mr. A. Conolly, clerk, Council Offices, Llandudno, by 10 a.m. on 22nd inst.

Hull.—The Corporation are advertising for tenders for the electrical equipment of their tramways, to the extent of about nine miles double track and half mile single track. It will be open to contractors to submit tenders for various systems, and the contract, which will not be divided, will include engines and generators, switchboards, feeders, poles, brackets, trolley wire, rail bonding, and all accessories, also the first instalment of cars (15 motorcars and five trailers). It is expected that the specification, lithographed plans of the routes, and other particulars will be ready for issue early in September, and copies, when ready, may be obtained from Mr. A. E. White, city engineer, Town Hall, Hull by persons proposing to tender, upon payment of a deposit of £10, which will be refunded upon receipt of a bona fide tender and return of the papers and plans supplied. Cheques to be made payable to Mr. Thos. G. Milner, city treasurer. Tenders, endorsed "Tender for Tramway Equipment," are to be addressed to the Chairman of the Works Committee, and delivered at the Town Clerk's Office, Hull, before noon on November 5.

West Ham.—The West Ham Council require tenders for the wiring for electric lighting of the technical institute and public library, Romford-road Stratford, E. Persons desirous of tendering are requested to send their names to Mr. Fred. E. Hilleary, town clerk, Town Hall, West Ham, by 6th inst., together with a deposit of a Bank of England note for £10, which will be returned after the tenders have been considered by the Council, and provided the tender is bona fide and has not been withdrawn. To each person making such deposit will be sent a copy of the plans, specification, and form of tender, prepared by Messrs. Gibson and Russell, 11, Gray's-inn-square, London, W.C. Sealed tenders, to be enclosed in endorsed envelopes supplied with the forms, to be delivered to the Town Clerk by 20th inst. The contractor whose tender is accepted, and with whom a contract is entered into, will be required to enter into a bond with sureties for the due performance of the contract, and he will also be required to pay to the whole of his workmen such rates of wages and observe such hours of labour as are recognised by the workmen's trades unions and in force at the time of signing the contract.

Barking Town.—The Barking Town Urban District Council are prepared to receive tenders for the supply and erection of the following plant: Section A.—Generating plant, boilers and fittings, economiser, feed pump, injector, etc.; steam dynamos, condensers, oil filter, fittings, etc.; steam, exhaust, feed, blow-off, and sundry pipes; valves water tank, etc. Section B —Storage batteries. Section C.—Switchboard and all connections. Section D.—Overhead travelling crane. Section E.—Conduits and mains for private supply. Section F.—Mains for public lighting, and adaptation of existing lamps. Section G.—Arc lamps and posts. Tenderers are at liberty to tender for any section or sections, or for the whole of the sections, but not for part of a section. Successful tenderers will be required to enter into a contract to pay the trades union rate of wages and to observe the trades union hours of labour. The ground plan of plant, diagram of switchboard, plan of streets, etc., and specifications, with forms of tender, may be obtained at the offices of Mr. W. C. C. Hawtayne, the consulting engineer to the Urban District Council Mansion House-chambers, 20, Bucklersbury, E.C, on payment of £2. 2s., which sum will be returned on receipt of a bona fide tender. Tenders, sealed and marked "Tender for Electric Lighting," addressed to the Chairman of the Urban District Council, Council Offices, Barking, must be sent in by noon on September 21.

Madras —Tenders are invited for the utilisation of water flowing from the Periyár Lake for purposes other than irrigation and not incompatible with the use of the water for drinking. The irrigating season extends over nine to ten months, during which time the discharge is likely to be from 1,100 to about 500 cubic feet a second, according to the demands for irrigation and the available quantity in the lake. Subject to the risk of interruption by accident or drought, supply can be given throughout the irrigation season. No supply can be guaranteed at other times, but, so long as water is available, the Government will be prepared to issue it in such daily quantities as may seem to it advisable with reference to the time which is likely to elapse before the supply is replenished by the setting in of the rains. The fall from the tunnel to the foot of the hills is approximately 900ft., and the distance measured along the course of the stream about 6,800ft. One cubic foot per second falling 900ft. is estimated to produce over 60 effective horse-power. Intending lessees should state the quantity of water required in cubic feet per second and the annual rent offered for each cubic foot per second. No rent will be charged for the first year from the date of the concession; for the second year the charge will be one-fifth, and an additional charge of one fifth will be made every year until the full rent is reached. The whole or part of the concession may be surrendered on a year's notice being given. Lessees will construct at their own expense, on plans to be approved by Government, all the weirs and other works required to divert the water from the river below the tunnel. For further information, application may be made to the Chief Engineer for Irrigation, Madras, by whom tenders will be received up to October 31, 1897.

Port Elizabeth (Cape Colony) —The Town Council of Port Elizabeth (Cape Colony) invite tenders for lighting the streets and municipal buildings of Port Elizabeth by electricity, in consideration of the grant of a concession for the exclusive right of supplying electric current through the streets and roads of the town, to private houses, stores, etc., for terms of 5, 15, 20, 25, or 30 years respectively. There are approximately about 54 miles of streets in the town, as follows: main thoroughfare, 5 miles 1,196 yards; principal streets, 16 miles 1,433 yards; minor streets, 32 miles. The streets of the town are at present lighted by 380 gas lamps of reputed 16-c.p. The municipal buildings consist of town hall, municipal offices, morning market, feather market, wool market, and museum. The main streets are to be lighted by arc lamps, and the side streets and municipal buildings by incandescent lamps. Tenderers must state at what sum per annum they are prepared to adequately light the streets and municipal buildings for the various periods mentioned above, if they are granted a concession for any one of the periods referred to. The concession will provide, inter alia, that the particular system and plant to be adopted by the concessionaires shall be subject to the approval of Council; the charge for supplying current to private houses shall not exceed 1s. 9d. per London Board of Trade unit; and that the Council will have the option of taking over the whole undertaking, etc., at a valuation to be made in case of difference by two arbitrators or their umpire at the end of the period of the concession at the then value of the plant and mains. Tenders, endorsed "Port Elizabeth Electric Lighting," should be delivered to the agents of the Municipality, Messrs. Davis and Soper, 54, St. Mary-axe, London, E.C. (from whom further information may be obtained), on or before September 21.

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RESULTS OF TENDERS.

Blackpool.—Tenders were accepted to the total amount of £95,488 for the construction of the Alhambra Theatre of Varieties, for the Alhambra (Blackpool), Limited, designed by Messrs. Wylson and Long, London. The architect's estimate of building complete and furnished as set forth in prospectus was £100,000.

BUSINESS NOTES.

Buckie.—The Police Commissioners are considering the expediency of having the Buckie telephone area connected with the trunk wire at Banff.

Colchester.—The draft agreement as amended by the Treasury solicitor for lighting the new military hospital has been approved by the Town Council.

Maerdy.—The order for the supply and erection of plant and mains for the lighting of the town of Maerdy has been obtained by Messrs. Crompton and Co.

New Theatre.—Mr. W. G. R. Sprague, the architect of various suburban theatres, is designing a new theatre, to be erected near the Garrick, Charing Cross-road.

Auckland.—At a special meeting of the Council held on Monday evening it was decided that street lighting, for which tenders were accepted, should come into operation this week.

Award.—At the electrical and engineering exhibition recently held at Newcastle Messrs. Crompton and Co. were awarded a diploma for excellence of exhibit for electric cooking and heating apparatus.

Salford.—The Council intend to enlarge their electric lighting works. A proposal is before the Council to extend their borrowing powers so as to be able to spend £80,000 on electric plant, buildings, etc.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended August 29 amounted to £1,535, as compared with £1 300 in the corresponding week of the previous year, being an increase of £235.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended August 27 were £2,661. 3s. 5d., compared with £2,372. 10s. 3d for the corresponding period of last year, being an increase of £288. 13s. 2d.

St. Helens.—Colonel W. Langton Coke, M.I.C.E. an inspector of the Local Government Board, will hold an enquiry at St. Helens this week into the proposals of the Corporation to borrow £67,328 for various works, which include a sum of £17,000 for electric lighting plant.

Winchester Electric Lighting Works.—We understand that the contract for the electric lighting works for Winchester has been secured by Mr. J. Thomson, of Peterborough, who has still in hand the restoration of the cathedral. Mr. Thos. Stopher, of High-street, is the architect.

Wakefield.—The citizens of Wakefield were promised some time ago that the electric light would be supplied in August, but the promise has not been fulfilled. The reason assigned for the delay is that the men in the employ of Messrs. Fowler and Co , of Leeds, the contractors for the engines, are out on strike.

Watford.—The Watford Urban District Council, after considerable discussion, have resolved to call a public meeting to consider the question of lighting the town by electricity, according to a petition of the ratepayers presented to the Council The scheme involves the expenditure of about £25,000.

Chelmsford.—Messrs. Crompton and Co., Limited, have now completed the erection of their new works here, and as these are being equipped throughout with the most modern machinery and appliances, they will be enabled to manufacture electrical machinery and appliances both economically and quickly.

City and South London Railway.—The returns for the week ended August 29 were £838, compared with £835 for the corresponding period of last year, being an increase of £3. The total receipts for the half-year 1897 amounted to £8,152, compared with £8,233 for the corresponding period last year, being a decrease of £81.

The International Electric Company.—A splendidly got-up catalogue comes to us from this Company, whose address is 55, Redcross street, Barbican, E.C. It contains particulars of everything, practically, that is required in a central station, except the running machinery. Details are also given of a very large quantity of the ordinary fittings.

Leigh.—The Urban District Council have confirmed the minutes of the last meeting of the Highways Committee, at which it was resolved that in reply to a letter from Messrs. Marsh, Son, and Calvert the Council would object to any application made by their clients for an order of the Board of Trade enabling them to construct tramways within the Leigh urban district.

Personal.—Mr. H. W. Appleby, of Rosling and Appleby, electrical engineers, Bradford, York, was married on August 31 to Miss Hilda M Steavenson, daughter of Mr. A. L. Steavenson, of Holywell Hall, Durham. The men employed at the works commemorated the event by having an excursion to Blackpool, at which they presented Mr. Appleby with a spirit case.

Keighley.—The Town Council have adopted the proposal of the Gas Committee recommending that they be empowered to insert provisions in the Bill to be promoted in Parliament next session to enable the Council to supply electricity for lighting and other purposes, if that course be found practicable, and failing that, that a provisional order be applied for under the Electric Lighting Acts.

India.—Latest advices from India state that the apparatus for lighting the Arkonam Junction Station with electricity will shortly be received from England. The Madras Railway Company has submitted to the Government an estimate for Rs 6,200 to construct a power-house for the engines and other works. The cost of the whole project amounts to Rs.17,230, which the Government has sanctioned.

Derby.—The Lunatic Asylum Committee of the Derby Corporation have decided to light the asylum with electricity. The borough electrical engineer (Mr. J. E. Stewart) has prepared an estimate of the cost of wiring and fittings, which amounts to £750. The Council is recommended to grant this amount, and direct application to the Local Government Board for sanction to the borrowing thereof.

Church-Lighting.—Some time ago the Sheffield Electric Light Company, who already supply the current for the lighting of St. Barnabas, St. Matthew's, Upper Chapel, South-street Chapel, and are now wiring Nether Chapel, were instructed to supply the necessary fittings for the illumination of the parish church. This week the light was turned on for the first time. St. George's Church, Preston, was lighted up with electric light on Sunday evening last.

Messrs. Davey, Paxman, and Co.—We have received a catalogue of engines, boilers, and other machinery manufactured by this firm, which is established at Colchester. The catalogue is profusely illustrated, and full dimensions and details are given. It is easy to see that Messrs. Davey, Paxman, and Co. turn out a very extensive variety of work of a very good quality, and we should advise all electrical engineers to study this catalogue when they contemplate recommending machinery.

Wilful Damage to Electric Lamps.—At the Westminster Police Court on Tuesday George Holton, a labourer, was charged with wilfully breaking an electric lamp outside a shop in Oxford-street. The evidence of the police went to show that many complaints had been recently made as to damage done to outside lamps, and as a consequence special watch had been kept on the district. The accused, who pleaded that he must have been the worse for drink, was fined 10s. and costs beyond the damage.

Brush Electrical Engineering Company, Limited.—The directors of the Brush Electrical Engineering Company, Limited, have decided, after placing £5,000 to reserve fund, to recommend payment of the arrears of dividend to the preference shareholders for the year 1895 and a dividend at the rate of 4 per cent. per annum on the preference shares for the year ended June 30, 1897, leaving a sum of about £3,000 to be carried forward to next account The transfer books will be closed from September 1 to 18, 1897, inclusive.

Rotherham.—A special meeting of the Town Council has been held to consider the advisability of applying to the Board of Trade for a provisional order empowering the Council to supply electricity for lighting and other purposes within the district. The Mayor (Alderman G. Neill, J.P.) presided. There was a moderate attendance of members. The Mayor, in moving the necessary formal resolution, remarked that he believed the burgesses generally would approve of the step which was being taken. The resolution was adopted unanimously.

Wrexham.—At the quarterly meeting of the Town Council a communication was read from the Local Government Board stating that the Board must defer their decision upon the application of the Town Council for sanction to borrow £8,200 for the purchase of the Willow Brewery premises for electric light station, baths gymnasium, etc., until they were furnished with an approximate estimate for the cost of providing these various institutions. It was resolved to engage Messrs. Lockwood and Barker, architects, Wrexham and Chester, to prepare the estimate asked for.

Newcastle.—At its next monthly meeting the Town Council will debate the following motion: "That this Council hereby resolves that, after the expiry of the present tramway lease, or sooner, if so arranged by this Council, the tramway service shall be undertaken by the Municipality under the direction of a special committee to be elected by this Council, and the said committee shall employ a manager or managers Further, that for this purpose parliamentary powers be obtained, and that the New Tramway Committee are hereby instructed to frame their scheme upon these lines."

Electricity and Laundry Work.—The fifth annual laundry, engineering, and horseless carriage exhibition is being held this week at the Royal Agricultural Hall, Islington. Of course the greater part of the space is taken up by laundry machinery and requisites, but we noticed a strong tendency towards the use of electricity. Messrs. Matthews and Yates had a good supply of their patent fans and air propellers, which were also to be seen at the stand of Mr. L. Armanni, in conjunction with electric heating irons, lamps, kettles, etc. Considerable interest was taken in the Blackman system of ventilating, heating, and drying; and the Walsall Electrical Company, Limited, show one of their switchboards, a dynamo, etc. The Electrical Cab Company had several of their vehicles on show and hire, and the Daimler Company and other manufacturers had an extensive show of motors of all sorts.

Penzance.—The report of the Lighting Committee, presented and adopted at the last meeting of the Town Council, states that the town clerk was instructed to advise the committee when it would be necessary for the Council to give public notice by advertisement of intention to apply in the next session of Parliament for a provisional order authorising the supply of electricity within

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the district of the borough. It was pointed out that the committee had included the district in their report, and they hoped the Council would take some steps by which the town would take in the districts surrounding. They hoped they would then be in a position to supply them with electric light.

Devonport.—The Borough Council at its last meeting appointed their Electric Lighting Sub-Committee of the Streets Committee a standing committee to exercise the powers conferred by the Devonport electric lighting order. The Town Clerk explained that the order was confirmed in July, 1896, and would expire in July next. Before the latter date the Council was required to lay down electric light mains in Fore-street, Tavistock-street, and Market-street. If they failed in carrying out those terms by the time specified, the Board of Trade had the right to revoke the order, and confer the whole of the powers and privileges now vested in the Council on a private company.

Dublin.—The following letter has been received by the Lord Mayor of Dublin: "General Post Office, London, August 20, 1897. My Lord,—With reference to the memorial signed by your Lordship and numerous citizens and traders of the city of Dublin on the subject of the extension of the telephone trunk system to the South-East of Ireland, I am directed by the Postmaster-General to acquaint you, for the information of the memorialists, that the Lords Commissioners of the Treasury have now sanctioned the provision of a trunk circuit from Dublin to Waterford, passing through Wicklow, Arklow, and Wexford.—I am, my Lord, your Lordship's obedient servant, JOHN MARON. The Right Hon. the Lord Mayor of Dublin."

Broadstairs.—The ordinary fortnightly meeting of the Broadstairs and St. Peter's Urban District Council confirmed the minutes of a special meeting which had been called to consider the amended draft order of the Isle of Thanet Light (Electric) Railway Company referred to in our issue of the 20th ult., and at which it was resolved that the sanction of the Council be given to the draft order subject (1) to the suggested alterations to Section 44, Sub-section 3, 6, and 8; (2) to the agreement to deposit a sum of money at the Broadstairs Bank; and (3) to the insertion of a provision that railway No. 9 should be constructed either before or simultaneously with No. 8, and that the Council's solicitor be empowered to notify the company of the Council's sanction when satisfied that the terms have been complied with.

Motherwell.—The committee referred to in our last issue have now resolved to recommend to the Town Council that an installation of electric light be laid down for the purpose of illuminating the streets of the burgh, and as the committee form a majority of the Council and are unanimous, their recommendation will become the finding of the Board. As the provisional order obtained by the Commissioners lapses in nine months, and a private company proposed beginning business in the burgh, the present action was in a manner forced upon the Commissioners; but the question having been under consideration for over three years, the decision has not been come to without mature reflection. It is proposed at present to illuminate the central portion of the town, but no definite system has yet been adopted.

Wolverhampton.—A number of extensions are being made for private consumers, whilst new consumers have been added recently. The latest addition is the lighting up of the Royal Star Theatre by electricity. The Springfields Horticultural Society's Show was held last week, and a novel and successful feature was introduced in the lighting of the tents with the new illuminant. The electricity was generously supplied by Thomas Parker, Limited, electrical engineers, whose works are situated a very short distance from the show ground. The tents presented a charming appearance, and the light enabled late comers to view the beautiful exhibits. The field was also lighted, and followers of the terpsichorean art tripped it on the light fantastic until a late hour under the electric rays. The new innovation was greatly appreciated.

Morecambe.—A Board of Trade enquiry has been held by Sir Francis Marindin, K.C.M.G., R.E., with reference to the application of the Morecambe District Council for sanction to borrow £4,000 for the purpose of constructing a tramway from East View, Morecambe, to Bare White House, referred to in our issue of 13th ult. It is proposed to lay a single line with crossing places, and the length of the proposed new tramway is six furlongs five chains. The inspector suggested that if there was a prospect of using electricity as a motive power it would be wise to lay the rails in such a way that they would do for the purpose. The solicitor for the Morecambe Tramway Company remarked that the Board of Trade had refused to give the company power to use electricity, because their line went over a level railway crossing.

Edinburgh.—During the summer vacation Messrs. Bryden and Sons have been engaged in introducing wiring with a view to the use of the electric light in Parliament Hall and other portions of the Court of Session. The hall will be lighted by 48 32-c.p. lamps suspended at regular intervals from the ornaments of the oak vaulted roof. To enable this to be done, part of the ornamentation had to be cut away, and holes were bored through what was left. Considerable difficulty was experienced in carrying out this part of the work on account of the hardness of the wood. In the entrance hall there will be 12 lights of 32 c.p. each; in the divisions six lamps will be placed; each of the Outer House bars will be adequately lighted, as well as the Justiciary Court and new Court-room. It is expected that the work will be completed before the Court sits in October next.

Cardiff.—At the last meeting of the Cardiff Union Building Committee a report by Mr. Appelbee, electrical engineer to the Cardiff Corporation, on the cost of supplying the workhouse with electric light was read. In it the wiring was put at £750 and the annual cost of the light at £307, as against £351 for gas, or an increase (including interest on capital expenditure) of £82 per annum. Mr. E. Seward, the Board's architect, estimated other costs of the installation at £475 The chairman raised the question whether, if the Board dispensed with gas, the present heating arrangements of the blocks would be equal to providing comfortable quarters for the inmates, and on this the consideration of the question was deferred for a report on this point. Messrs. Crompton and Co., Limited, have opened a branch here. Mr. W. W. Hughes will act as manager of the branch, directly representing the company under control of the head office at Mansion House-buildings, London.

Messrs. Johnson and Phillips.—This firm have sent us their new price-list of cables. In compiling this list they have endeavoured to so arrange the various sizes of conductors, and types of insulation, that they may be easily followed and understood. They commence with bare copper wire, which, with the various qualities of insulating material, is manufactured into cable suitable for the numerous requirements of the trade, such as aerial, pure rubber, vulcanised rubber insulated, of 300, 600, 2,000, and 5,000 megohms per mile. The conductors are also arranged in order of sectional copper area, instead of the old-fashioned way of grouping all single, three, seven, nineteen, thirty-seven, etc., strands separately. Thus it is easily seen that for a short run a $^{37}/_{16}$ will answer the same purpose as a $^{19}/_{13}$, and save the contractor proportionately at the rate of £10 per mile. All cables are very carefully tested before being despatched from the stores, and also vulcanised cables are tested in water after 24 hours' immersion, and no coil passed unless the insulation is up to the standard. We learn that during the year the firm have largely increased their depôts for the supply of cable at London, Manchester, Glasgow, and Brussels.

Lewes.—The Finance Committee of the Town Council have recommended the Council to apply to the Board of Trade for a provisional order empowering the Corporation to supply electricity for illuminating and other purposes in the borough, and that the town clerk should give a month's notice to each member of the Council of a special meeting to be held to consider a motion on the subject to be given by the chairman of the committee. It was said during the debate that under the Electric Lighting Acts an order could be obtained by a private individual to supply electricity as a monopoly to an urban district, and Mr. Walker had given notice that he would apply for such an order in respect of Lewes. The committee thereupon took the matter into consideration, as they felt it was very desirable that this monopoly should not be in the hands of a private company. They considered that even if the Council did not carry out the lighting they should have the power to place it in the hands of a company, and make such agreements as they thought necessary under the order to lay down. This order to a private individual or company could not be given without the assent of the Urban Council, but if they withheld their consent and did not give a good reason for doing so, the Board of Trade had power to grant the order. The proceedings of the committee were confirmed *nem con.*

Glasgow Telephone Enquiry.—The *Glasgow Herald* says, in reference to Sheriff Jameson's enquiry, that Messrs. Wright, Johnston, Mackenzie, and Roxburgh, who have been instructed by a number of subscribers to attend the public enquiry by Sheriff Jameson regarding the telephone service, have issued a circular requesting information for their guidance in the conduct of the investigation. "As this enquiry," the circular says, "will in all probability settle the position of subscribers for many years to come, both as regards the sufficiency of the service and the charges made therefor, it is most essential that full particulars of the past experience of the subscribers as to the working of the telephones should be laid before the court." Among the queries to be answered in an accompanying schedule are the following: "Have you within the last three years made complaints to the Telephone Company in regard to the efficiency of the service? State the grounds of the complaints: (*a*) delay in giving connection; (*b*) indistinctness; (*c*) ringing off before conversation finished; (*d*) failure to get connection on the ground that other subscribers engaged. Have your complaints been attended to? Do you consider the annual charges reasonable? If the annual charges for the instruments were lower would you use more instruments than at present, and would such be beneficial to your business or convenience?" The enquiry will be opened on Monday, September 27, in the Burgh Court Hall.

Portsmouth.—The Electric Lighting Committee have succeeded in their efforts to obtain additional plant to meet the demands anticipated for the coming winter. The delivery of the new machinery ordered during the spring has been delayed on account of the strike, and additional plant being absolutely necessary, the loan of a dynamo was sought. The British Thomson Houston Company have offered to lend a dynamo to the Corporation for six months at the bare cost of removal and return and the renewal of worn parts. The total cost, in fact, is fixed at £100. Driving gear for this new machine is nearly ready, and the committee have accepted the offer. The output of the new machine will be sufficient for about 2 000 lights, which will just enable the committee to get through the winter with present customers, but will not justify them in taking on any more. The committee, after a careful review of the situation, and with a lively sense of past misfortunes through having insufficient plant, also unanimously resolved to ask the Council to sanction the borrowing of £40,000 for further works. The whole of this sum is not likely to be required for some time to come, but it was thought desirable to obtain the power to borrow that amount at one time instead of obtaining it piecemeal, especially as the sanction of the Council must in every

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case be obtained before the money can be expended. It is estimated that about £21,000 will be needed next year, the principal item of expenditure being for a new boiler-house, shaft, economiser, coal store, means of conveyance direct from the ship, and new mains for sea-water for condensing purposes. In 1899 it is thought that a new engine, costing about £9,000, will be required, and this will leave £10,000 for contingencies.

Liverpool. — The Liverpool Tramway Company practically ceased to exist on September 1, and now the municipalisation of the tramways becomes an accomplished fact. The Corporation take over the management into their own hands, but, in accordance with arrangement, the directors of the company will give assistance and advice until such time as the municipal body have a thorough grasp of the working of the system. Though the actual transfer of the management took place on Wednesday, in point of fact the undertaking became the property of the Corporation six months ago, under the Act of Parliament sanctioning the purchase of the system passed last session. Sir Arthur B. Forwood's formal letter of resignation, previously referred to by us, was submitted to the Tramways Committee of the Town Council, when it was stated that if the appointment of the engineer was left an open question Sir Arthur would have no objection to resume the chairmanship. After a warm discussion the committee's resolution, "That Mr. Pearson be not engaged," was now altered to "That Mr. Pearson be engaged in a consultative capacity, if so desired by the committee." Mr. Oulton thereupon gave notice that at the next meeting he would move that Mr. Granville Cunningham and Mr. H. Graham Harris be appointed. It was stated at the September monthly meeting of the City Council that the Lighting Committee had spent the whole of the money placed at their disposal this year, and they could not further recommend the extension of the incandescent lights into the busy streets of North Scotland Ward. The electric light had already been carried as far as the end of Burlington-street, and it would be continued to the North Haymarket.

Blackpool.—The borough electrical and tramway engineer (Mr. R. C. Quin) has submitted to the Council a report on the advisability of effecting the immediate substitution of the overhead trolley system of electric traction in place of the conduit system which is at present in operation on the Promenade tramway. The report states that during the year ending March last the centre channel of the present system cost no less than £2,438, this including a sum of £700 for loss of current through leakage, which has been estimated only after practical tests. The estimate of the cost of installing the overhead trolley system, together with other improvements considered necessary, is £9,400, of which £5,000 will be for the line itself, £3,550 for alterations to the cars, allowing £850 for contingencies. The estimate of the annual cost is: interest and sinking fund, £9,400 at 5¾ per cent, £540; maintenance and repairs of overhead line, £260; cleaning of rails, £200—total, £1,000. These figures mean an annual saving of nearly £1,500 as compared with the present cost of maintenance. In installing the overhead system, the existing electric lighting pillars on the Promenade would be used as far as practicable, while along South Beach, and in Lytham and Station roads, posts would be erected down the centre of the track. The General Purposes Committee held a meeting on September 1 at which this report was discussed. All the members of the Council were agreed that a change from the present system was necessary, as it was unreliable and costly. The only objections raised were that the breaking of the conductor overhead might result in injury to passers-by, and that the closeness of the posts supporting the conductors to the trams might result in some accident to life or limb. The objections were answered by the engineer, and a resolution in favour of his scheme was adopted.

Nelson.—An official trial has been made of the newly-installed system of electric bells at the fire station to the houses of the firemen. The men had all received instructions to be absent from the station, it being intended to make a practical trial of the bells. As a preliminary, the inspector (Alderman Gott) gave the alarm of fire by breaking the glass over the button at the door, thus ringing the bell at the fire superintendent's house, in the fire station, and in the police station. He then rang the men up by putting on the "all hands" key on the switchboard, and thus completing the circuit to their houses. Within the space of two minutes the men had put in an appearance at the station, and forthwith manned the tender and steamer. The performance was a practical demonstration of the superiority of the new system to the old. On a large switchboard erected in a small room in the fire station are 30 switches, each possessing four different contacts. A fireman is represented by each switch, while switches are also provided for the rate office, refuse destructor, Corporation yard, etc. The first contact is to call "all hands," and when all the switches are placed on these contacts and the switch at the bottom of the board is switched on, all the alarm bells will ring. The second contact is connected with the wall box, and by breaking the glass of the box a spring is released which sets the bells at the firemen's houses and at the workshops in motion. The third contact is really a dummy, and is used to turn off any fireman from the circuit who may not be available for service by reason of absence or illness. The fourth is used to call the firemen individually. At the bottom of the switchboard to the left is a galvanometer which indicates whether the circuits are complete and the bells ringing. There is also mounted on the board a large alarm bell which rings all the time the circuit is complete. The big bells in the tower at the station will now fall practically into disuse, and one advantage of this will be that in case of a fire the men will be able to get thoroughly to work before the crowd gathers, though in case of emergency the old alarm will be used.

Blackhall.—New electricity buildings are to be erected at Blackhall (Mr. Francis Teague, electrical engineer). The buildings will make provision for an engine-room 91ft. 6in. by 36ft., a boiler-house 45ft. by 64ft., rectifier-room 25ft. by 12ft., coal-bunkers, pump-room, workshop, stores, and offices. An octagonal chimney about 170ft. in height will be erected. The arrangement of the proposed buildings is such as to allow of considerable extensions to be made without sacrifice of convenience or economy in working. The generating machinery now on order will be sufficient to operate the equivalent of 10,000 8-c.p. lamps, and will also include a reserve set of plant capable of operating about 6,000 lamps. The engines will be vertical compound, fitted with jet condensers, the flywheel being situated between the high-pressure and the low-pressure cylinders. On the rim of the flywheel will be mounted the copper coils forming the armature of the alternator, and these coils will revolve between the pole-faces of powerful electromagnets carried on a cast-iron casing which will entirely surround the flywheel and armature. In all, three such steam alternators are on order, two having engines of 400 i.h.p. each, and one of 200 i.h.p. Steam will be provided by three water-tube boilers of the Babcock and Wilcox type. On a raised platform at the north end of the engine-room the main switch-gear, which is of Messrs. Ferranti's standard type, will be erected, and from this point each generator and feeder main will be controlled. The rectifier-room above referred to will contain the apparatus for operating the arc lamps for street-lighting, and the employment of rectifiers will enable the Corporation to secure all the advantages of a direct current for arc lighting without the necessity of employing a separate generator. The rectifier will consist of a transformer which will convert an alternating current at a fixed pressure into a constant current of variable pressure. The current from this transformer will pass through a commutator driven by an alternating-current motor running in synchronism with the flywheel alternator. By an arrangement of brushes in contact with the commutator a current is led into the street lamps in one direction, whereas the current supplied by the transformer to the commutator changes its direction of flow 50 times per second.

Leeds.—A special meeting of the Leeds County Council was held Wednesday, September 1, at the town hall, the Lord Mayor (Sir James Kitson, Bart., M.P.) presiding. The following resolution was adopted and referred to the Parliamentary Committee to enquire and report as early as possible: "That the Council, as the local authority under the Electric Lighting Acts, 1882 and 1888, and the Electric Lighting Orders Confirmation (No. 12) Act, 1891, give notice in writing forthwith, in pursuance of Section 59 of the last-mentioned Act, to the Yorkshire House to-House Electricity Company, Limited, being the undertakers within the meaning of the said Acts, requiring them to sell their undertaking to the Council." It appears that in 1883 the Council authorised an expenditure of £10,000 on experimenting in electric lighting at the town hall. About £12,500 was so expended. In 1890 the Electric Lighting Committee recommended that the Corporation should undertake the work of supplying the electric light to the town. In April, 1891, the Corporation consented to a provisional order being promoted by the Yorkshire House-to-House Electricity Company, and that order was ultimately confirmed. It was stated at the meeting that, according to the fifty-ninth section of the order, the Council might at any time within 42 years of the date of the order give notice to the company requiring them to sell the undertaking to the Corporation, the terms being that the Council must transfer to the company such an amount of Leeds Corporation stock as would produce, by interest or dividends thereon, an annuity of 5 per cent. on the sum properly expended on the undertaking and chargeable to capital account. Further, if the undertaking was purchased within 10 years of the date of the order (which was granted on July 3, 1891), it was stipulated that if the company had failed to make a dividend of 5 per cent. per annum on their capital outlay, the Corporation had to make up the aggregate dividend of 5 per cent. per annum; but if in any year they paid more than 5 per cent., the amount in excess was to go towards wiping off the deficiency of other years. The terms varied for the acquisition of the concern after the expiration of 21 and 31 years, but it was under the clause relating to 10 years that the Corporation would act if they now acquired the undertaking. In the prospectus of the Yorkshire House-to-House Electricity Company there was a provision that, in the event of a return of capital or distribution of assets, the surplus assets, after the return of the whole of the capital, were to be divided equally between the holders of the founders' shares and the holders of the ordinary shares. In the first instance, the charge made for the supply of energy was the maximum allowed in the provisional order—namely, 8d. per unit; in April, 1894, it was reduced to 7d., and in July, 1895, to 6d. During 1893 the capacity of the works was increased to 1,500 i.h.p.; in 1894, to 1,800; and in 1896, to 2,800. In December, 1893, the lamps connected were 10,647; in December, 1894, 19,858; in December, 1895, 32,559; and in December, 1896, 39,396. It might be urged that Section 59 of the provisional order provided that they should issue Leeds Corporation stock yielding an annuity of 5 per cent. upon the capital expended, and it might be asked how they were to issue such stock when their present issue was redeemable in 1927. That was a difficulty that might arise, and he mentioned it because he knew there was a dispute elsewhere upon a similar point. Leeds Corporation stock at 2½ per cent. was at present about at par, and they should probably have to hand over to the company stock which they could turn into stock yielding 5 per cent. on the amount they had expended, and this was not unreasonable, having regard to the risks the company ran when they entered upon the venture. Again, if they estimated the

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capital up to now as £150,000, it did not follow that they should have to pay to them stock for £300,000. The Corporation had relinquished its right, at the suggestion of the Local Government Board, to issue irredeemable stock, but not its right to issue 5 per cent. stock. They would thus issue £150,000 at 5 per cent. instead of £300,000 at 2½, which would be an advantage in some ways. The Highways Committee was instructed to lay tramrails in Meadow-lane, and bond them at the same time, so that they would be ready for the application of electric traction. The resolution of the Markets Committee to fix up an electric light installation for the lighting of the square and adjoining alleys at the Kirkgate Market, also the Wholesale Fish Market, at an estimated cost of £2,000, as reported in our last issue, was carried. It was stated, on the authority of Mr. Nichols, of the city engineer's office, that the new installation could be effected under more advantageous conditions than those under which the lighting could be let to the House-to-House Electricity Company, and that whereas the 2,000 c.p. that would be obtained would cost £375 per annum, an equivalent supply of gas would cost £2,000 a year.

PROVISIONAL PATENTS, 1897.

AUGUST 23.

19403. Improvements in electric traction. Edmund Wright, 6, Station-avenue, Hagley road, Birmingham.

19424. Electrical glow light. Walther Nernst, 28, Southampton-buildings, Chancery-lane, London.

19431. Improvements in or relating to electric lamps. Frederick George William James Adams, 111, Hatton-garden, London. (Complete specification.)

19445. Improvements relating to the distribution of electrical energy by means of polyphase currents and to induction coils or transformers therefor. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Guido Grassi and Domenico Civita, Italy.)

AUGUST 24.

19469. A steamer or vessel to be propelled either by steam or electricity to travel upon either land or water. George Cartmell, 44, Queen-street, Whitehaven.

19506. Improvements in arc electric lamps. David Loch and Andrew Dalziel, 73, St. Stephen's-road, Upton Park, London.

19518. Improvements in electric arc lamps. Thomas Spencer, 24, Southampton-buildings, Chancery-lane, London. (Complete specification.)

19530. An improved incandescent electric lamp. George Frederick Redfern, 4, South-street, Finsbury, London. (Ernst Ternström, France.)

19567. Improvements in or relating to converter chambers and their connections and to fuse and switch apparatus for use therewith. Gerald William Partridge, 46, Lincoln's-inn-fields, London.

AUGUST 25.

19572. Improvements in electricity meters. George Hookham, 18, Southampton-buildings, Chancery-lane, London.

19573. Improvements in apparatus employed in connection with electric tramcars. Arthur Sowden, Penny Bank-chambers, Halifax.

19614. Improvements in electric storage batteries or accumulators. Thomas Scott and Henry Hankins, 65, Chancery-lane, London.

19627. An improved system of "joint box" for covering electric light cables. Henry Bignell Hammond, 26, Garden-street, Westminster, London.

19629. Improvements in monophase or polyphase alternating-current motors. Paul Marie Joachim Boucherot, 45, Southampton-buildings, Chancery-lane, London.

19638. Improvements in and connected with electrical storage batteries and plates therefor. Rankin Kennedy, 11, Furnival-street, Holborn, London.

AUGUST 26.

19664. Improvements in and connected with the armatures of electric bells and other like apparatus. William Richard Colville Barrington, 23, Coleman-street, London.

19696. Improvements in electrical ploughs. Edmund Edwards, 65, Chancery-lane, London. (The firm of T. Gansel, Germany.)

19714. Improvements in and connected with electric traction. Emile Bede, 4, South-street, Finsbury, London.

19719. Improvement in methods of and means for electrical conversion and distribution. Benjamin Garver Lamme, 322, High Holborn, London. (Date applied for under Section 103 of Patents, etc., Act, 1883, January 28, 1897, being date of application in United States.)

AUGUST 27.

19730. Improvements in paper and air insulated cables, wires, or conductors used for conveying or conducting electricity. Walter Hepworth-Collins, 17, Nicholas-street, Manchester.

19732. Improved method whereby to facilitate the coupling of wires for conveying an electrical current on railway trains. George Rennie Powell, Rosebank, Ashley Down, Bristol.

19745. Improved electromagnetic picking mechanism for looms. Wallace Fairweather, 62, Vincent-street, Glasgow. (Franz Eugen Klein, Germany.) (Complete specification.)

19755. Improvements in the curving or bending of pipes or conduits made of paper or light material used for carrying electric wires, and which are enclosed in a metallic sheathing. Hugh Donald Fitzpatrick, 70, Wellington-street, Glasgow. (G. Brandt, Germany.) (Complete specification.)

19763. Improvements in or connected with the mouthpieces of telephones, speaking-tubes, or the like. John Edwin Holmes, 8, Quality-court, Chancery-lane, London.

19794. Improvements in electric arc lamps. William James Davy and George Thomas-Davies, 40, Chancery-lane, London.

19797. Method and apparatus for the electrical treatment of fibrous materials. Goldsbury Harden Pond, McGill Buildings, Washington, D.C., U.S.A. (Complete specification.)

AUGUST 28.

19808. An improvement in electric switches for stage use. William Henry Whitesides, Grand Theatre, Leeds.

19846. Improvements relating to the manufacture of plates for electric accumulators. Leopold Guelzow, 75, Chancery-lane, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1896.

21749. Active material for secondary battery plates. The Sussman Electric Miners' Lamp Company, Limited, and Rosenthal.

22146. Electric light and power circuits. Bowles.

29907. Electric storage batteries. Brault. (Amended.)

1897.

12827. Electric primary and secondary batteries. Jeanty. (Date applied for under International Convention, November 19, 1896.)

15495. Contact boxes for electric railways. Brown.

16069. Electric batteries. Pullen.

16073. Safety switch apparatus for systems of electrical distribution. Oxley.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	9½-9¾
Brush Company, Ordinary	3	1-1¼
—— Non. Cum., 6 per cent. Pref.	2	1¾-1¾
—— 4½ per cent. Debenture Stock	100	103-107 xd
—— 4½ per cent. 2nd Debenture Stock	100	94-98
Callender's Cable Company, Debentures	100	108-113
—— Ordinary	5	7-8
Central London Railway, Ordinary	10	9¾-10⅛
——	6	5¾-6¼
Charing Cross and Strand	5	12¼-13¼
Chelsea Electricity Company	5	9¾-10¼
—— 4½ per cent. Debentures	100	110-113
City of London, Ordinary	10	23¼-24¼
—— 6 per cent. Cumulative Pref.	10	17-18
—— 5 per cent. Debenture Stock	100	130-135
City and South London Railway, Consolidated Ordinary	100	66-68
—— 4 per cent. Debenture Stock	100	138-140
—— 5 per cent. Pref. Shares	10	15¼-15¾
County of London and Brush Provincial Co., Ordinary	10	12¾-13¼
—— 6 per cent. Cum. Pref.	10	15¼-15¾
—— 4½ per cent. 2nd Debenture Stock	10	15-15½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1½ 2
—— 5 per cent. Debentures	—	89-94
Edison and Swan United Ordinary	3	2¼-2¾
—— 5 per cent. Debentures	5	4-4⅛
Electric Construction, Limited	2	1¾-2
—— 7 per cent. Cumulative Pref.	2	2¾-3¼
Elmore's Copper Depositing	1	⅝-¾
Elmore's Wire Company	2	2-2¼
W. T. Henley's Telegraph Works, Ordinary	10	18¼-19½ xd
—— 7 per cent. Preference	10	18-19 xd
—— 4½ per cent. Debentures	100	109-114 xd
House-to-House Company, Ordinary	5	9-9½
—— 7 per cent. Preference	5	10¼-10¾
India Rubber and Gutta Percha Works	10	20½-21½
—— 4½ per cent. Debentures	100	105-108
Kensington and Knightsbridge Ordinary	5	13-13½
—— 6 per cent. Pref.	5	8½-8¾
London Electric Supply	5	1¾-2
Metropolitan Electric Supply	10	16-17
—— 4½ per cent. First Mortgage Debenture Stock	100	118-122
National Telephone, Ordinary	5	6¾-6⅞
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	15-17
—— 5 per cent. Non. Cum. Third Pref.	5	6-6½
—— 3½ per cent. Deb. Stock	100	105-110
Notting Hill Company	10	15-16
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8¼-8¾
—— £4½ shares	4½	7½-7¾
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	104-106
St. James's and Pall Mall, Ordinary	5	17-18
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	37-40
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	8	10¾-11¼
Westminster Electric Supply, Ordinary	5	14¼-15¼
Yorkshire House-to-House	5	8-8¼

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NOTES.

The German Telephones.—The telephone line between Budapest and Berlin has been formally opened.

Electrical Manufactories in Italy.—There are in Italy now 12 factories for the manufacture of dynamos and electric motors, of which seven are in Milan, two in Turin, one in Savigliano, one in Genoa, and one in Lecco.

The Turin Exhibition.—Electricity will play a somewhat important part in the Turin Exhibition, and large fountains, with a water area of about 1,800 square yards, are being constructed, which will be illuminated in the evenings by powerful electric lights.

A Guiding Star.—At the recent military tattoo witnessed by the German Emperor and Empress in front of the Royal castle at Würzburg the square was illuminated with magnesium torches, while the bandmaster's bâton was rendered conspicuous by means of electric light. The Emperor has always been fond of stage effects.

The City and Guilds of London Institute.—We have received a bulky volume from this institute entitled "Programme of Technological Examinations, including Regulations for the Registration and Inspection of Classes in Technology and Manual Training." The book requires more than a passing glance, and therefore we hope in a forthcoming issue to say more about it.

The Lighting of Railway Carriages.—In Switzerland the lighting of railway carriages by electricity makes rapid progress. It is calculated that at the end of the year 1896 there were 525 carriages in Switzerland lighted by electricity. Certain companies are changing the lighting of their carriages from the old to the new system, and the others make the alteration while the carriages are in construction.

The Third-Rail System.—The *Electrical Review* of New York publishes an account of an accident which happened at Newington, Ct. A young girl was crossing the track of the New York and New England Railroad when she fell in such a way that her body formed a connection between the electric rail and one of the others. She was rescued quickly, and, though severely burnt, was not killed.

A Fire-Pump Worked by Electricity.—The latest of Messrs. Merryweather's novelties in fire-extinguishing apparatus is a house electric fire-engine, which can be worked entirely by one person, who has only to connect wires to the nearest electric light switch and hold the hose to throw a powerful jet of water on to a fire. The cistern contains 20 to 30 gallons of water, is on wheels, and has pump, motor, and hose attached.

Reduction of Canadian Customs Dues.—The *Times* correspondent at Ottawa says that on Saturday evening last, September 4, the Customs authorities issued a circular to collectors that goods from nations having treaties with Great Britain containing a most-favoured-nation clause are entitled to reduction, whether imported direct, or *vid* Great Britain, or *vid* any one of such countries. This covers almost all imports except those from the United States.

The Paris 1900 Exhibition.—The *Journal Officiel* has published notice of an open competition, by order of the Minister of Commerce, Industry, and the Postal and Telegraph Department, for the concession of the electric railway mentioned in our last issue, for the conveyance of visitors into the precincts of the exhibition buildings on the left bank of the Seine. Persons who wish to obtain the concession must make known their intention before September 30, by writing to the offices of the exhibition.

Motor-Car Explosion.—A motor chaise driven by naphtha exploded in Ludgate-circus on Thursday, but fortunately not much damage was done. Evidently the lay public—that is to say, so far as it is represented by the daily newspapers—classes everything which relates to "motorcars" as appertaining to electricity, for we notice that one paper said this motor-chaise was owned by a firm of electrical engineers. Having seen electric cabs make their successful appearance on the London streets, we felt inclined to exclaim "How are the mighty fallen!" but we are glad to find it was an error on the part of the newspaper.

The Purification of Water by Electricity.—Mr. Jules Buse has contributed an article to *L'Etincelle Electrique*, in which he says that the purification and sterilisation of water by electricity is practicable and economical, and commercially probable. He bases his opinion on the experiments of M. Gaston Seguy in 1877 and 1883, and incidentally remarks that the first manufactory for the sterilisation of water by ozone is in construction at the park of Saint Maur. Several works of the kind exist, he says, in other countries, and in Holland they even make the water from the marshes pure and drinkable.

Death by Lightning.—A rather remarkable instance of the waywardness of lightning has been unearthed by the *Lancet*. It appears that a Major Jameson was walking in a field near Guildford when he was struck and killed by a flash of lightning, which tore his clothing into shreds and scattered them in a most singular manner. This flash of lightning was neither preceded nor followed by others in the neighbourhood—in fact, there was only one clap of thunder and one flash—and the man was absolutely clear of any shelter, such as trees. That the man happened to be in the way of the lightning was a coincidence, but that his clothes were rent in such a violent and extraordinary fashion was probably due to the fact that they were dry, and therefore bad conductors

The Application of Static Electricity to Therapeutics.—Mr. S. H. Mouell, in his important book, a "Manual of Static Electricity in X-Ray and Therapeutic Uses," draws attention to the advantages of the electrostatic machine for X-ray work. He claims, moreover, to have procured with a Holtz machine, and five minutes' exposure, results as good as could have been obtained in half an hour with coils. A machine with 12 36in. plates is the size which he finds best, and though his work was done with a Holtz machine (the type most used in the States), the Wimshurst machine is, he says, certainly as good, and probably is better for the purpose. With this machine there is a brilliant illumination of the phosphorescent screen far superior to the flickering light given by a coil, and time is saved in exposures of photographic plates.

Telegraphy Without Wires.—A large quantity of instruments, etc., weighing in all about two tons, has arrived at Dover in connection with some experiments in telegraphing without wire to take place there. Experiments are to be made from Fort Burgoyne to the north of Dover Castle and other parts of the surrounding country, which offers every facility for work of this character on account of the prominent positions it affords. One section of the experiments will be of a very important character. From the success which has attended the experiments elsewhere, it is believed the system can be successfully applied to lightships, and from the position at Dover the Goodwin light-vessels will be experimented with. It is understood that the experiments will be under the super-

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vision of Mr. W. H. Preece. The sending apparatus will be at Fort Burgoyne, and the receiving apparatus will be moved to different parts of the district.

African Telegraphs.—Dr. Jameson has left Salisbury by the Umtali route for Blantyre, in Nyassaland, in order to take over the management of the construction of the Trans-continental telegraph line. The line is intended to span the African Continent from south to north—from Capetown to Cairo; but at present it is not intended to carry it beyond Lake Tanganyika, Uganda being liable to Mahdist raids and the southern Soudan being in the Khalifa's possession. Dr. Jameson's present task is to restore telegraphic communication with Nyassaland through Portuguese East Africa. This will involve the partial replacement of the poles and wires in Mashonaland, a great quantity having been taken away during the late rebellion, the wire in many cases having furnished the enemy with a species of ammunition for their guns. The work of extension has been going on for two years under the direction of Major Forbes, who will now hand over his duties to Dr. Jameson.

An X-Ray Story.—We have not heard so much of wonderful new discoveries in the X-ray department lately, and therefore the following story circulated by Dalziel's agency ought to be received with special thanks: "Baltimore, Md., August 26.—A young physician of this city claims to have made a wonderful discovery in connection with the X-rays, which is that an ordinary photograph may be subjected to the Röntgen process and it will disclose the internal organs the same as would be the result were the actual body placed before the rays. A man residing far from a physician can, it is said, now send in his photograph, and from it the physician can develop each organ separately, and ascertain whether it is diseased or not." Very few newspapers have published this story in England, which shows a lack of appreciation of humour scarcely credible considering how humorous (unconsciously, perhaps) newspapers often are when tackling scientific matters.

The Length of Telephone Conversations.—In the towns of Würtemberg the telephone can be used for five minutes' conversation for the sum of 1¼d. so long as the conversation is confined to a particular town, but in case of a connection being desired with a town at a distance the charge is 3d. for 30 miles. The duration of conversation permissible remains the same in each case. This reduction of price is of quite recent date, but it is interesting at this juncture in view of the agitation in England for a longer period of conversation. At the same time, it must be borne in mind that in Würtemberg an annual subscriber is only allowed so many calls, and all above that number he has to pay for at the common rate, whereas in England the annual subscriber can "ring up" as many times as he pleases. Further than this, the annual rates for private and exchange wires on the English Post Office telephone system are to be reduced from the beginning of next month.

The Geneva Electric Tramways.—The Saconnex-Champel line was completely established, in the first place, in 1894, and the Compagnie des Tramways Suisses adopted electric traction for that new line as an experiment in view of the utilisation of the same mode of traction for the lines previously worked by animal and steam power. After a year of regular working, which has proved the advantages of electricity, the company decided to introduce it in a general manner for the whole of the lines between Carouge and Moillesulaz on the French frontier. The transformation commenced on May 1 of last year. The motive power is supplied by the Manufacturing Company, of the town of Geneva. The turbines drive a Thury compound dynamo of 150 kw., 550 volts, with 365 revolutions. The old cars carry 34 passengers and weigh about 4½ tons, while the new cars carry 40 passengers and the weight is nearly 6 tons. Each car is driven by two four-pole motors. These motors use a current of 50 amperes at 500 volts, but are as yet only worked at about 20 h.p. or 25 h.p.

The Merchandise Marks Act.—The report of the Select Committee appointed to enquire into the effects and operations of the Merchandise Marks Act, 1887, has just been published as a parliamentary paper. The committee are satisfied that the operation of the Act has been, on the whole, beneficial, and there is abundant evidence that it has to a great extent stopped the fraudulent practices against which it was directed. The establishment and observance of higher standards of honesty, the report says, has tended to inspire confidence in the accuracy of marks placed upon British goods, and to enlarge to that extent and give stability to the trade of British merchants and manufacturers. Notwithstanding, therefore, that the competition of improperly-marked foreign goods is still in some cases injurious, and the Merchandise Marks legislation has made little progress outside the United Kingdom, India, and the British Colonies, the balance of the evidence is in favour of retaining the greater portion of the Act. The committee recommend that goods in transit shall be exempted from the operation of the Act, and also some alterations in the regulations of the Customs authorities.

Internal Resistance of Galvanic Cells.—Mr. Ernst Haagn has written an article, an abstract of which is published in the *Journal* of the Chemical Society, describing a method for the determination of the internal resistance of cells which is fundamentally similar to the Wheatstone bridge method for the comparison of the capacities of condensers, the known ratio of the capacities giving the ratio of the resistances. The availability of the method for various classes of cells is first proved by comparison of the results obtained with those obtained by other methods. The experiments afterwards show that the internal resistance of cells during electrolysis is quite independent of the current strength or current density. The slight variations which were found to occur are traceable to alterations in the concentration of the solutions. In the case of accumulators, during discharge the resistance at first slowly increases, the rate of increase being more rapid towards the end; whilst during the charging of the cell the reverse changes occur, the resistance at first diminishing rapidly and afterwards more slowly. The cause of this variation is partly the change in concentration in the sulphuric acid, and partly alteration in the surface of the lead plates.

The Brighten Seashore Railway.—The Brighton and Rottingdean Seashore Electric Railway is, we are told, gaining the confidence and patronage of the public, and is working very satisfactorily considering the enormous obstacles to be overcome. In addition to the regular trips from terminus to terminus, Mr. Volk has inaugurated a system of short trips half way out and back again, a total distance of about three miles, the idea being to always have a car in sight so as to sustain interest and curiosity. All the damage sustained during the memorable gale of last December has been made good, and the line is worked with, comparatively speaking, no hitches. The speed is at present rather slow, owing to the incapacity of the engine, which was designed for 110 b.h.p. and only gives out about 49½ h.p. Everything is, of course, in more or less an experimental stage at present, and it is impossible to give an accurate idea as to the cost of working, output, etc. Improvements in minor details can only be found out by

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practical experience in a pioneer movement like this. We understand that Mr. Volk contemplates putting in a bank of accumulators shortly, and is also considering the advisability of obtaining a portion of his current from the Corporation electricity mains.

"Made in ——."—The Industrial Association of Lower Austria has now submitted to the Ministry of Commerce its views on the Bill drafted by that department providing for the obligatory declaration of origin of all articles of manufacture. One of the objections raised to the Government scheme is not unfamiliar. The association says it is customary for the manufacturers in certain specified industries to put the name and address of the retail dealer on their goods. If this were prevented by the new Act, the retail trader would be greatly prejudiced, as he would be obliged either to sell his wares without the name of a manufacturer, in which case purchasers would have less confidence in their quality, or to reveal his source of supply to his competitors and the public. Besides, in Czech, and still more in numerous Hungarian districts, there is a strong aversion to buying articles that are not marked in the language of that nationality. The Government measure would therefore afford Hungarian industry a particularly effective protection against the importation of Austrian goods if the latter could no longer bear the name and address of the Hungarian dealer. The Industrial Association accordingly desires to see this paragraph altered in such a manner as to restrict it to unfair competition, and urges that the Bill should not become law before a similar measure is passed in Hungary.

The Newcastle Tramways.—Once again, after an interval of more than 12 months, the question of the tramways is being revived in Newcastle. The subject was first introduced over five years ago, in view of the termination of the present lease, which will take place in about two years' time. Great objection on the score of humane treatment has been taken to the working of the trams by horses, and at one time it was decided that a system of cable traction should be laid down at a cost of £10,000 per mile, or a total of about £128,000. There were endless discussions on the matter, and opinion was pretty equally divided, but the provisional order was obtained from the Board of Trade. Then it came to the presenting of the actual scheme, and at the last minute someone suggested electricity as a tractive power. After further discussions, the inclusion of electricity was decided upon, and then the ratepayers were asked for their opinion of and sanction to the Bill. The result was disastrous to the Bill, for the ratepayers almost unanimously rejected it. So matters ended in the early part of last year. Another committee has now been appointed (grimly called "the *New* Tramway Committee) to prepare a scheme and to consult tramway experts; and considering the latest developments of electric traction in this country, we shall be very much surprised indeed if a system of electric traction is not established in Newcastle before very long.

The Study of Electricity.—It is interesting to note the readiness with which all our large colleges meet the demand for instruction in matters pertaining to electricity and allied studies, and a few particulars will be useful. The University College, Liverpool, session commences October 4, and an entrance examination for intending students in their sixteenth year will be held on October 1 and 2. The University of St. Andrews formally opens on October 5, and the winter session of the United College will begin on October 6, and of St. Mary's College on October 26. The twenty-seventh session of the Durham College of Science begins September 27. The entrance examinations to both colleges of the City and Guilds of London Institute are held in September, and the sessions commence in October. The session of the Glasgow and West of Scotland Technical College commences on October 4, and the entrance examination begins on September 28. The University of Glasgow session commences on October 14, and the session of the Hartley College, Southampton, on September 28. The Davy-Faraday Research Laboratory of the Royal Institution begins the next term on October 4. A combined examination for natural science scholarships and exhibitions will be held by Balliol College, Christ Church, and Trinity College, Oxford, beginning on November 16. The next session of the Mason College, Birmingham, commences on September 30.

Additional Lighthouses for the Red Sea.—In regard to the question of the Red Sea lights, energetic steps have been taken by the principal public bodies in India. The committee of the Bengal Chamber of Commerce, in addition to making representation to the Government of Bengal, with the request that it might be forwarded to the Secretary of State through the Government of India, addressed letters to the Chambers of Commerce at Bombay, Madras, Rangoon, Kurrachee, and Colombo asking for support. The committee also addressed the Calcutta Marine Insurance Agents' Association, who asked for the co-operation of the Institute of London Underwriters, the Liverpool Underwriters' Association, and the Underwriters' Association at Bombay. The committee of the Chamber at the same time addressed letters to the London Chamber of Commerce and the Chamber of Shipping of the United Kingdom, pointing out in detail the principal dangers which rendered the navigation of the southern portion of the Red Sea hazardous, and asking for support. The matter has been taken up warmly by the Chambers of Commerce at Bombay, Madras, and Kurrachee. The committee of the Chamber of Commerce at Colombo also has stated that it cordially approved of the proposal, and would give it all the support in its power. On learning that the steamship and insurance companies desired an increase of lighthouses, and are willing to pay the necessary extra dues, the committees of the Bombay and Madras Chambers have both addressed letters to their respective Governments.

The Heilmann Locomotive.—It seems that the efforts of the French Western Railway Company to construct a really practical electric locomotive have at last been crowned with success. A perfected Heilmann machine has been produced, which is far superior to the steam locomotive from every point of view. Next spring travellers from Paris to Granville, Laval, or Angers will make the journey in three hours without a stop Machine No 8,001 is driven by two Gramme generating dynamos of 1,600 amperes, each worked by a steam-engine. A curious apparatus operates directly on the axles, giving them an energetic twist. The dynamos are placed in a large cabin at the front of the engine, which ends in a beak, intended to diminish the resistance of the atmosphere when the train is running at high speed. The engineer occupies the cabin, wherein are levers controlling all the apparatus of the train. One of the chief problems to be solved was how to get rid of the trepidation, which in the case of a locomotive weighing 120 tons would have rendered the metals unsafe. No. 8,001 can start a train weighing 450 tons without the slightest jerk, and on St. Cloud Hill, after a stop, it restarted quickly and easily though only using a sixth part of its power (950 amperes instead of 6,000). Regular speeds of 110 or 120 kilometres are assured with such machines as this new one. Its power in ordinary working circumstances is 1,600 h.p. We cannot vouch for the strict accuracy of these facts,

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which do not come through a technical source, but we reproduce them on the authority of the *Morning Post*, a paper usually well informed on such matters.

Plans for Telegraphic Communication with the Klondike.—The Canadian Government have submitted formal proposals to the Government of the United States to establish communication with the Klondike region in Alaska by the construction of a telegraph line from the head of winter navigation on the Lynn Canal, in the centre of the Klondike district. The proposals have been approved by the British Principal Secretary of State for Foreign Affairs, and were forwarded by the Governor-General of Canada, through the British Embassy, to Washington, where they are now in possession of the Interior Department. According to the *Western Electrician*, the proposals, while reserving the right of either country pending the settlement of the international boundary line between the United States and Canada south of Mount St. Elias, urge the expediency of establishing a permanent route, giving access to the interior at all seasons of the year. The most feasible route, in the judgment of the Canadian authorities, would be to start from the head of winter navigation on the Lynn Canal (the body of water running from near Juneau up beyond Dyea and Chilkoot, forming part of the present overland route), crossing the mountains by White Pass or any other pass which may seem more accessible, and proceed northward to Fort Selkirk, thence to Klondike. The Canadian Government asserts its readiness to undertake to open communication by constructing a telegraph line from the head of winter navigation on the Lynn Canal, traversing a distance of 80 miles across the summit of the mountain range, where a trail can be followed to Fort Selkirk and Klondike.

An Electric Tramway for the Lake District.—From time to time we have heard rumours of a scheme to construct an electric tramway from Windermere to the village of Grasmere, and there is no doubt that such a tramway would be of immense service in relieving the congested highway traffic in the tourist season. While believing that the scheme would be a financial success, one must take into consideration the fact that to many people a great attraction is found in the coach drives from place to place, and therefore it is not likely that this system of locomotion will be very seriously disturbed by a tramway. Details of the scheme are, of course, scarce, but the *Railway World* says that the line would start from the Waterhead Pier at Windermere, near to the north end of Waterhead Green, and, skirting Lake Windermere, proceed in a direct line across Borrans Field (site of a Roman encampment). It would twice cross the River Rothay and once the River Stock, and continue to Rydal Lake, where, following its west bank, the tramway would reach its head. Again crossing the Rothay it would lead to the south end of Grasmere Lake, and proceed thence up its eastern side to the Prince of Wales Hotel, where the terminal station would be erected on adjoining land. The proposed route is nearly level throughout, and would not interfere with the scenic beauty of the district. An outcry is bound to be raised by someone or other against the introduction of mechanical means of locomotion in such rustic and grand scenery, but it is marvellous how quickly such opposition ceases. In the Alps there are all kinds of railways and tramways in the mountains, traversing far more magnificent scenery than any to be found in the United Kingdom, but they do not spoil the scenery. A railway line is but as a thread in a piece of cloth, and one looks at the whole mass, and not at individual rocks, before forming an opinion as to the beauty of the scenery.

The Output of the Heart.—A paper on the above subject, by G. N. Stewart, read before the British Association, shows a new and reliable method of measuring the quantity of blood circulated by the heart. It is another example of the advantage one branch of science can be to another. A solution of a substance, which can be easily recognised and quantitatively estimated in the blood, say a 1·5 or 2 per cent. solution of sodium chloride, is allowed to flow for a measured time, not greater than the circulation time, usually about 10 to 15 seconds, into the heart. The solution is delivered from a burette connected either with a catheter passed through the jugular vein down nearly to the right auricle, or into the auricle, or with a glass tube inserted through the carotid artery into the left ventricle. In the latter case, a valve in the course of the connecting tube prevents any back flow of blood. Both femoral arteries, or sometimes both brachials, are exposed. A collecting cannula is inserted into a branch of one of the arteries, and the other is laid on two hook-shaped platinum electrodes connected with the Wheatstone's bridge, in which a telephone is inserted in the usual way. Weak induction shocks from the secondary of a du Bois coil are sent through the arrangement, including the piece of artery on the electrodes, and the bridge is balanced. When the mixture of blood and salt solution reaches the electrodes the balance is upset, and the telephone announces the moment of arrival of the mixture. A sample of blood is now drawn off by means of the collecting cannula, during the passage of the salt solution, and immediately defibrinated. Then it can be determined at leisure how much of the salt solution must be added to a sample collected before the injection to make its resistance equal to that of the sample collected during the passage of the mixture. Numerous observations can be made in this way on one animal; and from these data the output of the heart for the period of injection, and, therefore, the pulse-rate being known, for a single beat, can be calculated. The author then details the results he obtained with this method. In general, he concludes that these experiments show that the more recent measurements of Tigerstedt and Stolnikow are too low, while the older numbers of Volkmann and Vierordt are too high.

Picketing.—Mr. W. J. Shaxby has just brought out a book which is well worth reading. It is called "The Case Against Picketing," and is published from 17, Johnson's-court, Fleet-street, E.C. Mr. Shaxby has gone deeply into his subject, and states his case in a lucid and succinct manner. He first of all argues why picketing should be made illegal; then he suggests how to deprive it of its "power and sting," and he enforces his arguments by a critical examination of "the collected wisdom of Royal Commissions," by stating the law and practice in the Colonies and abroad, and by setting forth the present legal position in England. Mr. Shaxby certainly has very strong grounds for his case. The Conspiracy Act says that "attending at or near the house or place where the person resides, or works, or carries on business, or happens to be, the approach to such house or place, in order merely to obtain or communicate information, shall not be deemed a watching or besetting within the meaning of this section" (Section 7). Steps should be taken to give effect to the meaning of Section 7 of the Conspiracy Act by making it a penal or even a criminal offence to attempt in any way to intimidate workmen against carrying on or continuing any work which they may wish to undertake. It is a well-known fact that serious intimidation has taken place, even to the employment of brute force, and until this injustice has been removed it is impossible that differences of opinion

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between masters and men can be approached from a reasonable standpoint. Picketing as at present carried on is an unjust weapon most unjustly used. It has no relieving feature about it. A certain number of men say "We will strike," and that in these days infers by past experience that "We will use all the means in our power to make everyone else strike." The masters have just as much moral right to say, "We will not let you strike, and we will use all the means in our power to prevent anyone else striking." We notice that various trade organisations are seriously considering the question with a view to obtaining an amendment to the Act of 1875, and we hope that their efforts will be so successful as to define clearly the legal limits of picketing, and what is legally to be understood by such terms as "intimidation," "persistently follows," and "besets." It will not be an easy matter to settle, but the time has come when it must be settled.

British Capital and Russian Industries.—The British Consul at Kieff in his last report has some interesting observations on the absence of British capital in the many developments of Russian enterprise. He says that the metallurgical industry of Southern Russia may be said to be entirely in the hands of French and Belgian capitalists. Of the foreign companies registered in Russia 21 are French, with a capital of £5,600,000; 26 Belgian, with a capital of £4,000,000; 8 German, with a capital of £2,840,000; while Great Britain is represented by three companies with £757,220 of capital. Nearly all this foreign capital is invested in coalmines, ironworks, locomotive and railway wagon shops, tramways, etc. The major portion of these undertakings have been commenced within the last half-dozen years, "and when one hears of large ironworks paying dividends ranging from 80 to 40 per cent.; that £25 shares of these ironworks are worth £300, owing to the building of the Siberian railway; that they have Government orders in hand for the next 10 years at prices ensuring the same good dividends, one feel inclined to assume that for the average Briton with capital to invest Russia is a land beyond the pale of civilisation, instead of being from 60 to 72 hours' journey from London. It is no secret that the present Minister of Finance is most desirous to draw foreign capital into Russia, and it seems somewhat singular that the capitalists of Great Britain are practically unknown in the land." The metallurgical industry of Russia has, the Consul observes, more than ample room for further extension, and it will be many years before there will be any necessity for syndicates to control or regulate it. The Government sanction was given the other day to a French company with a capital of 1,000,000f., formed to build and exploit the electric tramway just commenced in the town of Ekaterinoslaw. "There is little good to be got by complaining of the falling-off in our exports into Russia, seeing it is out of our power to compete against the existing high tariff; but there is sure to be a good return to those manufacturers who find their markets gradually diminishing, and who are prepared to start works in this country, as well as to the capitalist who is prepared to invest his money in the industries so rapidly developing in Russia." The other British consular officers in the Odessa district mention the same matter, and the Vice-Consul at Nikolaieff, after mentioning one Russian estate on which iron ore and kaolin have been discovered, offers to give any information in his power on the subject to British firms in the engineering, mining, or porcelain-making industries He explains that Russian capitalists do not invest their money in this way, for money is scarce in Russia, and Russians can get good interest for it without incurring risks or taking any trouble. They buy Government stock or land bank loan tickets, or lend money on mortgage at 8 per cent. without risk.

The Engineering Strike.—The Amalgamated Society of Engineers have, it is stated, approached the Electrical Engineers' Union with a view to getting them to withdraw their members from the employment of the electrical engineering firms who are resisting the demand for a 48 hours' week. It is understood that the union have decided not to withdraw any of their men, nor to make any levies, on the grounds that they have no sympathy with the movement, and that the Amalgamated Society of Engineers did not consult them when the movement was begun. The Engineering Employers' Federation on Saturday issued the following statement as to the claims of the A.S.E. that upwards of 200 firms in London had conceded the eight hours' day: "As Mr. John Burns and others protest that the eight hours' battle is 'practically won' in London by the A.S.E., and as further 'great concessions' are being constantly advertised, a little light upon the subject may be appreciated. It is claimed by the A.S.E. that upwards of 200 firms in the London district have conceded the eight hours' day since the agitation began. An analysis of 200 names of firms published gives the following results. Particulars: Not in existence, one firm; unknown, not in directories, 13; in financial difficulties, five; entered twice under different names, four; Government shops entered three times, three; small jobbing concerns working solely for the larger firms, 51; Trinity House (!), one. Not in the engineering trade—Battersea Vestry (!), one; brewers, four; distillers, two; contractors, one; newspapers (!), four; Army and Navy stores, one; Co-operative stores, one; miscellaneous, 14. Makers of specialities—Fire-engines, two; motors, two; electric workers, two; cycles (one with six men), two; gas-engines, two; ammunition, four; brassfounding, one; patternmakers (one with three men, four; working eight hours before agitation began, four; deny having granted eight hours, two; conceded under pressure of work, or compulsion, and waiting only opportunity to revert to nine hours, nine; total, 140. (The largest firms said to have conceded are the two makers of fire-engines. One of them has conceded *pro tem.* on condition that the old system be restored if the men do not win. The other has granted an advance in wages in lieu of the reduction in hours.) This disposes of 140 out of the 'glorious total.' Of the remainder the analysis is not yet complete, but the following notes are illustrative and instructive of how the list is made up: (*a*) An 'engineering firm,' the full establishment of which consists of a father and two sons, they have mutually agreed to concede the eight-hour day to each other. A happy family arrangement. (*b*) A concern which takes out its dividend in philanthropy. Magnificent, but not business. (*c*) A carpet depôt, which knows nothing about either engineers or eight hours. (*d*) A small foundry employing three or four men has not granted the eight-hour day. (*e*) A model baker employing three men. (*f*) A concern employing only piecework men on outdoor work; never did more than 50½ hours. (*g*) A large American concern, with a branch in London, to which it was intended to transfer the most of the business, under pressure (the hands being all union men) conceded the eight-hour day, but now doing as much as possible of their work in America. This is a case of British trade unionism destroying British industry. (*h*) A concern which granted the eight hours because too busy to resist the demand, but working overtime ever since. These are typical cases selected at random." We do not think it necessary to add any remarks of our own to this comprehensive statement.

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ELECTRICITY AT THE BRITISH ASSOCIATION.

BY OUR SPECIAL CORRESPONDENT.

The recent meeting of the association at Toronto has given an excellent opportunity for the assembling together of scientific workers on two continents, and the reputation of Prof. Forsyth has no doubt induced many mathematicians to attend the sittings of Section A. Electricity has, however, taken a less important place than usual among the subjects of the papers read. One department of the section was devoted at Tuesday's sitting entirely to electrical papers, and several of these were carried over until Wednesday.

Undoubtedly the most important communication on electricity was the report of the Electrical Standards Committee, in which it was stated that the committee are about to undertake the experiments necessary to determine a standard unit of current, and so complete the specification of the three fundamental units of electric measurement. The work will, we understand, be carried out by Profs. Ayrton and J. V. Jones.

Three types of alternate-current curve-tracer were exhibited and described to the section. In the first of these, an ingenious device by Prof. Braun, of Strassburg, a kathode ray is used, which is deflected to and fro in a magnetic field produced by the alternating current. The ray registers its own motion on a photographic plate, and is absolutely dead-beat, following every fluctuation of the magnetic field. In the second instrument, that of Prof. Rosa, the potential at a given point is measured by the potentiometer method. The given point is connected to the potentiometer by an ebonite disc revolving on the dynamo shaft, and carrying a metal plate which makes contact with a brush on the rim of the disc at the same phase in each revolution. The length of potentiometer wire necessary for a balance is registered automatically on a revolving drum, and the brush can be moved along the rim of the disc synchronously with the revolution of this drum, the two being actuated by electromagnets excited by the same current. In Mr. Duddell's form of oscillagraph, two parallel phosphor-bronze strips are stretched in a constant magnetic field, and traversed in opposite directions by the alternating current. They are attached to opposite ends of the diameter of a mirror, which they consequently twist, and this rotation is registered by photographing on a revolving drum a beam of light reflected from the mirror. To obtain as much damping as possible, the whole instrument is immersed in oil.

A new Lorenz apparatus for the determination of the ohm has been recently constructed for the McGill University, Montreal, and preliminary tests were made with it by Profs. Ayrton and J. V. Jones, the results of which confirm the accepted value of the ohm. Prof. Jones made a communication on the calculation of the coefficient of mutual induction between a circle and a coaxial helix, and Prof. Greenhill discussed some of the elliptic integrals involved in the calculation.

Two important papers on the electric arc were presented by Mrs. Ayrton and Prof. Crew and Mr. Basquin. The first of these, read by Prof. Ayrton, dealt with the relations between arc curves and crater ratios with cored positive carbons of different diameters, and many valuable numerical results, diagrams, and details were given in the paper, which will doubtless be printed shortly *in extenso*. The paper of Prof. Crew and Mr. Basquin treats of the source of luminosity in the electric arc. To investigate this the authors used the arc formed between a solid fixed iron rod and a revolving iron disc, and in order to separate the effect of the electric current itself from chemical and other phenomena which might persist after breaking the current, it was necessary to examine the arc when no electricity was passing across it. This was accomplished by using a high-speed 100-volt alternator to feed the arc and mounting a circular metal screen pierced with radial slits so that it rotated synchronously with the dynamo. In this manner, on looking through the slits at the arc, the latter was only viewed during the passage of the current in, say, the negative direction. By a suitable switch it was arranged that the current should be cut out just as it passed through the zero value from positive to negative, and the circuit was closed again at the corresponding point of passage from negative to positive. As the current was zero at these instants there was no trouble from self-induction. The appearance of the arc presents an intense cloud of yellow light, persisting some time, and a much fainter and rapidly evanescent blue flame. The distribution of intensity of lines in the spectra of these two parts is quite different, that of the yellow cloud being very unlike the ordinary arc spectrum of iron.

In his paper on the constitution of the electric spark Prof. Schuster presented an account of experiments to determine the velocity with which metallic particles are shot out from the terminals during the passage of an electric spark, and the part played by them in the discharge. He found by photographing on a rapidly revolving plate the spectrum of the spark between two metallic terminals in air, that the air becomes luminous instantly, and the luminosity lasts only for an extremely short time. The metal particles, on the other hand, leave the terminals with a velocity amounting sometimes to 2,000 metres per second, and on arriving at the middle of the spark-gap remain luminous for some time. It is evident that the projection of the particles and their luminosity are phenomena distinct from the discharge proper, which takes place through the air. A paper by Mr. T. W. Edmondson on the disruptive discharge in air and dielectric liquids was read by Prof. Webster. In the case of air, the potential, V, necessary for disruptive discharge between two spheres of 3cm. diameter at a distance, d, apart, was measured by an absolute electrometer, and it was found that the formula $V^2 = a\,d + b\,d^2$ was applicable, a and b being constants. The values of a and b vary with the size of the sphere. In the case of oil direct measurement of potential was impossible, because of the violent motions and convection currents set up in the oil. A spark-gap in air was therefore used as a standard of potential. Castor oil and kerosene were found to be among the strongest dielectric liquids, and the results are in general agreement with those of Macfarlane. The dielectric strength of air comes out 28·5 to 36·0 kilovolts per centimetre, varying according to the size of the sphere used, and is higher than Macfarlane's value. Some experiments with alternating currents verify Jaumann's contention that the potential required to produce any spark is less the more rapidly the potential is changed. It may be noticed in passing that some results obtained by Prof. Trowbridge, of Harvard University, relating to the resistance of vacuum tubes to condenser discharges of high frequency, confirm this result. The resistance of a tube which is apparently a megohm or more to constant currents is only five or six ohms to the condenser discharges; in other words, the dielectric is broken down easily by these violent vibrations.

Some new forms of gas batteries were described by Mr. Willard E. Case, in which one terminal is a carbon rod or tube, and the other a carbon tube with gases passed into it. The E.M.F. depends on the gas used, and in most cases the polarisation is somewhat large. Among the gases used were hydrogen, marsh gas, and carbon monoxide.

Prof. Callendar and Mr. Barnes have been studying the Clark cell, the chief drawback to the use of which is the slowness with which its E.M.F. changes when its temperature is altered. They have devised a form of cell which, although only a slight modification of the ordinary pattern, is free from these objections. Working in quite another direction, three students of the Central Institution—Messrs. Spiers, Twyman, and Waters—have found that the H type of cell shows very small lag when subjected to cyclical changes of temperature. H-cells were taken and their temperature altered by equal stages, first increasing, then decreasing, and it was found that the final E.M.F. was nearly equal to the initial one, while the curve of E.M.F. with decreasing temperatures was nearly coincident with that for rising temperatures. The result seems to point to the superiority of this type of cell. In the discussion which followed, Prof. Carhart described a cell of the straight form which he found exceedingly satisfactory, in which the zinc electrode was a perforated disc with crystals of zinc sulphate above it and sulphate paste between the other electrode and itself.

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Prof. Webster stated that cadmium cells are just as easily manipulated and as reliable in their E.M.F. as zinc cells, and they change their E.M.F. less than the latter with alterations of temperature. It is probable that in course of time cadmium will replace zinc as a negative electrode for these standard cells.

Three papers of interest on galvanometry were sent by Prof. Ayrton and Mr. Mather, and read by the former. In the first paper the subject of shunts for ballistic galvanometers was treated. The difficulty of applying a shunt to a galvanometer of the d'Arsonval type is that its damping coefficient changes with the resistance of the circuit. Some plan must, therefore, be devised for keeping the total resistance constant. In condenser work this is easily accomplished by shunting the galvanometer with a constant resistance, and connecting the condenser terminals to two points on this resistance. The authors find that for induction work, such as using an exploring coil to measure a magnetic field, the conditions are satisfied if resistances are inserted to make a constant current shunt to the exploring coil. If r be the resistance of this coil, p a resistance in parallel with it, and s a resistance in series with these and the galvanometer, then we must have $p = r/n - 1$, $s = (n-1)\,r/n$. In the second paper the authors exhibited and described an exceedingly sensitive d'Arsonval voltmeter, in which all the parts are designed in scientific proportion, and the coil of which is free from all traces of magnetism. This latter condition is not often attended to, yet it may increase the sensitiveness as much as sixteenfold. A table was exhibited showing the sensitiveness of many types of galvanometer, from which it appears that the most sensitive galvanometer recorded is one constructed by Prof. Paschen, of Hanover, in 1893, with 60 ohms resistance; with a period of 10 seconds and a distance of 2,000mm. from mirror to scale this instrument gives a deflection of 90,000mm. per microampere. In their remaining paper the authors show that a long-period sensitive galvanometer offers no advantages over a short-period instrument for null methods. The needle will move as far from rest in the same time under strong as under weak control, and it is useless to make the instrument sensitive if rapidity of reading is the sole desideratum.

Mr. A. P. Wills described experiments to measure magnetic or diamagnetic susceptibility, for feebly magnetic or diamagnetic bodies, by weighing the force exerted on a rectangular slab of the material when pulled into or urged out of a horizontal strong magnetic field. The slab was placed with its longest edge perpendicular to the field and its shortest edge parallel to the lines of force. One of Mr. Nicola Tesla's new oscillators was sent for exhibition at the meeting of the section, and created considerable interest.

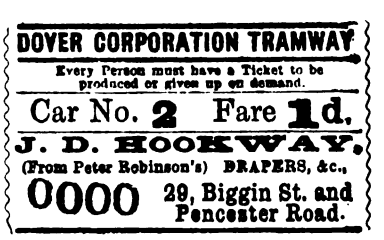
Although not directly an electrical paper, it may be permissible to refer here to the communication by Prof. S. P. Thompson on kathode rays. Prof. Thompson described four different kinds of such rays. Firstly, there are the ordinary rays as radiated from the kathode; these he calls orthokathodic rays. Secondly, when these rays fall on a surface they excite X-rays, and having done so they lose their power of further exciting X-rays; these may be called parakathodic. Thirdly, if the kathode rays pass across a negatively charged body, or through a negatively charged hollow body, such as a metallic sieve or hollow spiral in electrical connection with the kathode, they lose their power of exciting fluorescence in glass, but they make the gas inside the tube slightly luminous and its spectrum may be observed; the rays have also lost the property of deflection by a magnet. Such rays Prof. Thompson would term diakathodic rays. Lastly, there is a class of rays found issuing from the narrow ends of the funnels in a Holtz's funnel-tube, when the current goes from the narrow to the wide end of the funnels; these rays are deflectible by a magnet, but they produce neither fluorescence nor X-rays; they may be termed isokathodic.

In the Mechanical Science Section electricity was poorly represented, the principal papers being a description of the Montreal electric tramway system by the chief engineer and manager, Mr. G. C. Cunningham, and a paper by Mr. J. G. W. Aldridge on the "Present Tendencies of Electric Tramway Systems in England." Mr. Cunningham gave details of the construction of the Montreal installation, which is an overhead trolley system, set up in spite of the usual protests concerning unsightliness and danger from falling wires. It is satisfactory to learn that since the company commenced operations in 1892, not a single passenger has been injured by a falling wire. The following numbers are indicative of the efficiency of the system, in reading which it must be remembered that Montreal is a hilly town, with some gradients approaching 10 per cent.: consumption of coal, 7lb. per car-mile, or 1lb. per ton-mile, or 2·75lb. per electrical horse-power; consumption of energy, 293 watt-hours per ton-mile; cost per kilowatt-hour 0·25d., per car-mile less than 0·5d. The average speed is 7½ miles an hour, and cars run during 21 hours out of the 24. The snow-fall is 10ft. in winter, but the service has never been rendered discontinuous by reason of snow. The number of passengers carried is three times as great as in 1892.

From Mr. Aldridge's paper, and the discussion which followed, there was apparently a unanimous opinion that the overhead trolley system is the cheapest and best, if considered without reference to other traffic; but that the system would not be permitted in the larger cities of Britain and the rest of Europe, largely because of supposed depreciation of property by the erection of the overhead wire, partly also because municipal bodies would look upon the overhead wires as an obstacle to traffic, and partly, also, because of danger in case the wire breaks. Mr. Aldridge described an ingenious scheme in which the overhead wire is carried by the car, the current being derived alternately from a post in the street and a stud on the ground, but as these studs would require underground leads they would apparently be expensive to lay and keep in order. Prof. Perry described an underground induction system in which a transformer is used, with its primary circuit and half of its magnetic circuit underground, the other half of the magnetic circuit and the secondary coil being on the car close to the ground, and the car being driven by an alternate-current motor. This system is as yet in the experimental stage, but more may be heard of it in the future.

THE DOVER TRAMWAYS.

Dover is the most recent convert to electric traction, and it enjoys the unique position of being at present the only town in Great Britain to lay down its first tramlines for electric power. Other towns have, as a rule, commenced with the use of horse traction, and in many cases the poor financial results have prevented the change to a more profitable system. We say more profitable, because it has been repeatedly proved that with electricity as a motive power the number of passengers carried increases by leaps and bounds. The credit of laying out these tramways must


DOVER CORPORATION TRAMWAY
Every Person must have a Ticket to be produced or given up on demand.
Car No. 2 Fare 1d.
J. D. HOOKWAY.
(From Peter Robinson's) DRAPERS, &c.,
0000 29, Biggin St. and Pencester Road.

The First Ticket.

be given to the energetic borough engineer of Dover, Mr. H. E. Stilgoe, while Mr. Stephen Selloń has been responsible for the electrical part of the scheme. The final extent of the tramways to be laid was described by Mr. Stilgoe in a paper read before the Association of Municipal Engineers last April, and printed in our issue of May 7. The line now completed is the section between the London, Chatham, and Dover Station and Buckland. This was inspected by Major Marindin and Major Cardew early last week, and was found by them to be in every way satisfactory.

The plans prepared by Mr. Stilgoe were found to have been strictly followed, and, excepting a slight alteration to one curve, the work of a few hours, these gentlemen found

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nothing wanting. Thus the opening ceremony was fixed for Monday last, when, without a flourish of trumpets, the trams commenced their useful work. We had the privilege of witnessing the opening of the line by the mayor. Starting from the town hall at 12.15, the mayor drove the first

MR. HENRY EDWARD STILGOE, BOROUGH ENGINEER, DOVER.

car, containing a few invited guests, to Buckland. The return journey to the railway station was then made, and we finally stopped again at the town hall. Beyond a tendency to reckless driving, in which we suppose he wished to emphasise the rapid progress of the town, the mayor proved himself quite capable of managing the car. This formal journey being completed, we proceeded again to Buckland, the driver this time being Mr. A. J. Lawson, the engineer of the County of London and Brush Provincial Electric Lighting Company, from whose station at Dover the power is supplied. The regular service then began, and we had also to pay for the return ride. Our ticket was numbered 0007, and Councillor W. J. Russell, of Canterbury, was the first paying passenger. He kindly lent us his ticket, which we reproduce herewith. It

ALDERMAN H. MINTER BAKER, MAYOR OF DOVER.

seems that Mr. Russell is a great advocate for the electric light in Canterbury. The cars then ran regularly throughout the day, and found great favour amongst the general public. The policy of the Corporation in fixing the fares is a liberal one, and will, in our opinion, lead to the success of the undertaking. Thus penny fares are in force everywhere, and the two-mile ride over the line now opened can be obtained for that modest sum. As the 'buses now charge 4d. for the same distance, the benefit of the tramways to the inhabitants of the Buckland district will be appreciated.

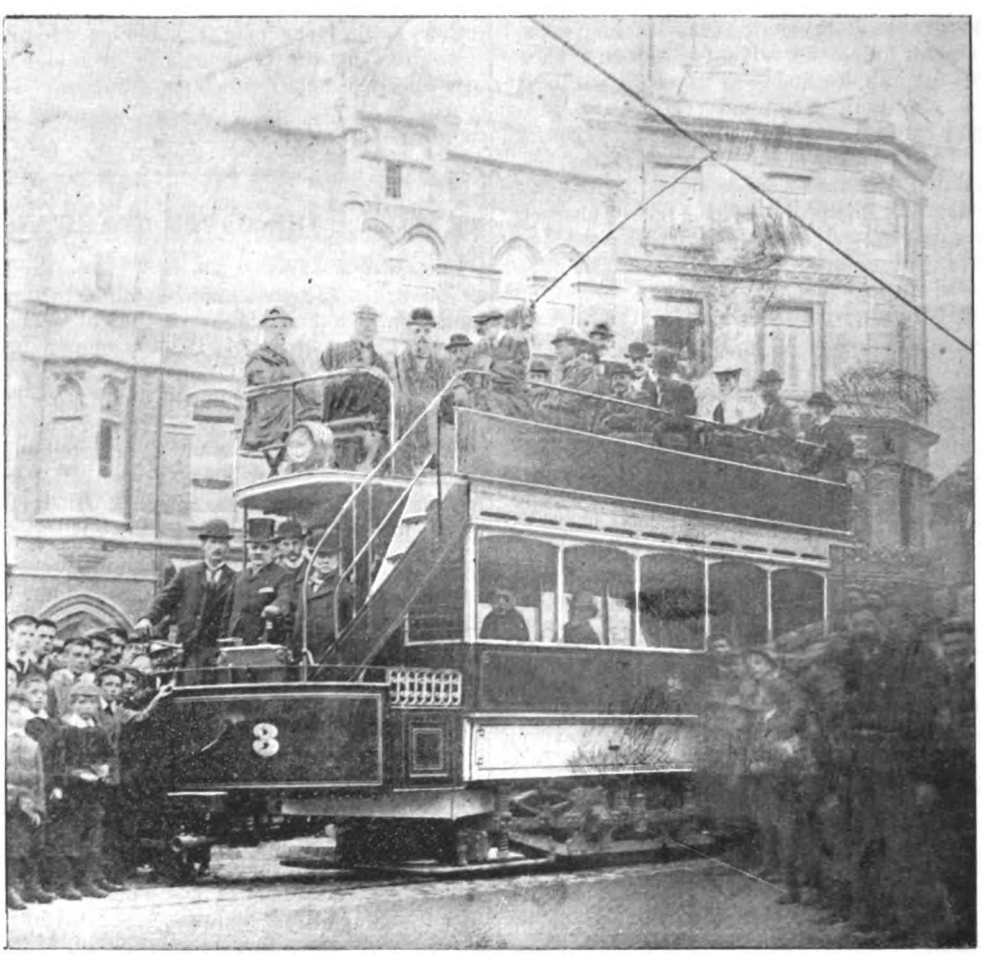

FIG. 1.—The Mayor of Dover Starting the First Car on the Electric Tramway.

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The general mechanical and civil engineering details of the line were fully described by Mr. Stilgoe in his recent paper, but the electrical part of the scheme will bear amplification. The contractors for the whole of the supplies were Messrs. Dick, Kerr, and Co., while the road-work contract was awarded to Messrs. J. J. Briggs and Co., of Blackburn. The combination of the heavy rails supplied by the first-mentioned firm with the good street work carried out by the latter firm, has resulted in a most easy-running track.

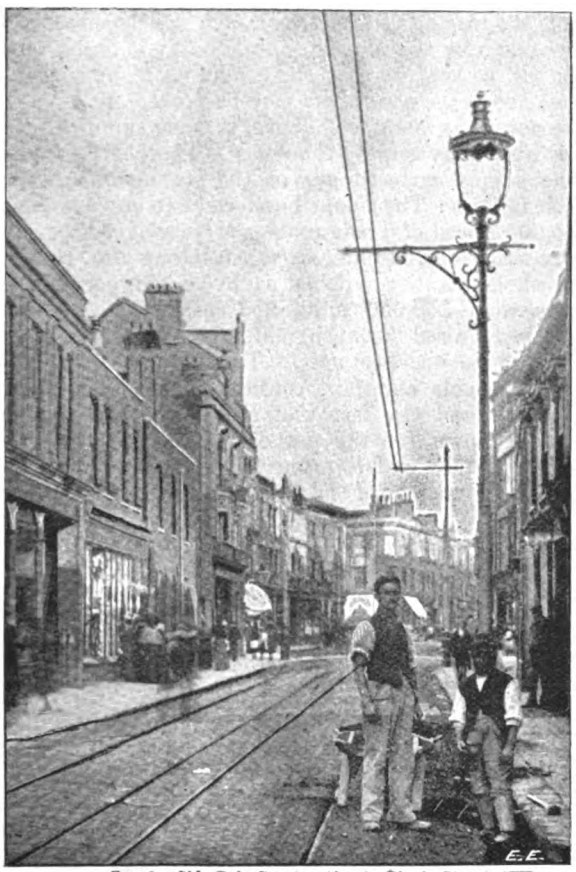

FIG. 2.—Side Pole Construction in Biggin Street.

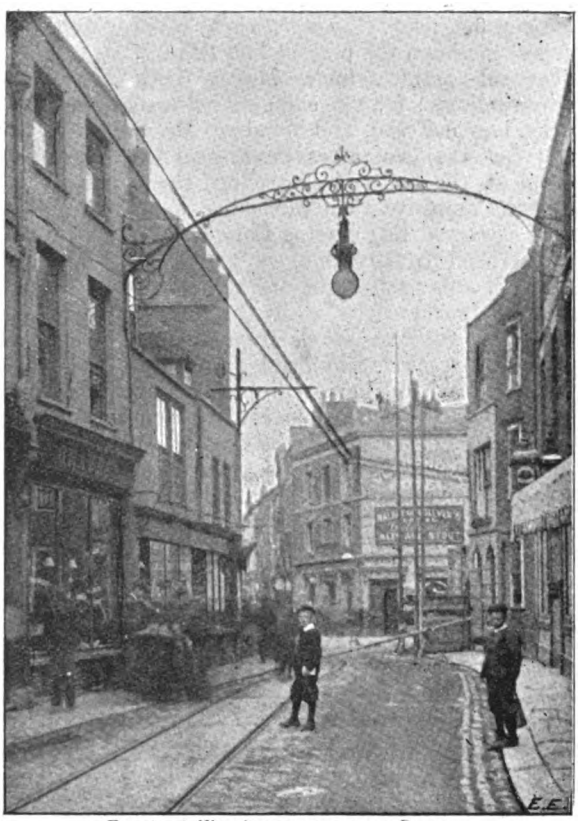

FIG. 4.—A View in Snargate Street, Dover.

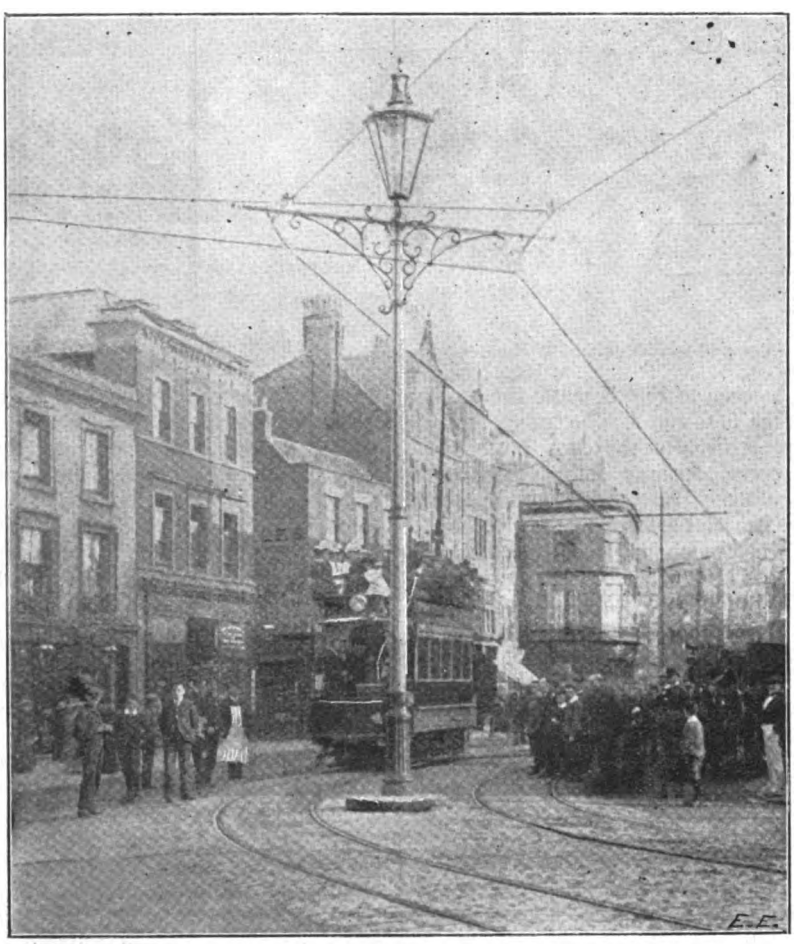

FIG. 3.—The Overhead Construction in the Market Place, Dover.

To recapitulate briefly, the rails are of the girder type, of steel, weighing 87lb. per yard; they are 30ft. long

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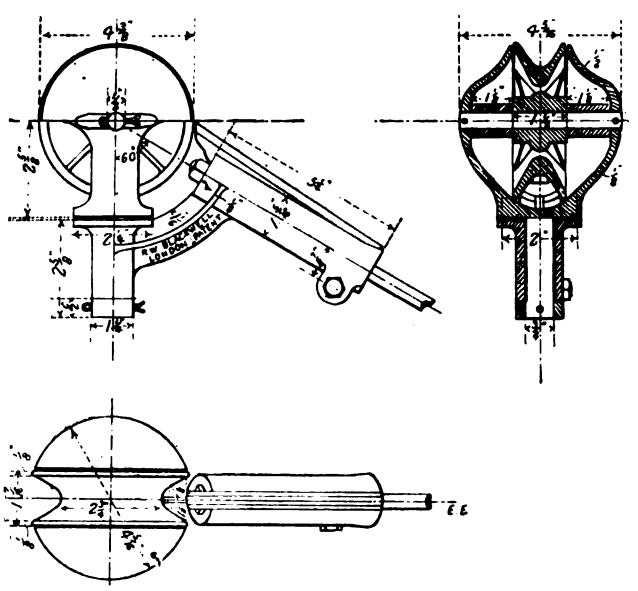
6½in. deep, and are slotted for the tie-bars, and drilled for the fishbolts and electrical bonding. The fishplates are of steel, 20in. long, and are of special design, the patent of Messrs. Dick, Kerr, and Co. Each rail is laid on a continuous block of Portland cement concrete (5 to 1) 12in. wide and 8in. deep. The worst curve is one of 45ft., and the steepest grade on the present line 1 in 257.

The sub-contracts under Messrs. Dick, Kerr, and Co. were as follows: for the engines, poles, brackets, trolleys, trucks, line material, and bonding, Mr. Robert W. Blackwall; for the generators, motor-generator, switchboards, motors on the car, and controllers, the British Thomson-Houston Company. The car bodies were supplied by the Brush Electrical Engineering Company. Commencing with the overhead construction, we give three typical photographs of this part of the work. The first one (Fig. 2) shows the bracket poles, while the pole in the foreground is provided with an arc lamp attachment. The greater part of the track is equipped with these side poles, the brackets of which do not project far over the roadway. Fig. 3 shows the centre-pole construction in the Market-place, where also arc lamps are used on some of the poles. The design of these poles is neat and effective. The other view of the overhead work was taken in Snargate-street, and shows also the artistic supports of the arc lamps, which in this case are quite independent. The trolley wires are No. 0 B. & S., of special copper, carried about 21ft. 6in. from the ground. Section switches are placed at every half mile along the route, so that repairs can be effected at any part without cutting off the whole supply of current.



FIGS 5, 6, AND 7.—The R. W. Blackwell Patent Spherical Trolley Head.

The trolleys used can be seen in Fig. 3, while the trolley heads are illustrated in Figs. 5, 6, and 7. The trolley springs are not placed outside, as is usually the case, but consist of a series of strong spiral springs coiled inside the horizontal axis of the trolley. The tension of these can be varied at will by a worm and wheel gear at the side. This is a much neater arrangement than the exterior springs, and is more convenient when outside passengers are carried. The spherical trolley head, which was originally designed by Mr. Philip Dawson, is particularly applicable to the side pole construction. The swivel of the head is provided with ball bearings, which enable the trolley wheel to readily follow the trolley wire, and the spherical construction also prevents any hanging up of the trolley should the wheel accidentally leave the wire.

The two motors on the cars are of the G.E. 800 type, each capable of a nominal output of 25 h.p., mounted on the two axles of a Peckham truck. The motors are regulated by one or other of two K2 series-parallel controllers placed one at each end of the car. Eight of these motorcars have already been equipped and four trailers. The Peckham trucks appear to carry all before them in this country, as every electric tramway now running are using them. The car bodies, which were supplied by the Brush Electrical Engineering Company, are very comfortably fitted. They hold 20 passengers inside and 24 outside. The cars are lighted by incandescent lamps arranged in series off the power circuit. Another special feature of the car equipment is the placing of a meter on each car to measure the energy taken by the motor. In this way a check on the driver will be kept, so that any undue waste of energy by careless use of the controllers may be prevented.

The power, as mentioned above, is being supplied by the Dover Electricity Supply Company. The charge is made for the supply metered out of the station on a sliding scale, as follows: The Council undertake to buy a minimum of 160,000 Board of Trade units per year at 3d. per unit. If more than 240,000 units are taken in one year, the price of the whole quantity supplied is to be 2¾d. per unit, and if more than 360,000 units 2½d. per unit. If electric energy is required between midnight and 5.30 a.m., the price is to be 4d. per unit. These terms seem to us to be reasonable and fair, considering the quantities to be supplied and the fact that additional plant has had to be laid down for the purpose. This plant consists of two McIntosh and Seymour engines, direct coupled to two 100-kw. dynamos of the General Electric type. These

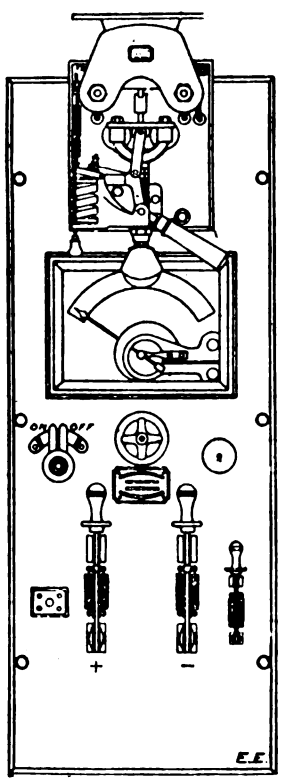


FIG. 10.—The Standard Switchboard Panel used at Dover.

traction sets are each capable of giving regularly 200 amperes at 500 volts, and can stand for an extended period a 25 per cent. over load. These engines, illustrated in Figs. 8 and 9, have cylinders 11in. and 19in. diameter respectively and a 15in. stroke. The illustration hardly gives one a true appreciation of the strength of the various parts, which can be better gained by an inspection when running. The great flywheel power, and good governing of these engines, makes them specially applicable for traction work. The tandem arrangement of the cylinders is also good. The electric generators are six-pole machines with parallel-wound armatures. They have six sets of brushes, with four carbon brushes in each set. The regulation of these dynamos is excellent, as no shifting of the brushes is required with varying loads. Either of these plants will for some time be able to run the whole of the tramway service. They can, however, be assisted or provided with additional load by a 30-k.w. direct-current and alternate-current transformer, also supplied by the British Thomson-Houston Company. We understand that this little machine will be used at night if a very few cars are to be run after shutting down the main service. We think, however, that its chief use will be to supply the lighting mains with the little current they require during the daytime, and hence saving the necessity of running a

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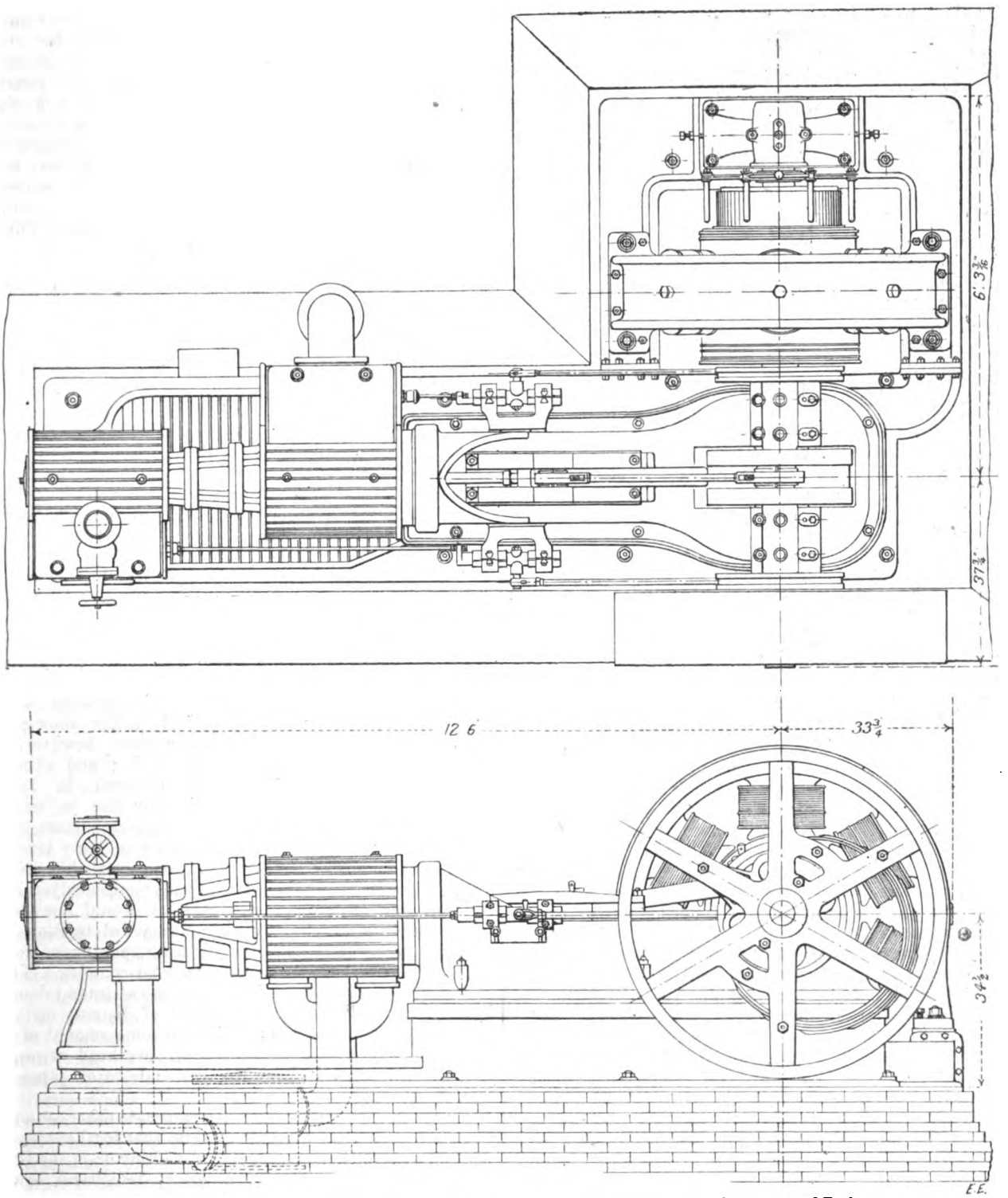
steam alternator. This will save the company a considerable expense.

The switchboard is built up of two standard G.E. panels, as shown in Fig. 10, with additional panels for metering and other purposes. The apparatus for recording the efficiency of the return circuit to see that the seven-volt limit prescribed by the Board of Trade is not exceeded was not in place when we arrived at the station, but it will be similar to that used at Bristol. A new departure, however, was the use of a Wright's maximum demand indicator to register the mean value of the current returning to the works by the earth-plates. This quantity is well worthy of recording, but in our opinion it would be better to do without earth-plates entirely, as they conduce to leakage to earth. If, on the other hand, the return feeder is relied on to bring the current back from the rails, the tendency for the return current to go through earth would be minimised.

The current going out to the line is passed through two meters, one of which acts for the Corporation and one for the company. If these two meters cannot agree within 5 per cent., a third meter is at hand ready to check between them, and the reading of this umpire meter will then decide which reading is to be taken for the days the record of which is in dispute. Mr. Stilgoe has also, in his office at the town hall, a set of recording instruments to enable him to see what current is being taken at any moment. In conclusion, we congratulate all concerned, both engineers and contractors, on the successful completion of this first line at Dover. The other branches are being rapidly pushed on, and will be opened as completed.



FIGS. 8 AND 9.—Plan and Elevation of 100-KW. Dynamo coupled to a McIntosh-Seymour Tandem Compound Engine.

Brush Electrical Engineering Company, Limited.—The eighth annual general meeting of this Company will be held at Cannon-street Hotel, London, E.C., on Friday, September 17, 1897, at 12 noon, to receive the report of the directors and the accounts to June 30, 1897, to declare dividends, and to transact the ordinary business of the Company.

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THE PRESENT TENDENCIES OF ELECTRIC TRAMWAY TRACTION.*

BY J. G. W. ALDRIDGE.

Whether it be in England or the Continent, Canada or the United States, or other leading country of the day, we find nearly everywhere the same general methods being adopted of abolishing animal traction as rapidly as possible upon existing tramways and substituting mechanical systems in its place, whilst for all new lines (extensions in which have been extremely numerous, and will be still more so) no question of employing animal power is entertained. There is no need to discuss the reasons for this great change that has come over street transit during the past 10 years. They are well known to everyone, and, indeed, self-evident. It is, however, well worth while to examine briefly the various considerations that have caused one form of electrical traction to be adopted rather than another, or, what is practically the same thing, to note the conditions which prevail generally which have so far led to the use of overhead wires, accumulators, conduits, etc., and which will in the future cause one or other of these to take the lead.

Take the United Kingdom as a condensed example of tramway or street railway practice in general. There are practically 130 miles only of electric tramline at present being worked or under construction in Great Britain and Ireland. Out of this length of track 103·5 miles are worked on the trolley or overhead wire method, 15·75 miles with a third rail, six miles by means of storage batteries, and only four on the conduit system. The relative proportions between these various methods will probably remain about the same elsewhere for all other countries using tramways on a similar scale; but the total amounts in the above example are small enough to make the United Kingdom feel very much left behind in regard to rapid transit developments. However, the prospects in the early future of great extensions are sufficiently good to arouse some hope that English engineers will soon be able to make up for lost time.

When we come to enquire into the reasons for any one method being employed to a greater or less degree than another, there is to some extent involved a brief consideration of their essential features, especially those of a permanent nature. The trolley system is at present admittedly the cheapest to erect, and also to operate and maintain under practically all conditions. Is this likely to continue to be the case? So far as would appear from latest experiences, no system has yet been developed which can in any way compete satisfactorily with the overhead method on the score of economy in first cost or working expenses, and if this were the only consideration to regard, it might be expected that no other system would have a chance to succeed.

The prejudices to overhead wires from an æsthetic point of view are very largely dying out in proportion, as it is seen that trolley wires, when properly installed, do not present any greater eyesore than is given by the generally unæsthetic appearance of an average city street, whilst they offer every possible facility for the working classes (otherwise condemned to remain near their employment in the crowded, and therefore less healthy, city districts) to live in purer air and more open quarters at less expense. Other objections to the overhead wire are surmounted with even less trouble, the obstacles which it is said to present to the passage of fire-escapes along the street have been proved a mere bogey; and even if they existed, it would surely be the duty of the fire brigade to improve their apparatus than prevent the adoption of a universally beneficial system of rapid transit—either mechanical or electrical. The possible danger to ordinary street traffic from a broken wire is easily guarded against; human beings are not readily killed, or even seriously injured, by a 500-volt shock, whilst a horse may just as easily be killed or injured (in fact, such instances have occurred) from defect in a closed-conduit system as with a broken trolley wire. Moreever, these breaks in the overhead wire are of less and less frequent occurrence, and reasonable care in erection and supervision is sufficient to avoid them altogether.

It is possible to erect or equip a new trolley line under average conditions for a sum of not more than £5,500 per mile of single track, including rails and permanent way generally, joint bonding overhead structure (with side bracket poles), trolley wires, feeders, and all accessories such as are required for this system as compared with others. An open-conduit system, such as that employed at Budapest, Brussels, Berlin, and New York, can hardly be built under any circumstances for a less sum than £10,000 per mile of single track, under equal conditions, nor can a closed-conduit system be similarly laid down for less than about £7,000 per mile of single track. Moreover, the last-named types of electric line are extremely difficult to properly and economically maintain or repair; in many cases there is constant disturbance of the street paving, quite irrespective of the use of manholes (as appears to be proved by the employment of a hinged slot rail at Blackpool) for greater ease of inspection.

From what has been said it appears obvious, in view of the prevailing facts and conditions, that the erection of a conduit line in any place at such a considerably greater outlay than is necessary, in so far as the tramway service alone is concerned, implies the existence of local restrictions—the municipality or other authority with whom lies the ultimate command of the streets and roads has in such cases forbidden the use of overhead wires on grounds more or less reasonable and permanent. At the present moment it cannot be said that this has been done anywhere in the United Kingdom by municipalities erecting or working their own lines. It is all very well to insist upon the wires going underground at someone else's (the tramway company's) expense; but Glasgow, Halifax, Hull, Leeds, and Sheffield do not propose to build expensive conduits at their own. They prefer to erect trolley lines throughout, even in the heart of the city, principally because the lines belong to and are, or will be, worked by the municipality, which therefore has to pay the cost of conversion from horse to electric traction. The existing conduit lines are by no means numerous; in the United Kingdom there is only one—viz, that at Blackpool—originally built for the purpose of showing what could be done in this direction. The Blackpool line dates back to 1884 or thereabouts, and accordingly ranks among the oldest of electric lines. No other town, however, has in the meantime followed its example; and although Birmingham has quite recently declared in favour of a conduit system, this is probably due to misconception of the true facts, and in any case must entail special allowance in respect of long lease and easy terms to those operating such lines. Crowded capitals like Berlin, Paris, Brussels, and Budapest (as already mentioned) all have their conduit lines; and so, doubtless, would London, if conditions were ripe for adopting mechanical traction. In all these cases the reasons for insisting upon underground rather than overhead wires are somewhat complex. There is a great deal of æsthetic feeling in the attitude taken up by the local authorities, a great deal of distrust on their part with regard to new methods, and some amount of fear lest accidents should happen from overhead wires, or excessive damage be done to gas and water pipes by leakage currents.

Whatever may be the case with respect to other countries, there seems not the least doubt but that local authorities in the United Kingdom may rely absolutely upon the Board of Trade regulations for all necessary safeguards against the effects of serious electrolysis, and, given sufficient confidence in their own surveyors or engineers, they may also very safely sanction the use of trolley wires when properly erected and maintained. Probably the chief reason for building conduit lines in New York at an enormous outlay is that the use of overhead wires for every conceivable purpose has been so overdone in the States that a natural prejudice exists against any further extensions, besides which much greater latitude is allowed in America than the United Kingdom with respect to the maximum stray currents, the matter, indeed, being left to be decided by the tramway company's pocket rather than an independent official standard. Of all the overhead

* Paper read at the British Association meeting at Toronto.

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wires, however, the trolley is most justified in remaining. Telegraph and telephone wires are better maintained underground, so, too, with electric light mains and all other similar services—in fact, there seems good reason for burying them all except the trolley wires; certainly the trolley-wire feeders ought to be underground. In such a case it seems difficult to see what real and substantial grounds exist for the æsthetic objections to trolley wires, when they alone are visible in the streets, especially when the advantages of rapid service are considered. No tramway company can afford to put down a heavy conduit line and give the cheap transit required by the public, except on specially favourable terms such as very few municipal governments would grant; there does not consequently seem much likelihood of this type coming into extensive use in its present form.

Various modifications have been proposed in underground conduit working by means of which this great expense may to some extent be avoided, and perhaps the best of these new methods would appear to be one which consists practically of a trolley wire placed underground in a shallow conduit under one of the line rails, so that only two rail slots are employed at Budapest. The endless varieties of closed-conduit systems have not as yet shown sufficient merit to justify their serious consideration; based as they nearly all are upon moving switch contacts underground, which are made to energise consecutive lengths of a surface conductor, the possibilities of a breakdown are enormously increased, while the leakage must be considerable and the capital outlay not so very much less than that of an open conduit substantially built of concrete with cast-iron yokes. Efforts have been made in places like Hanover and Dresden during the past 18 months to combine the advantages of overhead wires in outside or suburban districts with the use of accumulators for working the cars in the more crowded city streets. The arrangements which appear to have been adopted are somewhat open to criticism; the batteries are carried continually upon the cars, and therefore add considerably to the dead-weight carried on the trolley wire section; they are, of course, being charged from the overhead wire, which also provides current for the car motors. A much better arrangement (where the local authority insists on prohibiting the overhead wire in city streets) would be to put the batteries on a small dummy car for the use of the city section only, the motorcar picking it up at the end of the trolley section and drawing it along (like a locomotive tender) over the route where no trolley wire may be erected. At Hanover, the current consumption with trolley wires only amount to ·7 unit per car mile; with mixed working—trolley and accumulator—the power-house is called upon for an average of ·97 unit per car mile, a considerable increase in energy, and one which is practically so much unnecessary waste. The inherent defects of accumulators for electric tramway working, when installed upon the cars, are so well known that they need not be dealt with now; suffice it to say that in their present form the proper place for storage batteries is not, and never can be, upon the vehicles themselves, but rather in the power-house or sub-stations for regulating and transforming purposes.

The unprejudiced and careful student of electric traction methods is therefore brought again and again to the final conclusion that the trolley system has proved itself to be, so far, the best all-round device capable of being employed in tramway working with true economy and sound financial success; and although it has many admitted defects, yet when properly limited and regulated, as is done in the United Kingdom by Board of Trade rules, there should be no fear of its giving satisfaction alike to local authorities, tramway company shareholders, and the great travelling public. Although, however, a full appreciation of the overhead wire system has thus been offered, there are—and, without doubt, will be—numerous instances of lines for which some other method must be employed—that is, the use of overhead wires is absolutely prohibited for one reason or other. In New York alone, for instance, the leading tramway company has decided to equip the greater part of its system at an enormous expense with open-conduit working, there being, apparently, no chance of securing sanction for trolley wires.

Under circumstances like this, what efficient and cheap substitute can be offered for the overhead wire system? So long as the heavy element of lead remains the chief essential of an accumulator, there does not appear much prospect of early and great improvements in this direction. Scope for the device of new mechanical contact systems is, however, so great that we need not by any means despair of success with a better and cheaper form of conduit, or other arrangement, for avoiding the overhead wire. At any rate, the author has kept this in view for some time past while experimenting upon other mechanical devices than the simple overhead wire; and in the following brief description of a new system he attempts to show that some measure of success seems to offer itself on striking out into a direction somewhat different from those hitherto followed. The author's object in these improvements is to do away in electric tramway work with the overhead contact wires permanently stretched lengthwise above the track, and supported from bracket poles or span wires in the usual variety of ways. The necessary contact between a fixed conductor along the line of route and the travelling car is obtained instead by erecting as long a contact wire or ribbon, *a*, as possible upon each car, stretched between two poles, *e e*, somewhat similar to ordinary trolley poles, placed at each end of the car (Fig 1) and sloped in opposite directions. In this way there is secured a travelling contact length of as much as 50ft., varying, of course, with the length of car, but the longer the better. This contact wire or ribbon upon the car makes a rubbing contact on its upper surface with the under surface, *l l*, of short rods, wires, ribbons, rollers, or other contact pieces of copper or other suitable metal, suspended transversely to the track from the arms of ordinary street trolley poles, so as to lift and swing slightly in the direction of car movement when the travelling car contact comes underneath and presses upwards (Fig. 2).

When short distances are permissible between the street poles, say, not exceeding 18 or 20 yards, then the travelling car contact thus mentioned may be made sufficient to maintain contact uninterruptedly, the front end of same

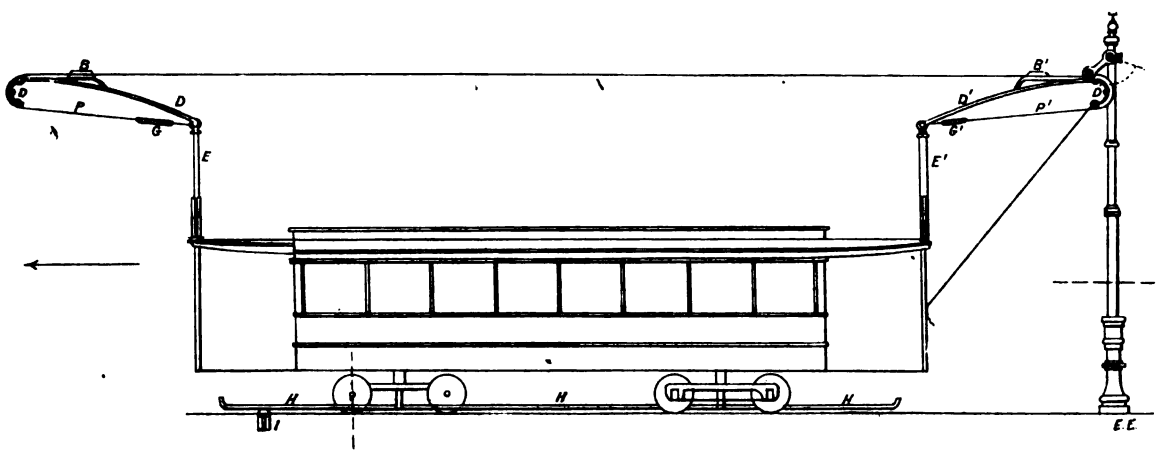

FIG. 1.—Elevation of the Aldridge Electric Tramcar.

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reaching the forward pole contact before the rear end has left the rear pole. But in case the spacing hitherto generally adopted for the street poles, say 40 yards on the average, be desirably maintained, the system is then arranged to bridge over the intermediate gap by means of an insulated surface contact stud or plate, *i i*, fixed in the ground between or near the track rails in a somewhat similar way to any of the accepted methods. Each contact piece of this kind is situated approximately midway between

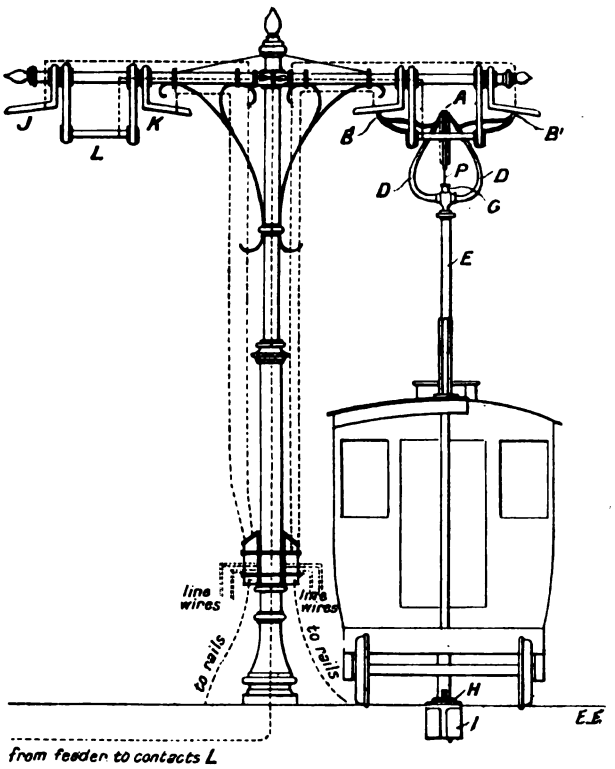

FIG. 2.—End Elevation of the Car and Contacts.

adjacent poles and a long bar, metal ribbon, or other suitable appliance; *h h* is mounted underneath the car in any of the accepted methods so as to make contact with the metal stud or plate, *i*, which projects slightly above the street surface. In this way the car, when about to pass off one of the pole contacts, makes contact by means of the bar, shoe, or ribbon underneath the car, with the surface contact in front before the overhead contact leaves the pole in the rear, thereby securing continuity of current between the generating station (through the feeders and line contacts) and the car motors, which are connected to both the

side extensions, *b b*, upon the car overhead contact supports, *d* (Fig. 5). The side contact at the rear end of the car overhead wire, just before the latter leaves the pole contact, switches in the street surface contact next ensuing, while the side contact at the front end of the car overhead wire, immediately after the latter reaches a pole contact, switches off the street surface contact next preceding that pole. The switch operations thus indicated may also be effected by mechanical means alone. Thus the overhead side contact may by means of a striking arm or other such appliance be made to move round a step-by-step switch on the well-known principle of a double

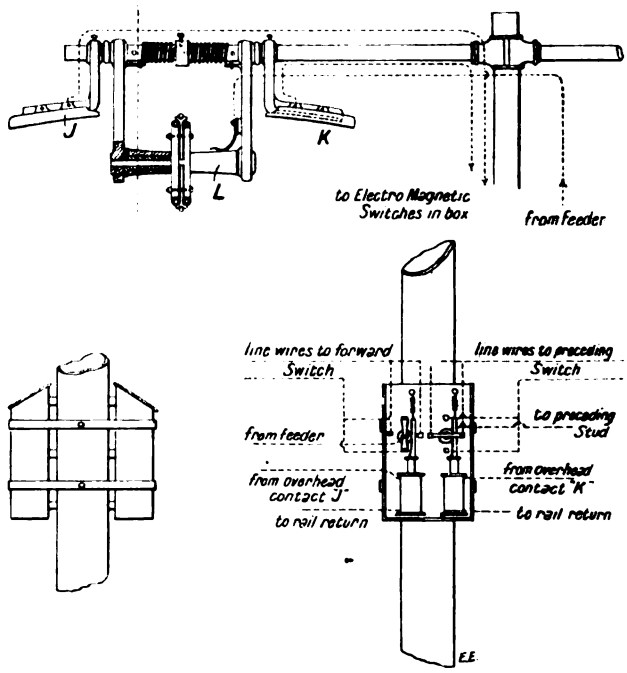

FIG. 4.—Details of the Contact Gear.

ratchet brace, each switch moving round continuously in one direction only, and making or breaking contact at each step according to the position of the preceding switch in the same manner as is usual with two-way switches constructed without an "off" point, and for the purpose of making or breaking a circuit at either of two places. Or the overhead side contacts, b^1 b^1, may, as already set forth, simply be electrical contacts, in which case they are properly insulated and connected to the main overhead car contact, *a*, so that on making contact with the insulated switch contacts, *j k*, on the street poles, a current passes from the

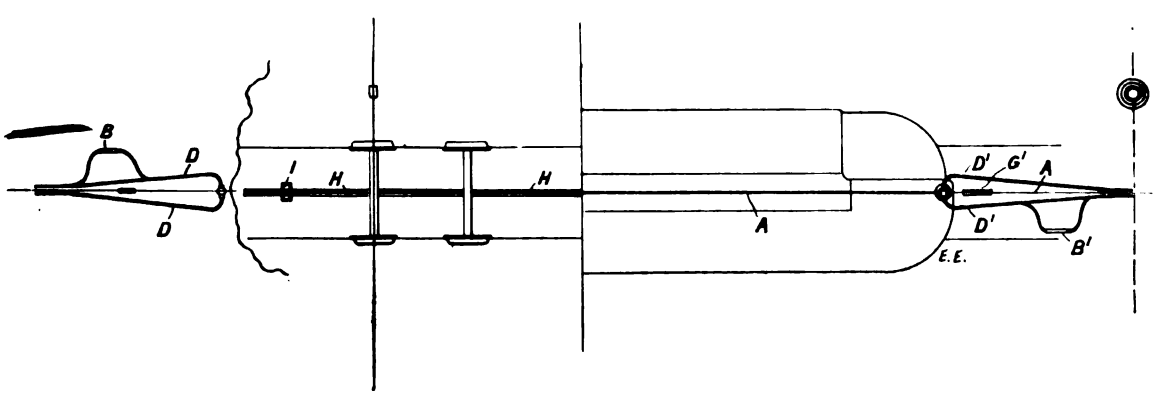

FIG. 3.—Plan and Section of the Car and Contacts.

car contacts underneath and overhead, the current returning to the power-house through the rails in the usual way. Similarly, on passing off one of the street surface contacts, the forward end of the overhead contact on the car reaches the next pole contact before the rear end of the contact bar, shoe, or ribbon underneath the car has left the street surface contact.

In order to avoid the street surface contacts being always "alive"—that is, permanently connected with the feeders from generating station—they are connected up to switch contacts, *j k* (Fig. 4), mounted upon the street poles, and operated automatically by means of main overhead car contact, *a*, through the side contact, *b* or b^1, to the street pole contact, *j* or *k*, as the case may be, and thence to electromagnets placed in a box or boxes secured to the street pole, or in any other suitable position, and operating switches in the same way as already described for automatically switching the street surface contacts into and out of circuit. Although these two methods are specifically mentioned, there are, of course, other ways of reaching the same end.

It will thus be seen that the only surface contact in circuit, and from which current can be obtained, is the one under the car itself. There is accordingly no danger of

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electric shock to passers-by or horses drawing vehicles along the street and accidentally stepping upon the surface contacts with one foot. By the use of such an arrangement the overhead contact devices, both on the car and attached to the street poles, may be brought considerably lower down than is possible with safety when the ordinary trolley system is employed. This reduces the cost of street poles, and also gives a better appearance to the car itself. The overhead car contact, *a*, is so arranged that a sufficient tension in it for good electrical contact with the

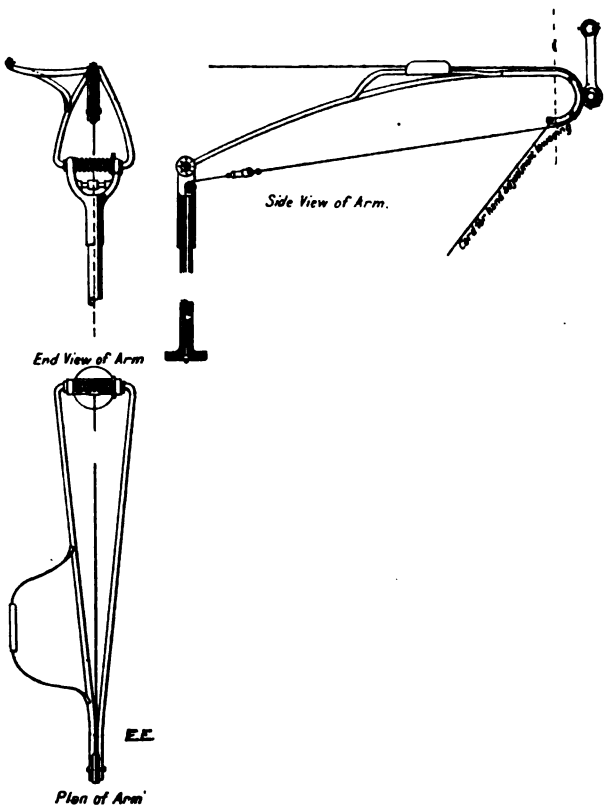


FIG. 5.—Details of the Top Collector.

street pole contacts is automatically maintained by means of springs, g g^1, and if the wire or ribbon forming the car overhead contact should by any possibility break, the outstretched arms, d d, on the car at once swing downwards, and contact with the street poles cannot be restored until the wire or ribbon is repaired. This prevents a broken car wire or ribbon overhead being alive—*i.e.*, charged with electricity—with consequent danger to passengers on the top seats. When these overhead contacts are in their normal position, they stretch at least 8ft. above the floor level of top deck, and are therefore quite out of reach of the passengers.

The net results of this new system set forth by the author may be summarised briefly as follows: (1) The poles only are visible in the streets, and as these may also serve for electric lighting, there is practically no more structural

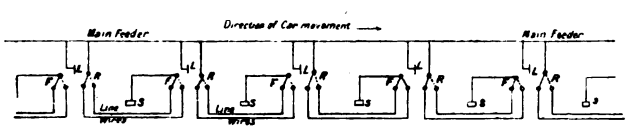
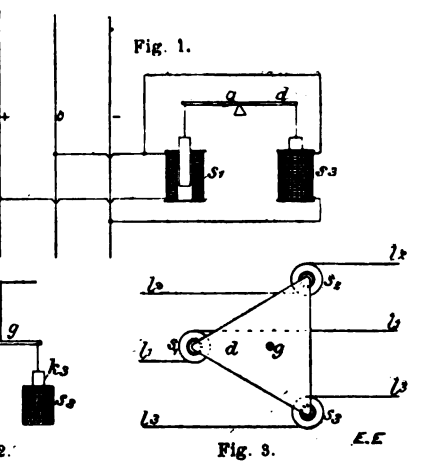


FIG. 6.—Diagram of Connections.

work in the streets than is in any case required for public electric lighting. (2) The necessary poles may, as a rule, be considerably shorter than is usual for an overhead trolley-wire system. (3) The fixed wires on the street are avoided; the moment a car has gone by, there is nothing to show the presence of an overhead wire contact. (4) The poles can quite well be kept at the same average distance apart as now obtains with overhead trolley-wire systems, or for street electric lighting. (5) The stay wires and anchor poles at curves, etc., usual with trolley systems are done away with, and the construction at such points is otherwise much simplified. (6) The cost of such a system is, of course, higher than that of trolley working, perhaps ranging up to 25 per cent. more, though this, of course, will vary with local conditions. In any case, however, it will be much less than any of the open-conduit systems, and also less than the closed-conduit methods, seeing that contact studs only occur at the most every 30 or 40 yards, instead of 10ft. or 12ft. The extra cost of wires and cables for the circuit connections need not be very great, as they only need to carry current for one car at any time; besides which, there is, on the other hand, a saving due to the abolition of heavy bare copper trolley wires, designed to carry large currents in order to save on the feeders.

APPARATUS FOR INDICATING A BROKEN WIRE IN A MULTIPHASE SYSTEM.*

Messrs. Schuckert and Co., of Nuremberg, are introducing an apparatus for instantaneously indicating in the central station a break in one of the line wires of a multiphase system. The apparatus is based on the principle of the well-known differential gear, shown in Fig. 1. It is well known that two coils, as shown in the illustration, will retain their equilibrium just as long as the effect of each



of the coils is equal. No matter what the absolute value of the currents may be, the equilibrium of the two coils is only disturbed when the balance between the two circuits is upset. Such an arrangement is well known, and is often used in three-wire systems to indicate where the pressure of the one side is different from that of the other. Messrs. Schuckert and Co.'s apparatus differs from the above in the fact that more than two coils are used and also that the frame, d (Fig. 2 and 3), are free to tilt in any direction. In consequence of this mode of arrangement the apparatus will indicate a break occurring in either of the conductors of the multiphase system, the different branches of which carry usually equal or nearly equal currents, because the equilibrium is disturbed when such a break occurs. In the three-phase system, three currents, l_1, l_2, l_3, are conducted around three coils, s_1, s_2, s_3, each possessing an equal number of turns. These coils are placed in the three corners of the triangle, d. An iron bar, K, dips into each coil. The three bars, k_1, k_2, k_3, are hung in the corners of an equilateral triangle, d, which is supported by its centre of gravity, g. The equilibrium is preserved only as long as the three coils have currents of equal strength permeating them. It is destroyed as soon as one wire breaks. Then the triangle, d, dips, and at the same time causes a bell to ring in the engine-room. This apparatus may also be used for two-phase installations having three conductors. In that case, it will be only necessary to change the number of turns on that coil through which the current of the middle conductors passes. This new number of turns in the coil must be made equal to $s/1{\cdot}4$, s being number of windings upon the other coils.

This arrangement is an obvious one, but may be none the less useful. It occurs to us, however, that in the case where lights are supplied from the same mains as power, the want of balance of the lighting in units might produce the same effect as a broken wire.

* *Dingler's Polytechnisches Journal.*

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TO CORRESPONDENTS.

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ELECTRIC TRACTION.

The development of electric traction in Great Britain is in a healthier condition now than it has been for many years. In many towns we have noted the fact that schemes for electrical traction are proposed, and in not a few the work is in course of construction. Again, we commemorate this week the opening of the municipal electric tramways at Dover. The fact that municipalities are taking up the question themselves is a great aid to progress, as such action minimises the objections which in the case of company lines have been such a drag on progress. We believe that parliamentary agents and counsel are largely responsible for most of these objections, and are accordingly glad that the Light Railways Act will deprive these gentlemen of many opportunities of hampering the provision of greater travelling facilities. It is comparatively easy to pick holes in the best-laid plans, and it is equally difficult to draw up a scheme fair to all concerned. The fact that the scheme must be sufficiently good to ensure financial support is considered by many to be quite enough to warrant it being termed "another oppressive monopoly." With a corporation as promoter the procedure is made more easy; and we believe that although tramways may be worked more economically by a company, they can certainly be equipped in a more economical manner by a corporation. The choice of what system to adopt for electric tramways is still before us. We are glad to see that much of the unreasonable prejudices against the trolley system are disappearing, and that in many English towns the overhead construction has found acceptance. This is the case at Dover, where the streets are not at all disfigured by the additions they have lately received. At complicated crossings and in busy towns there is often a reasonable objection to these overhead wires, and in such places a conduit, or contact, or accumulator system is more likely to gain favour. So the search for a more perfect system continues, and this week we are able to publish Mr. Aldridge's solution of the problem. We regard these proposals rather in the light of a suggested method, and as the detailed sketches are from the patent drawings, they must not be regarded as final. Briefly, the system is a cross between a surface contact and a trolley system. In the trolley part of the system several trolleys are placed on the poles by the side or in the centre of the street, and the wire is placed over the car. The suggested plan of projecting this small length of conducting wire beyond the frame of the car cannot, in our opinion, be entertained at all. It would prevent cars approaching each other at the ends of the line, and also be dangerous when taking sharp curves. In fact, from the present information, we cannot see that the arrangements proposed have any advantages over a thoroughly well designed street contact system. On the other hand, the double system of street and elevated contacts with two long collectors and switch-gear adds many complications which are not desirable. The author's estimate of the additional cost for his system also appears to us to be somewhat too favourable, but

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we should like to see drawings of the practical details proposed by him.

THE HIGH-TENSION DIRECT-CURRENT SYSTEM.

We are able this week, through the courtesy of the Electric Construction Corporation, to publish *in extenso* Prof. Kennedy's report on the Oxford electric lighting station. The figures contained in this report will be of great service when estimating the actual value of the system, which up to the present has been largely a matter of opinion only. The great advantage of this high-tension direct-current system over its alternate-current rival is that the transforming apparatus is only worked at times of full load, and hence at high efficiency. At other times the accumulators in the sub-stations and in the central station are able to supply the whole of the load without necessitating the employment of a full staff of engineers and stokers at the central stations. The large annual loss in the alternate-current working due to the hysteresis of the iron of the transformers is also avoided, and the high-tension current is only employed at times of heavy load to reduce the large copper losses which are found in the low-tension direct-current system. As regards the cost under the so-called Oxford system, we note that the works' cost for the third year of working has come down to 1·86d. per unit, while at Wolverhampton, where the same system is used, the works' cost for the first year was only 1·83d. per unit, which figure compares favourably with those obtained in the average alternate-current stations. The report, which is a model of its kind, adds considerably to our previous records of exact measurements in connection with different systems for the supply of electrical energy.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

QUESTIONABLE ELECTRIC LIGHTING IN EDINBURGH.

SIR,—Were it not for your editorial footnote to the letter of "Finem Respice" in your impression of the 3rd inst. we would not have troubled you, as there is plenty of electric lighting of a questionable kind in other places besides Edinburgh, and with rubber-covered cables and wood casing as well as with lead-covered wires; but as we have taken over the business and patent rights of the Free Wiring Syndicate we wish to state that we do not use a concentric, but a "twin wire" system, the latter having the advantage of being simpler and of requiring no special fittings or accessories.

As regards its legitimacy, speaking for our own system we can say that no installation has ever been condemned, and that all the central-station engineers who have seen it have expressed very great satisfaction therewith; moreover, it *is* provided for in the new rules of the Electrical Institute of Engineers.

To run wires in the manner your correspondent states was done in Edinburgh, would not in our opinion be to the satisfaction of the insurance companies or the supply authorities.—Yours, etc. (for the National Electric Free Wiring Company, Limited),

B. H. JENKINSON, Engineer and Works Manager.

London, W.C., September 7, 1897.

THE SHOREDITCH DESTRUCTOR.

SIR,—In your issue of September 3 there appears a letter from "Enquirer," to the tone of which you very properly take exception. I do not suppose that Messrs. Manlove, Alliott, and Co., Limited, the makers of the Shoreditch destructor, will take the slightest notice of such a letter, but as the furnaces are worked under my directions I cannot allow it to pass without remark.

The letter appears to suggest that some kind of jockeying goes on in the way of using superior kind of fuel at nights. I desire to say nothing of the kind is done; the refuse is all taken as it comes, and the day quality and night quality are not selected in any way. As a matter of fact, any selection or separation would be an extremely difficult matter, even if it was desired to do so. Arrangements are made to store rubbish for Sunday use, but the quantity coming in is insufficient to last over Sunday, and consequently on that day some coal is used. The reason is not want of storage, but want of refuse.—Yours, etc.,

E. WILLSHEAR,
Engineer-in-Charge, Dust Destructor, Shoreditch.

SIR,—Replying to your editorial comment on my last letter, which has no other motive but of a desire to arrive at the truth, and nothing but the truth, of steam-raising economics when using town's refuse fuel, my letter contains nothing that could be construed into an attack upon the system of cremating town's refuse. I consider that the system in itself is an excellent and desirable one, and am also prepared to acknowledge that in the destruction of refuse there may occasionally be a waste of heat flowing to the chimney; but this possible fact does not necessarily imply that it would be an economic move to attempt to recover such heat for steam-raising and steam-power purposes.

There are many rivers in England and many estuaries and bays in which there is an hourly waste of hydraulic power, but this patent fact does not necessarily prove that it would be commercially economic to conserve and dynamically convert this power by an expensive outlay in turbines and impounding works, the interest and maintenance costs of which might probably, and would most likely, attain a higher value than that represented by the saving of power.

In the same way the application of an expensive steam-generating and hot-water storage plant to recover the (low temperature) waste heat evolved by the consumption of town's refuse, often carrying with it as much as 80 per per cent. of latent moisture, might not necessarily prove to be an economic move, for the reason that interest on the plant, and the generous rate of depreciation that must be allowed (especially in the face of the new Workmen's Compensation Act) for high-pressure steam plant placed in an atmosphere of a refuse-destroying house, would probably amount to as much as the saving in fuel, etc, brought about by the attempt to recover the waste sensible heat of the gases issuing from the refuse furnaces. It is well known that some 75 per cent. of the heat evaporative efficiency of a coal-fed Lancashire or any other boiler is obtained from the flue-plate or crown surface immediately over the fire-grate, covered with fuel in a high state of incandescence.

Now there is no such equivalent condition in general destructor practice, and this, coupled with the fact that whatever the heat of combustion, a great portion of such heat is absorbed in raising the temperature of an immense volume of gases, and the magnitude of this volume will keep down the average temperature, which will not attain a much higher degree than that equivalent to steam at 200lb. pressure.

It is well known that efficiency of heat transmission is a function of the degree of difference between the source of heat and its receptive surface, and, therefore, seeing the comparatively slight difference between the heat of the gases and the heat of the water in the steam generators, the efficiency of heating surface to which low-temperature gas is applied will be very poor indeed; and this will involve the provision of a large heating surface and an abnormally costly boiler plant to produce any appreciably useful result at all. It may be argued that if such boilers are made with

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sufficiently large water-holding capacity there will be no need of the expensive hot-water storage vessels, but even admitting such reduction, the cost of such an installation per *unit of actual horse-power developed* on the driving pulley of the engines must be very high indeed, and in the absence of an exact knowledge of this particular factor *no one can say;* and *I venture, with all deference, to further say* that no honest man has a just right to say that the process at Shoreditch, from the point of a steam raiser, is either economic or desirable. It may be both; but to what extent when compared with high-class, high-pressure, coal-fed steam-engine plants? The introduction of coal, or its gases, into inferior refuse to raise its calorific value is a practice that has only to be thermo-chemically reasoned out to be condemned as wasteful in the extreme, and utterly opposed to good, or rational, practice.

One remarkable fact relating to the 15 years of general practice in cremating furnaces is the want of absolutely independent and reliable data that will permit one to measure the economic value of the system as applied to steam raising.—Yours, etc., ENQUIRER.

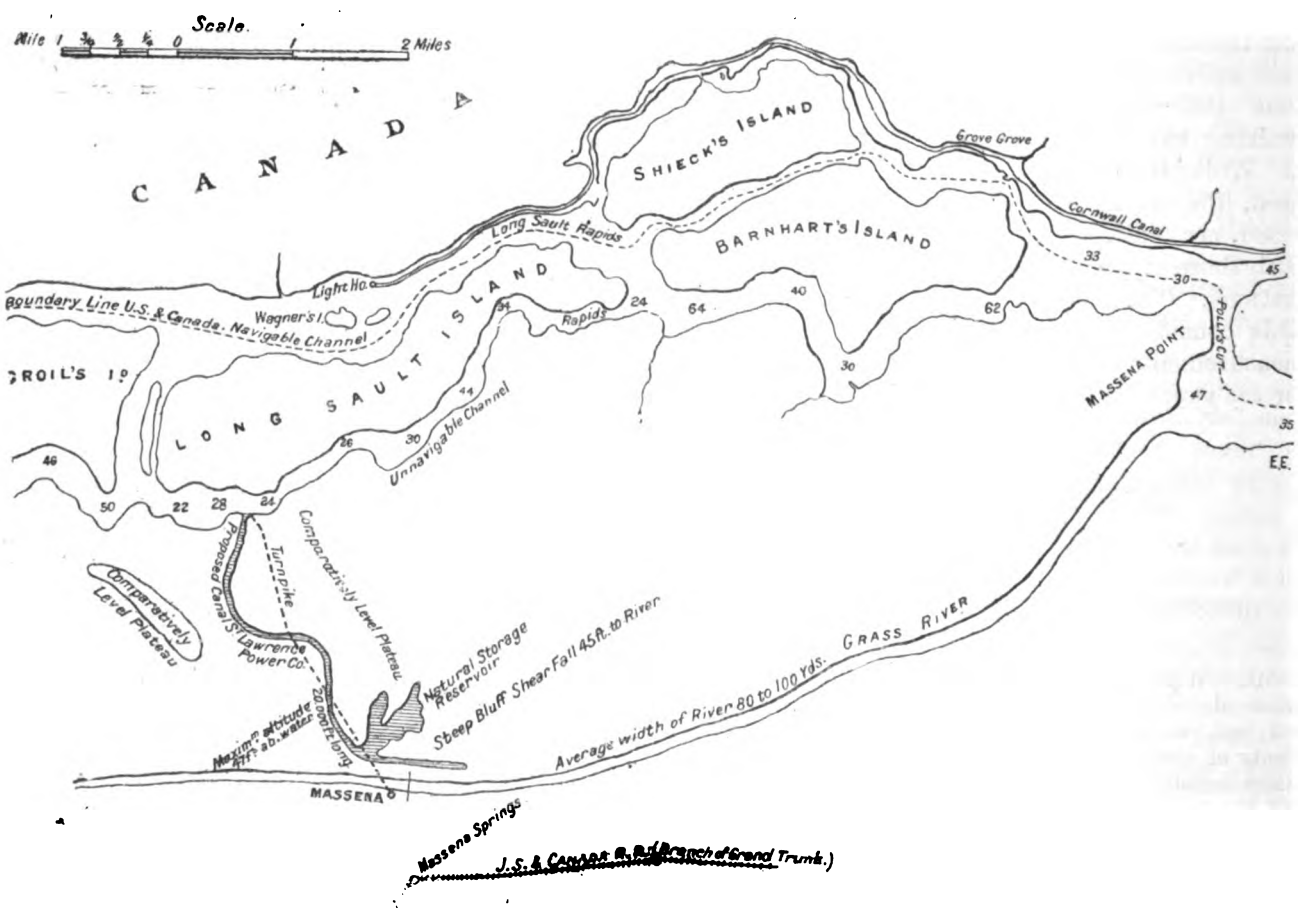
THE ST. LAWRENCE POWER TRANSMISSION SCHEME.

As indicated in our issue of May 21, 1897, the engineers for this large power transmission scheme are Messrs. Kincaid, Waller, and Manville, and Mr. John Bogart, of New York. Mr. Bogart has been spending a few weeks in England, and through the kindness of his English collaborators we had an opportunity of lunching with him on Wednesday last.

A small but representative gathering assembled at the Café Royal, and during the lunch we were able to collect a good deal of interesting information concerning the scheme. The toast-list was properly restricted, Mr. MANVILLE, the chairman, first proposing "The Queen" and then "The Health of Mr. Bogart." In response, Mr. BOGART gave a brief *résumé* of the inception and organisation of the St. Lawrence scheme. The following is the gist of his remarks, and of the information we acquired from our personal interview.

Mr. Bogart's experience in obtaining powers in the watershed of the St. Lawrence River commenced some years ago at Sault St. Marie. It seems that at this place, where Lake Superior discharges its surplus waters into the other lakes of the great chain, there is a fall of about 20ft. Here some large power works for the preparation of wood pulp have been erected, and Mr. Bogart has been largely responsible for this scheme. The plant is placed on both Canadian and American banks of the fall, and it is Canadian wood which is mostly used for the pulping purposes About 3,000 h.p. is here available, but only a small portion of it is distributed by electrical means. It seems that the electrical plant is on the Canadian side, but that a large portion of the electrical energy generated is conveyed across the border by means of overhead wires. As Mr. Bogart humorously remarked, the United States have not as yet imposed an import duty on this energy.

The next great water scheme in this watershed with which Mr. Bogart had to do was that at Niagara, where at present some 15,000 h.p. are being regularly developed. The details of this scheme have been so often described that we need not recapitulate them now. We need only say that the undertaking has been an electrical success, and that we were assured it would be a financial success by the end of next year, when some 40,000 e.h.p. would represent the plant capacity of the station. The capital



Map of the St. Lawrence, showing the Canal for the Massena Transmission Scheme.

expended by the Niagara Company will then be about £1,800,000, or £45 per electrical horse-power of output. We need hardly remind our readers that this figure is not an exceptionally low one if viewed in the light of central-station practice in England.

After these preliminaries we come to the inception of the St. Lawrence power scheme. The scheme is now reduced to an engineering problem in course of construction, the whole of the contracts being let. Hence we shall not prejudice its prospects by repeating Mr. Bogart's fishing story. It seems that Mr. Albert Man, of Sawyer-Man fame, went to Massena two years ago

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to enjoy the excellent fishing for which the rivers there are noted. After fishing in the St. Lawrence his boatman took him down the rapids shown in the map we give herewith, until he came to the entrance of the Grass River. The return journey was made up the Grass River to Massena. The exciting passage down the rapids of the main river impressed on Mr. Man the absence of any corresponding fall in the Grass River, which is a sluggish stream about 5ft. deep. He also noted the fact that the distance between Massena and his starting point on the St. Lawrence was short. With the optimistic view of an angler, he estimated the difference of level at 100ft., and informed his New York friends of his idea as to the ease with which a large power transmission scheme could be arranged at this spot. The next move was to instruct Mr. Bogart to make a report, and this gentleman, after a careful survey, confirmed the feasibility of the project. Messrs. Kincaid, Waller, and Manville were then consulted as to the electrical portion of the scheme, and it speaks volumes for the energy of all concerned that within so short a time the scheme has been successfully financed and the first contracts let. The principal engineering work is the construction of a canal to lead the water of the St. Lawrence to the top of the buffs near Massena. The country to be traversed is suitable for the work, as the deepest cutting will only be 80ft., or, in other words, the top of the small ridge to be crossed is only some 54ft. above the water-line of the canal. This canal will be about 220ft. in width along the water surface, and about 26ft. in depth, and will have a water-bearing section of something over 6,000 square feet. Running at a reasonably slow speed, it will enable a sufficient quantity of water to be put into the Grass River to develop 150,000 h.p. with a working head of 40ft. At present only half this power will be utilised, and the order for 75,000 h.p. of electrical machines has accordingly been ordered from the Westinghouse Company. This will be divided up into 15 sets of turbines and generators, each of 5,000 e.h.p. output. The details of the turbines will be found in our previous description, but we learned more information about the electrical equipment on Wednesday. The generators will be constructed on the three-phase system with a potential difference of 2,200 volts between adjacent wires. The outside diameter of the machines will be about 20ft. The frequency has been fixed at 30 periods per second. The great point of the scheme is the low capital charge at which the large power units can be installed. Thus Mr. Manville informed us that the cost of the electrical generators only comes to about 30s. per electrical horse-power output. The whole scheme, including the canal for the full power and the machinery for 75,000 h.p., is estimated to cost within £500,000, or about £6. 13s. per electrical horse-power. When this figure is compared with the £45 per electrical horse-power for Niagara, the result is most startling, and it shows what exceptionally low capital charges the company will have to allow for in fixing their annual charges for power. Of course, these figures are on the assumption that the power can be sold.

The difficulty of finding consumers for such a large power output will be at once apparent, but the great strides now being made by the various industries in which electricity is used as a reducing agent will, we think, provide the solution of the difficulty. Thus we were told that a firm contract has been made with a carbide of calcium syndicate to take up some 30,000 h.p. as soon as it is ready. It is proposed to charge at first £3 per horse-power per annum. This, if all the power were taken, would result in an annual income of £225,000, or 45 per cent. on the capital outlay. Of course, other power will be transmitted to towns in the neighbourhood, when higher prices can be easily obtained. Thus Montreal is only 60 miles away, while with increased facilities from high-tension distribution New York and Boston may be reached. We understand that Mr. Nikola Tesla has so far committed himself as to promise to have perfected a new system of distribution by the time the St. Lawrence Company have the power ready. This new system is to transmit power over 300 miles, with a line loss of, say, 5 per cent. This promise was not made to an untechnical newspaper reporter. The site of the town which will rise as the result of this cheap power will be at Massena, on the banks of the canal, which will be used as a means of approach by the lake steamers. In conclusion, we need hardly say that we are pleased to see that English engineers are engaged in this great work.

THE IMPROVED TUDOR ACCUMULATOR.

In a recent issue we brought into question the necessity of carrying in a motor-cab the weight of accumulators necessary to propel the vehicle over the whole distance it has to travel in a day. We have pointed out that as soon as it is realised that there is a demand for charging terminals, there will be an ample supply of the same; and that the affixing of a flexible conductor would be analogous to putting a nosebag upon a horse. Since then, Mr. Preece has expressed a confident hope that we may see charging stations scattered all over London for working the electrical traffic.

Since then, again, it has been shown in our columns that, taking a given total weight made up of vehicle, passengers, accumulators, etc., the maximum useful work is obtained when half the total weight is in accumulators. In this case we may say that half the work done is useful and the remainder—although necessary—useless. Now, if we diminish the quantity of "useless" work, still keeping the total weight constant, we shall not be able to travel so far, but we shall increase the ratio of useful to "useless" work; or, in other words, we shall travel more economically, provided the accumulator be not overworked. Thus, glancing at the diagram on p. 232, if we reduce the weight, A, of accumulator from ·5 to ·25—that is, from one-half to one-quarter of the total weight—we shall not reduce the useful effect from ·25 to ·125 of the maximum, but only from ·25 to ·1875. The weight of accumulator has been halved, but the useful effect has been diminished only by one-fourth.

Assuming that we do not require to travel, without recharging, the maximum distance practically possible with an accumulator under given conditions, there is clearly a calculable economic advantage in travelling shorter distances and in recharging more frequently. Then we can diminish the weight of accumulator to that which will carry us over the shorter distance. But, on the other hand, it is essential that we should have an accumulator capable of maintaining a rate of discharge that will exhaust its stored energy in a period of time not much greater than that corresponding to the diminished distance.

Another very important requirement is that the accumulator should be capable of withstanding a very high rate of charge as well as of discharge. After a drive of 14 or 20 miles a "fare" might not, especially at lunch time, object to a rest of half, or even three-quarters of an hour; but four, to say nothing of seven hours, would be quite out of the question.

Time of discharge, or of charge, will, of course, vary as the ratio of capacity to rate of discharge or of charge. Thus it will be expressed in hours by $\frac{\text{ampere-hours}}{\text{amperes}}$. There are very few accumulators for which this ratio can safely be made to approach so low a value as unity; fewer still in which it can fall below this, either for charge or discharge. Thus, for the E.P.S. (T) accumulator the lowest safe value according to our experience is $\frac{2{\cdot}2 \text{ ampere-hours}}{{\cdot}66 \text{ ampere}} = 3$ hours 20 minutes. With respect to the more recent traction battery by the same manufacturers we have heard of its being discharged—at the sacrifice of 30 per cent. of its apparent capacity—in less than two hours. But we are inclined to the opinion that the lowest safe value in this case for the above ratio is $\frac{4{\cdot}5 \text{ ampere-hours}}{{\cdot}9 \text{ ampere}} = 5$ hours, and it has been stated that seven hours is practically the period occupied in recharge. Manufacturers of accumulators of the "pasted" type usually, and wisely, stipulate for a minimum period of three hours in discharge, and for a longer period in charge. For the Epstein accumulator it has been claimed that the discharge can safely be effected in two hours, but for charging a longer period would, we

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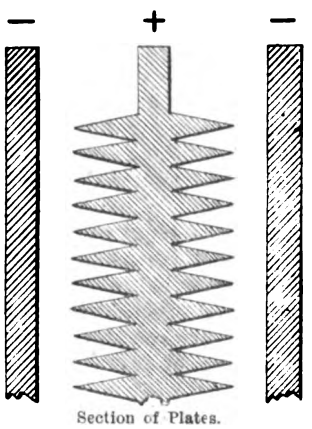
think, be required. According to Sarcia, the Laurent Cély (chloride) cell requires 6·5 hours for its discharge, although it has been claimed that this can be effected in three hours. We know of a "lithanodiform" accumulator that is apparently not damaged when discharged in one hour. But when it comes to a question of safe discharge—or charge—within a period of less than one hour—within even 30 minutes—we are forced to admit that the modernised Tudor accumulator stands alone.

In the original Tudor accumulator of the Société Anonyme Belge pour l'Eclairage Public par l'Electricité, both elements were constructed with lead plates deeply grooved by means of suitably shaped rollers. These plates were first coated by electrolysis with a thin layer of peroxide—a process devised and patented in 1889 by Fitz-Gerald and Hough, for the purpose of ensuring perfect contact between the active material, in the case of both elements, and the metallic supports, and to prevent the formation of sulphate at the junction of the two materials. The grooves were then filled with a paste of lead oxide, and the plates, when dry, were passed between smooth rollers, so as partly to close up the grooves. The cell was not originally intended to give a very high rate of discharge; the minimum period being limited to 3¼ hours. The minimum period of charge was limited to 4·3 hours. It was, nevertheless, ascertained by Prof. Kohlrausch that the cell was capable of withstanding the effect of a discharge within the period of a quarter of an hour (·22 hour). The cell, in fact, was uninjured; although we may be allowed to assume that there was some considerable loss of peroxide active material.

The "shedding" of this active material—albeit it may be compensated by the electrolytic formation of peroxide on the metal—has been sufficiently objectionable to bring about a modification of the Tudor accumulator, which appears to be amply justified by the experience, obtained mostly in France, of the last two years. The spongy-lead element, though improved in detail, is of the same type as heretofore. But the peroxide element is now purely of the Planté type, and is extremely well designed. The accompanying sketch



Section of Plates.

almost obviates the necessity of a description. As was observed by M. Blanchon in the paper recently read by him before the Société Internationale des Electriciens, the appearance of the plate resembles that of the radiators used for heating; and in some cases the gills are no more than 1mm. apart, so that the actual surface is increased tenfold. The same may be said of other forms of the Planté plate; but to appreciate the present form with regard to efficiency, strength, and durability, we have only to compare it with other forms. The plate is of pure lead; the so-called incorrodible alloys being rejected. The thickness of the middle portion or core is determined by the current it is required to conduct, and, of course, varies according to the dimensions of the electrode. It is of solid metal, without perforation or fissure, nor is it sensibly exposed to corrosion; the only fault we can find with it is that it does not taper towards the bottom of the cell. This objection does not apply to the projecting gills, which are, moreover, of the right form to ensure durability. Their extreme edges will suffer disintegration; but the form is preserved. According to the electrician whose name we have mentioned above, the layers of peroxide, at most one-tenth of a millimetre in thickness, are wonderfully adherent, and it never happens that any portions break off and fall between the plates so as to cause a short-circuit. It is stated as a fact that, when the plates have been formed, they never buckle, however large the current taken from them.

It would save some trouble and liability to error in the case of practical men, if electricians, here as well as abroad, would state the capacity and rate of discharge of any particular accumulator *complete*—plates, electrolyte, and containing vessel—instead of, or in addition to, these values per kilo or per pound of *plates*. Capacity is not supposed to be the strong point of a Planté cell, but it is stated that, at a very slow rate of discharge, the capacity of the Tudor cell is represented by 6·5 to 8 ampere-hours per kilo of plates. This is 3 and 3·7 ampere-hours per pound of plates, and, taking ·77 as the ratio of weight of plates to total weight of cell, the capacity would be from 2·3 to 2·85 ampere-hours per pound of cell. This is distinctly satisfactory for a battery of the present type; but it must be borne in mind that the effective capacity varies within very wide limits according to the rate of discharge. In the case of the Tudor cell, calling the capacity 100 when the discharge takes place in 10 hours, it becomes 90 when the time is reduced to five hours, 77 when the time is three hours, 65 when it is two hours, 46 when it is one hour, and 30 when the discharge is effected in half an hour. In the latter case, 70 per cent. of the capacity is apparently lost; but, of course, the charge is not expended, and does not therefore need to be replenished. With very high rates of discharge the waste is not directly one of electrical energy; but, in the case of traction, it is a waste of energy in transporting an accumulator virtually of low capacity in lieu of one having a comparatively high capacity.

So much for a decidedly improved accumulator of the Planté type. It is quite possible, and indeed probable, that we may ere long have something to say on improved storage cells of the Faure type. Good work is no doubt being done in this direction also, and it would be a mistake to suppose that accumulators of the latter type are likely just yet to become obsolete.

ON A RESEARCH IN THERMO-ELECTRICITY BY MEANS OF A PLATINUM RESISTANCE PYROMETER.*

BY H. M. TORY, M.A., LECTURER IN MATHEMATICS AND DEMONSTRATOR IN PHYSICS, MCGILL UNIVERSITY, MONTREAL.

The paper is an account of some experiments carried on in the McDonald Physics Building of McGill College, with a view to applying the electrical resistance pyrometer to the phenomena of thermo-electricity. The method was suggested by Prof. Callendar, whose work, with that of Messrs. Griffiths, Heycock, and Neville, has fairly well established the formulas for calculating temperature by this means. The object of the investigation was to give a more rigid verification of Tait's parabolic formula.

The research, as conducted, naturally divides itself into three parts: (1) The study of the usual form of copper-iron junction. (2) The study of a cast-iron wrought-iron junction. In conducting some experiments on the cyclical variation in the cylinder wall of a steam-engine, Prof. Callendar found a couple of this type most suitable. (3) A direct comparison of the electrical resistance pyrometer with the platinum-platinum-rhodium couple.

In all cases the compensation method was used for measuring the E.M.F., the junction being balanced against a storage cell, which in turn was continuously balanced against a Clark cell kept at contant temperature. A carefully calibrated rheostat and a resistance box both of the same material were used. The copper, cast iron, and wrought iron were tinned together at one end and heated in an oil-bath, in which also was inserted the tube containing the pyrometer. The observations were taken only at perfectly steady temperatures. The direct-reading galvanometer, devised by Prof. Callendar for the purpose, was used in

* Paper read at the British Association meeting at Toronto.

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taking temperatures with the pyrometer. A carefully calibrated resistance box of the standard type was also used. The platinum temperatures were calculated from the formula

$$pt = \left(\frac{R_t - R_0}{R_{100} - R_0}\right) 100 \quad . \quad . \quad . \quad . \quad (1)$$

and the air thermometer temperatures by means of the difference formula

$$t - pt = \delta \left(\left(\frac{t}{100}\right)^2 - \frac{t}{110} \right) \quad . \quad . \quad . \quad (2)$$

The object being to show the relation between the experimental curve and Tait's parabola, it is quite obvious that the ordinary method of plotting the temperature and the E.M.F. is not sufficient. A difference method similar to that above—equation (2)—was therefore adopted. The values of t were taken as abscissas, and the corresponding values $t - t_c$ as ordinates, t_c denoting the couple temperature, where $\frac{E_{100}}{100}$ is the temperature coefficient.

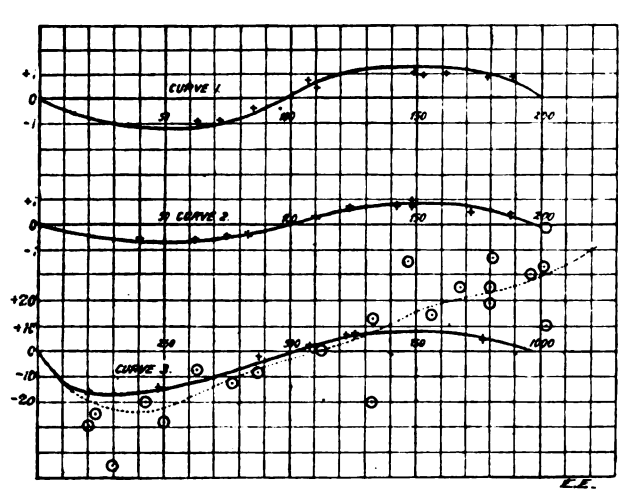
The relation to the parabolic formula may be shown thus:

If $E_t = \alpha t + \beta t^2$ (Tait's formula),

then $$t - t_c = \delta \left(\left(\frac{t}{100}\right)^2 - \frac{t}{100} \right),$$

when δ is a constant depending on the nature of the metals. The value δ was calculated from the observed difference, $t - t$, at 200deg. With this value for δ the parabola was plotted, passing therefore through three points on the experimental curve, those corresponding to 0deg., 100deg, and 200deg. The accompanying curves show the differences from this parabola plotted along the axes.

In order to compare the Le Chatelier couple directly with the resistance pyrometer, the couple and the pyrometer were placed in the same porcelain tube. The couple was the usual form, a pure platinum wire coupled with another of platinum containing 10 per cent. rhodium. The wire was obtained from Messrs. Johnson, Matthey, and Co. The junction was placed so as to be directly under the pyrometer coil, from which it was separated by strips of mica. The temperatures, as before, were taken only at steady points. These points were obtained by varying th gas supply under a vessel containing molten tin, and by taking the melting point of tin, the boiling point of sulphur, and the melting point of silver. The curve in this case was also plotted against the parabola, the value δ being calculated from the observed difference of temperature, $t - t_c$, at 979deg. The temperature coefficient of the junction was in this case taken as $\frac{E_{500}}{500}$, so as to give the nearest parabola throughout the whole range.



Curve I. shows the differences for the copper wrought-iron couple. The abscissas are temperatures by the air thermometer, the ordinates, as before stated, the differences from the parabola. The difference is − 1·1deg. at 50deg., and about +1·1deg. at 150deg. If the temperature of the neutral point be calculated from the difference equation, using for δ the value found at 200—namely, 23 25deg.—then T_0 (the neutral point) = 265deg. The experimental curve shows it to be somewhat lower than this.

Curve II. shows on the same scale the differences for the junction of cast iron and wrought iron. The differences are smaller in this case, and the curve more regular. The neutral point, calculated as before, is 917deg., which lies entirely beyond the limits of the experiments. The value of δ is 5,765. By reference to the thermo-electric diagram it will be seen that the line for cast iron lies on the same side of the copper line as that of wrought iron, but a little lower down.

Curve III. shows the differences as before for the platinum-platinum-rhodium couple. The scale here for the abscissas is just one-fifth that in the other two cases, and that of the ordinates one-tenth. The greatest difference will be seen to be at 150deg., the differences being much greater below the 500deg. point than above.

The curve representing the formula of Holborn and Wien has been plotted, and the differences from the same parabola are shown by the dotted line. Their observations are necessarily much less accurate than those taken by the resistance pyrometer, as is shown by the points marked with a circle, along the difference curve. This is owing in the first place to the difficulties in air thermometry work, and also to the fact that the temperature was changing when the observations were taken. Their curve, though similar, shows the E.M.F. for the same difference of temperature to be considerably higher than in the present case, due probably to a difference in the composition of the alloy. Various other empirical formulæ have been suggested, but as they have no theoretical basis, they have not been considered. It is obvious that a straight line does not fulfil the conditions unless it be between points not very far separated. Tait's formula, as far as it holds, perhaps simply amounts to drawing the nearest parabola, as the differences found in the present observations are quite beyond the limits of possible experimental errors. There seems to be no reason, however, to conclude that the formula may not represent the physical explanation of the effect, at least to a first approximation.

NEW METHOD OF INVESTIGATING THE VARIATION OF THE MAGNETIC QUALITIES OF IRON WITH TEMPERATURE.*

BY F. H. PITCHER, M.A.SC.

Owing to the apparent lack of exact knowledge on the subject of the variation of hysteresis in iron with temperature, and as it is of some importance in the working of transformers, it was thought well to investigate the subject further. At the same time it was intended to repeat the experiments of Hopkinson and others on magnetism at high temperatures by a different method and with higher fields. For this purpose a new method, devised by Prof. Callendar, was employed.

Description of the Method.

The specimen of iron in question was in the form of a wire, and was tested by the direct magnetometric method in the broad side-on position. The first intention was to insulate the specimen in a small and very thin platinum tube, heated by having a current passed through it. The temperature of the specimen was to be inferred from the resistance of the platinum tube over the length occupied by the iron wire specimen. The resistance was to be measured by the fall of potential between the terminals of very fine platinum wire leads, attached to the platinum tube at the ends of the above length.

In this way, if the tube were made considerably longer than the wire, the middle portion occupied by the wire would be very uniformly heated, and very exact values of the mean temperature could be obtained. The slack of the platinum tube when heated was arranged to be taken up by copper springs. To prevent oxidation of the iron wire specimen, and at the same time to promote a steady temperature throughout the length of the platinum tube, the whole was enclosed in a vacuum tube. The vacuum was maintained by a five-fall Sprengel pump, which was kept running

* Paper read before the British Association meeting at Toronto.

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during the experiment and was assisted by a water-pump in the early stages of exhausting the tube.

With this method in view, a platinum tube was constructed from a strip of foil 20cm. long, 2·95cm. wide, and 0·00254cm. thick. It was rolled around a mandrel 0·438cm. diameter, and after annealing kept its dimensions without necessitating binding wires. The fine platinum leads were attached by winding their ends once around the tube and twisting up tight. A specimen of iron wire was threaded through mica wads of the same diameter as the mandrel, and slipped into position inside the platinum tube. The ends of the platinum tube were bound with bare copper wire to No. 0 copper rods, and the whole carefully centred in a glass tube.

The tube was exhausted, and a preliminary test for uniformity of heating made before placing it in the solenoid. It was seen to be heated very uniformly up to 2cm. from each end. The apparatus was then fixed in position in the solenoid, and the whole placed in position with respect to the magnetometer. It was found, however, that platinum tubes constructed in this manner from thin foil would not stand at high temperatures. Two others were tried, which, on account of not having thicker foil of sufficient length, had to be constructed out of foil of one-half the thickness—one being wound three times around the mandrel and the other five times. These shared the same fate as the first one, giving way in circular cracks running sometimes over one-half the width of the foil.

The initial extension of the copper springs was not more than 2mm. in any case, and the ends of the tubes made as square as possible so as to equalise the tension. This method was therefore abandoned until drawn tubes of suitable thickness could be obtained. In the meantime the platinum tube was replaced by the iron wire specimen itself, and in this way observations were obtained, and, by making the specimen its own thermometer, very exact values of its temperature could be obtained.

By heating the specimen in this manner there would be a strong circular field due to the heating current. The curves plotted from the temperature and magnetometer readings would therefore have to be corrected for this circular magnetism. This was effected in the manner explained, which, however, limited the temperature to which the wire could be raised. A set of observations was taken with the specimen in air and another in a high vacuum. The true magnetic behaviour of the iron with temperature could then be obtained from these two sets.

Description of Apparatus.

The Solenoid.—The magnetising coil as made in the laboratory was wound on a brass tube about 70cm. long and having an outside diameter of 2·23cm. The tube was fairly straight, and previous to winding was filled up and polished in a lathe and then carefully lacquered.

Winding.—

Length of winding	60·25	cm.
Depth of winding (four layers double silk covered No. 24 B. & S.)	0·245	,,
Whole number of turns	4,079 0	,,
Total resistance	28·1	,,

This winding was fed on by hand in a lathe and was very fairly uniform. Each layer was carefully paraffined before winding the next. The insulation resistance when finished, as tested on 100 volts, was over a megohm. The winding was backed up at the ends by square ebonite washers, which were fixed to the tube by brass set screws.

The Water Circulation.—A water circulation was arranged for dissipating the heat when large magnetising forces were used. A thin brass tube was chosen, so that if it were slipped into the solenoid tube the annular space between them would be about 2mm. The smaller tube was centred by brass rings fitted at the ends to the annular space between the tubes. The joint was made tight by soldering. The water circulation was effected by two small brass tubes, about 0·75cm. diameter, entering laterally through the solenoid tube beyond the ebonite end into the spaces between the tubes.

Combined Galvanometer and Magnetometer.—This instrument was simply a mirror galvanometer, mounted on levelling screws, and with two coils of copper wire fitted closely on each side of the needle. The instrument was made fairly dead-beat by employing a large thin aluminium vane, just fitting the needle chamber, to carry the mirror and needle. The resistance of the coils was found to be 100·3 ohms at 18·7deg. C. It was used for measuring currents and resistances by the fall of potential method. The direct effect of the solenoid was balanced in the usual way by a balancing coil.

The Mounting for the Iron Wire Specimen.—The iron wire specimen was 26·1cm. long and 0·127cm. diameter. Its ends were fused to copper wires 10·5cm. long and 0·40cm. diameter, an arrangement intended to conduce to a constant temperature throughout the length of the iron wire when the heating current was passed through the circuits. The ends of the copper wire were riveted and tin-soldered to two No. 0 B. & S. copper rods, which were brought out at both ends of the containing tube. The rods were at about 6cm. from their inside ends, and copper springs, three strands No. 18 B. & S., wound oppositely, were introduced to take up the slack of the specimen and copper wires when heated. The springs fitted the enclosing glass tube fairly well, but better centreing was obtained by brass washers soldered on the 6cm. segments at about 5cm. apart and turned up to fit the tube. Two fine platinum wires for potential leads were attached at 15cm. apart to the iron wire specimen. They were brought out in glass capillary tubes running through diametrically opposite holes in the washers and inside the springs to one end of the glass containing tube. The ends of the capillary tubes were allowed to protrude about 5cm. beyond the containing tube, and were fused at both ends to the platinum wires. The diameter of the platinum leads was 0·005cm.; total length 98cm, resistance 8·06 ohms.

The glass containing tube was made tight at the ends in the following manner. At the end where the capillary tubes were brought out a large brass cup, 2cm. deep and 2cm. internal diameter, drilled through the bottom to fit the rod and capillary tubes, was threaded over into position and soldered to the rod. This tube just fitted the inner solenoid tube, and had an internal diameter of about 1·27cm. It was slipped over the apparatus till its end reached the bottom of the cup. The cup was then filled with melted fusible alloy, and to make tightness doubly sure a mixture of beeswax and resin was run around all the joints. The other end of the glass tube was drawn down so as nearly to fit the copper rod, and a similar but, on account of having to go through the solenoid tube, smaller cup soldered to the rod, after putting a small initial extension of about 2mm. in the springs.

The seal was made in the same way as before. The connection to the pump was made by means of a small copper tube entering through the bottom of the brass cup and sweated in with solder. It was bent up at a right angle to facilitate a mercury immersion joint. The length of glass tube between the cups was 61cm., which was about 2cm. longer than the inner brass tube of the solenoid.

When the apparatus was in place so that the specimen was symmetrical with respect to the solenoid, the small brass cup was just at the end of the inner solenoid tube. Three brass set screws, ranged symmetrically, were tapped through this end of the solenoid tube and screwed down hard on the cup. At the other end of the solenoid tube a brass binding screw was soldered. This, with a similar screw on the adjacent end of the copper rod, formed the heating current terminals. By making the heating current return around itself in this way, its direct effect on the magnetometer was minimised.

A compressed fibre block was screwed to the copper rod near the ends of the capillary tubes, and vertical holes drilled side by side in it, to form mercury-cups for the platinum leads. Twin wire leads of approximately equal resistances were brought from the terminals of the standard resistances in the magnetising and heating current circuits, together with a similar pair from the mercury-cups at the ends of the platinum potential leads, to three pairs of mercury-cups on the table near the telescope and scale. The readings for magnetising current, heating current, and E.M.F. over the specimen could be very conveniently and quickly obtained by dipping the ends of the galvanometer leads into each pair of cups in turn.

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THE ELECTROPHONE.

BY J. WRIGHT.

This modern application of the telephonic principle as a means of establishing communication between a popular theatre or opera house and one's private drawing-room is daily growing in public favour. By its means one can sit comfortably at home in all weathers and listen to the latest comedy, opera, or tragedy, as the case may be, by the payment of a purely nominal rental. Such being the case, a few words as to the apparatus employed, as well as the *modus operandi*, may prove of interest.

The electrophone in its simplest form is an application of that familiar and wonderful invention the telephone, and, like it, has a system of transmitters and receivers, the one being stationed at the theatre and connected by a line (overhead or underground, as the case may be) with the other, which is situate in the subscriber's house. I will primarily, therefore, proceed with a description of the transmitters. These are of the well-known Ader pattern, consisting of a series of carbon rods, A (Fig. 1), smaller in diameter at their extremities than at the centre, loosely supported in a horizontal position by the carbon blocks, B, which are provided with cavities in the sides for their reception. These carbon blocks are mounted by means of screws on the under side of a thin wooden diaphragm of pine or other resonant wood, C, and the whole is supported by a massive rectangular framework of cast lead, D. The connections to this transmitter are made by pieces of flexible cord, having thin copper tabs soldered to their extremities and clamped under the small nuts or screws which hold the carbon blocks, B, in position. These substantial transmitters are susceptible to the softest strains of an orchestra, and are equally as efficient when subjected to a full chorus. They are, therefore, admirably

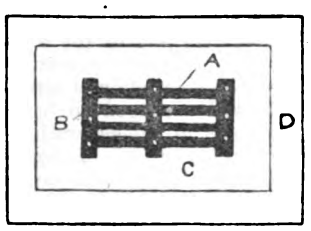

FIG. 1.

adapted to the purpose, and very seldom get out of order. They are as a rule arranged in what is known theatrically as the "float"—*i.e.*, the part of the stage just in front of or behind the footlights—and are, on an average, from 12 to 24 in number, but this, of course, depends a great deal on the size of the stage. They are mounted in cavities of such a size as to allow a certain amount of side and end play for freedom of vibration, and the upper surfaces of their diaphragms are flush with the stage. The mounting consists of a rubber ring suspension on stationary wire hooks, this form of fixing having been found advantageous as offering immunity from actual stage vibrations, and allowing them plenty of freedom on all sides for their own individual action, which is maintained uniform and steady by the weight of the leaden frame.

The accessories, comprising induction coils, batteries, automatic switches, and so forth, are contained in an accessible cupboard in a suitable portion of the wings, or under the stage. The coils, which are the same in principle as an ordinary telephone induction coil, need no description. The battery power for each theatre is supplied by a couple of E P.S. accumulators in teak boxes, provided with handles and portable in form. Now as regards the switching arrangements.

It is necessary, in order to prevent loss of battery power over the transmitters while idle during the day, to have a means of cutting them out of circuit until required. This is effected by a species of automatic switch, a diagrammatic representation of which is shown in Fig. 2, where A is the active electromagnet, B is a species of horizontal pivoted lever, provided at one end with a counterweight, and at the opposite, or working extremity, with a loosely-hinged pawl, C. The latter when depressed by the lever, B, under the influence of the armature of the electromagnet to which it is attached, actuates a compound ratchet wheel, D, composed of two discs—one of brass and the other of ebonite. These two discs are clamped together in such a relative position that their teeth alternate. Contact is thus made and broken with a small vertical brass spring, E, which acts as a contact brush. These switches are as a rule connected on the first line—viz., that in connection with the first transmitter, and are actuated by a current from a battery of E.C.C. dry cells, situated at the central exchange or switch-room.

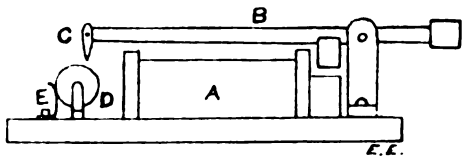

FIG 2.

From the cupboard containing the accessories the wires from the various transmitters are led to jacks similar to those used on telephone switchboards, to which in general construction, in fact, the central distributing board bears a close resemblance. The connection between subscriber and theatre jack is made by means of a two-way cord and plug in the usual manner.

Now as to that part of the apparatus situate at the subscriber's house, to wit, the receivers. These are also of the Ader pattern, and have double poles, being very similar, in fact, to the small receivers attached to the

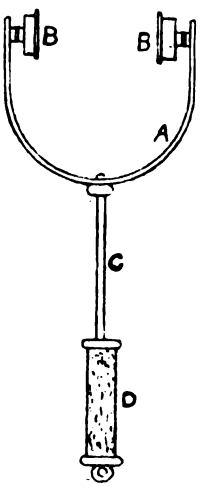

FIG. 3.

instruments of the National Telephone Company. There are two of these to each person, and they are conveniently arranged on a light metal frame, A (Fig. 3), semi-circular in form and of a convenient width to fit over the ears. The receivers are indicated in Fig. 3 by the letter B, and they are attached to the frame by the medium of a swivel joint behind, which allows of a certain lateral motion in order that they may be comfortably adjusted to the ears.

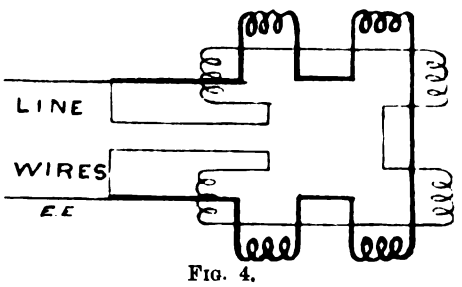

FIG. 4.

A metal rod, C, attached to the frame ends in a leather-covered handle, D, by which the instrument is held when in use. The connections to the receivers are made by means of a flexible cord, which runs up through the centre of the handle and rod and subdivides to the receivers. A small flat table of polished wood is provided to carry the contact jacks. This can be stood on a convenient table and connected with the system by a wall socket and plug and a length of twin cord. The receivers are for an ordinary

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subscriber four in number, but extra ones can be fitted if desired. The connections from the receivers to the line are, as shown in Fig. 4, divided into two loops supplying respectively the right or left receivers of each set.

I may here state that the Electrophone Company, whose chairman is Lord Loftus, are working in unison with the National Telephone Company, so that it is necessary for a subscriber to be connected with the telephone system in order that he may be able to communicate with the switch-room. The electrophone is generally fitted as an extension to the telephone apparatus, being put in circuit by means of a switch after having obtained a connection with the required theatre.

The invention has also been adapted to a system of automatic boxes for use in restaurants and places of amusement. This modification takes the form of a clock-work mechanism, which controls the contacts by means of levers attached to the driven spindle. The action of the apparatus is as follows: On the insertion of a sixpenny piece in the slot provided for the purpose it slips down a shoot and forms a rigid link between a winding spindle and the spring barrel. On turning a handle in front of the case, the clockwork is wound up, and the receivers, which are on separate handles, and are suspended on hooks at the side of the instrument when not in use, are brought into circuit, and remain in that condition until the mechanism has run down, which it does at the end of a few minutes; the hearing can then be prolonged by a repetition of the operation. Automatic boxes of this type are to be found at the Café Royal, Piccadilly Restaurant, and other similar resorts. A constant supply of popular music is maintained on these boxes during theatre hours, and is denoted by an indicating arrangement fixed over each box.

These indicators are a species of electromotor, consisting of armature and field magnets with a commutating device. The movable spindle carries an index finger, which indicates on a dial the particular entertainment that happens to be connected at the time. The indicators of several boxes are connected in one circuit, the remaining terminal of each one being earthed, and they are driven by a battery of some 50 accumulators from the central switch-room.

In conclusion, I may mention that the transmitters of this system have been fitted in popular churches, so that subscribers may listen to their favourite preacher at home. In such cases they take the form of a dummy bible lying in a natural position on the pulpit desk, or a hassock under the lectern, and are also fitted in the galleries at points where they will readily collect the sound of the preacher's voice.

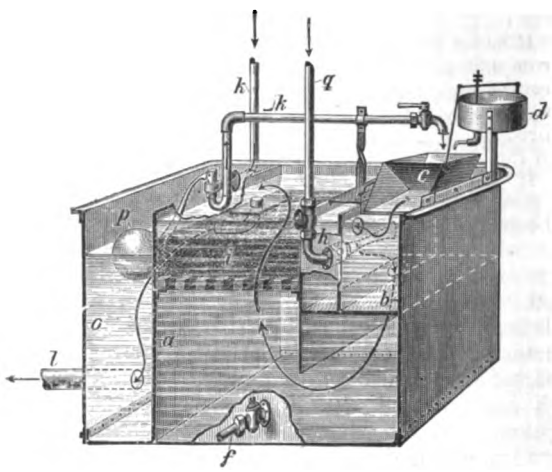
The company have reception-rooms at the Victorian Era Exhibition, Earl's Court, and also at their headquarters at Pelican House, Gerrard-street, Soho, where this invention may be tested.

PREVENTING BOILER INCRUSTATION.

There are many steam users who are paying annually large sums for cleaning out the hard deposits from their boilers, or an equal quantity of deposit which is only kept soft by the free use of boiler compositions, the cost of which is often a large sum per year.

The prevention of incrustation, or of the lime deposits in boilers, is better than means of keeping it soft for occasional removal, for this removal is not always easily done at the proper time, and is never easy from some parts of tubular boilers. These facts lend interest to the apparatus illustrated by the accompanying engraving for the continuous softening of feed water. Various apparatus for softening purposes have been brought before the public, but that explained below is interesting to a larger number of users because it is made in sizes suitable for the smaller requirements of from 50 to 700 gallons per hour, as well as for large outputs.

The water to be treated is led through the pipe *k* into one of the chambers of the tumbler receiver, *c*, and when this chamber is filled the centre of gravity is removed, and the receiver tips over in such a manner as to pour its contents into the mixing tank below, bringing the other chamber of the receiver below the cock at end of the pipe *k*. To the tumbler receiver is fixed a link, which at every oscillation actuates a valve fixed on the bottom of the holder, *d*, in which precipitation chemicals are contained. As the movement of the valve at *d* can be regulated, any given quantity of chemicals is by this arrangement mixed with the water. The impurities are precipitated to the bottom of the tank, *a*, while the pure water ascends through an intermediate filter, *i*, consisting of wood-wool, and leaves the apparatus through the pipe *l*. The precipitated impurities are removed by the cock, *f*, every four to six weeks, and the filter material is taken out at the same intervals to be cleansed, and can be used repeatedly.



The apparatus is made under the patents of Julius Brunn, and is being introduced by Mr. Paul Schon, 22, Walbrook, and Mr. John Siddeley, of 110, Fenchurch-street.

OXFORD ELECTRIC LIGHTING.

The following is the report of the working of the Oxford electric light system by Prof. A. B. W. Kennedy:

At the request of the Electric Construction Company, I arranged to make a complete test of the whole of the working of their system at Oxford, so as to arrive at figures which should represent the efficiency and economy of the arrangements used there. For this purpose I arranged to have a 24 hours' continuous test of the plant in the generating station and sub-stations, and carried this test out on December 22 and 23 last. I took the necessary staff with me from my own office, and was much aided by and obtained every facility from Mr. MacLean and his staff at Oxford.

At the generating station the whole of the coal (which was best Welsh) was weighed on to the boiler-house floor. In the engine-room the electrical output of the dynamos was measured, not only on the ordinary station instruments, but upon a Kelvin ampere balance and a Kelvin electrostatic voltmeter. I believe, therefore, that the units generated are known with very great accuracy.

The energy generated at the central station is transmitted at a pressure of about 1,000 volts to the Broad-street station in the city, which is the principal sub-station on the system, and where there are two continuous-current transformers and a battery. The current received at this station was measured by the station ammeters, and its pressure by the station voltmeters; the average drop in pressure during the whole time, between the generating station and Broad-street, on the primary cables, was 14·1 volts, or about 1·4 per cent. The efficiency of primary transmission was therefore 98·6 per cent.

The energy received at Broad-street is distributed by a high-tension switchboard to the motor transformers at six sub-stations. One transformer was not in use on the day of the trial. Broad-street itself constitutes one of these sub-stations. At each sub-station there is one or more continuous-current motor transformers, the number of these machines being in all 11. For the purpose of the test ammeters were placed in the secondaries at each sub-station, and readings were taken of these at frequent and regular intervals. These instruments were not so correct as the standard instrument used at the generating station, and their scales were not so convenient, especially in the lower parts, but taken as a whole I have no doubt that their indications are correct within small limits of error. The batteries at Broad-street were charged off the secondary of the transformers, through a booster, at the same station. They were charged in parallel with the ordinary supply of current and discharged into the secondary mains direct when the transformers were shut down, or, if necessary, in parallel with any of them.

The actual manner in which the work was carried on is shown graphically in Diagrams T 155 and T 158 which accompany this report. The test commenced at 6 a.m. on December 22, at which time the plant at the generating station was started. The plant was run until half-past nine, with three sub-stations in circuit; it was then shut down until soon after 2 o'clock,

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the secondary mains receiving current during this time from the battery, and none of the sub-stations being at work. At 2.15 the transformers in three sub-stations were started, and by 3 o'clock the regular switching in of the transformer stations began, the last of them being put in about half-past four. About 8 p.m. the first transformer was shut down, and at 1 a.m. the last was shut down. Up till 10 o'clock the battery was being charged, as shown on the diagram. After 1 a.m. the battery discharged on the circuit, and the test ended at 6 a.m. on the 23rd, when the plant in the generating station was ready to be started up again.

It ought to be mentioned that during several hours—namely, from 4.20 p.m. to midnight—a set of 20 arc lamps in series was worked direct from the primary terminals at Broad-street. This is the only portion of the whole output which is not taken through the motor transformers. The remaining 12 arc lamps on the circuit are worked from the secondary network.

It will be noted from the diagram that between 2.30 and 3 p.m., when the battery was doing the whole of the supply, the generating station was still at work, and transformers were

The diagram shows that the motor transformers generated 958·2 units, of which 172·0 units were taken up in charging the battery, leaving 786·2 units as delivered to consumers by the motor transformers direct. The total number of units delivered to consumers during the test was 902·1, the difference being made up by 115·9 units of battery discharged. Besides this amount, a further amount of 78·0 units was delivered to series arc lamps direct from the primaries, making the total kilowatt-hours delivered, including the arc lamps, up to the figure shown at the end of the curve of total kilowatt-hours delivered—viz., 980·1 kilowatt-hours.

A table appended to this report gives in figures various details of the observations made. It will be seen that the total units generated during the 24 hours amounted to 1,538·7, of which 980·1, or 63·7 per cent., were actually delivered to consumers, including, of course, the series arc lamps. The percentage thus given therefore represents the total efficiency of distribution, assuming that the consumers got 100 volts throughout. As a matter of fact they no doubt got a somewhat higher pressure on the average, but in a case of this kind it would not be right to

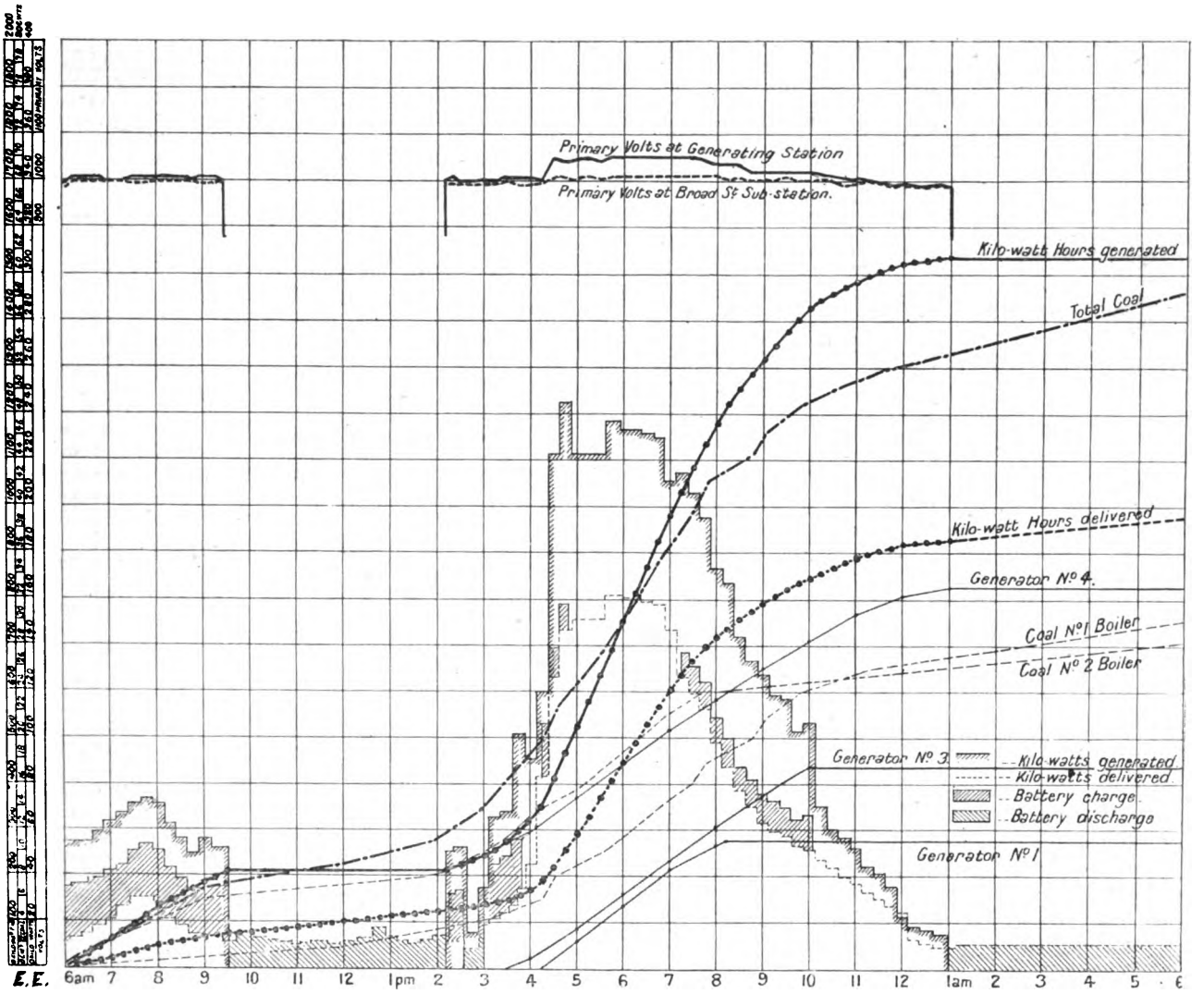
Primary Volts at Generating Station
Primary Volts at Broad St. Sub-station.
Kilo-watt Hours generated
Total Coal
Kilo-watt Hours delivered
Generator No 4.
Coal No 1 Boiler
Coal No 2 Boiler
Generator No 3.
Kilo-watts generated
Kilo-watts delivered
Battery charge
Battery discharge
Generator No 1
E.E.
6am 7 8 9 10 11 12 1pm 2 3 4 5 6 7 8 9 10 11 12 1am 2 3 4 5 6

DIAGRAM T 155.—Oxford Electric Lighting—Diagram of 24-hour Test, December 22, 1896.

running. This was done for the sake of measuring the amount of loss in the primaries of the transformers.

The Diagram T 155 shows not only the points just mentioned, but shows also the times at which the different generators were put upon the load at the station, the hours which they worked, their output, and the total output generated in kilowatt-hours. It shows by a separate curve also the total kilowatt-hours delivered to consumers as well as the coal used.

The Diagram T 158 shows more in detail the working of the sub-stations, and the way in which the total output delivered was made up. The zig-zag full lines show the output at each sub-station and the hours during which it was running as well as the load at which it was running, and the highest point in this zag-zag curve corresponds to the highest point in the curve of units generated by the motor transformers. Of the units generated by the motor transformers, a portion, which is shown on the diagram, goes into the battery as charge, and of this a portion is returned by the battery as discharge. The latter quantity has to be added to the kilowatt-hours delivered by the motor transformers to obtain the total number of units delivered to consumers.

take this into account. Allowing for the units used for station lighting and for the battery booster the actual proportion of the energy generated which was sold and paid for was 61·9 per cent.

The total coal used during the trial was 6,552lb., its calorific value being determined (by tests which I had specially made), at 13,850 British thermal units per pound. The coal used per unit generated was therefore only 4·26lb., a figure so exceptionally low that the actual coal used per unit delivered to consumers, even at the efficiency which I have just stated, was only 6·68lb.

Out of the whole energy generated, 172 kilowatt-hours, or 11·2 per cent., was used in charging the battery. The efficiency of the battery—that is to say, the ratio of units discharged to units charged—was 69·4 per cent. The loss in the battery, including booster and resistance losses, was thus 30·6 per cent. of its charge, which amounts to 3·6 per cent. of the whole units generated.

At the generating station three sets were run during the day, a larger set for 14¼ hours and two others for the smaller number of hours stated in the table. The load factor of the central station was 67·9 per cent. This is a fair figure, although no

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doubt if a higher one could be reached it would tend to increased economy. The comparatively low distribution efficiency is therefore no doubt caused by the low load factors of the different motor transformers. These are shown in the table, from which it will be seen that they vary from 19·4 to 52·0 per cent., and that the mean of the whole is only 39·6 per cent. As these machines, like any others of the kind, are necessarily much less efficient at low than at high loads, I have no doubt that the efficiency of distribution will rise at Oxford as the load increases and allows the sub-stations to be worked more nearly up to their proper output.

As regards the practical working of the system, I have pleasure in saying that everything during the trial went without a hitch, as it has done on former occasions when I have visited Oxford; and that although the system looks somewhat complicated on paper, yet in actual working it appears to give very little trouble and to be easily managed. I have visited the different sub-stations from time to time, not only on the day of the test but on other occasions, and have been pleased to find how easily they run without anybody continuously in attendance; in fact, with only an occasional visit from an inspector. The switching arrangements seem to act perfectly—they are all worked from Broad-street—and the arrangements for oiling the bearings, etc., work automatically for a long period without giving any trouble.

Total kilowatt-hours generated.....	1,538·7 kw.
Total kilowatt-hours delivered to consumers	980 1 kw. (Secondary volts assumed = 100.)
Maximum observed load at generating station	245·0 kw. at 4.45 p.m.
Maximum observed load delivered to consumers	161·5 kw. at 5.45 p.m., including the series arc lamps.
Mean primary volts at generating station	1,014·4 volts.
Mean primary volts at Broad-street...	1,000 3 volts. (Secondary volts assumed = 100 throughout.)
Efficiency of distribution.....	63·7 per cent.
Efficiency of distribution, allowing for station lighting and battery booster	61·9 per cent.

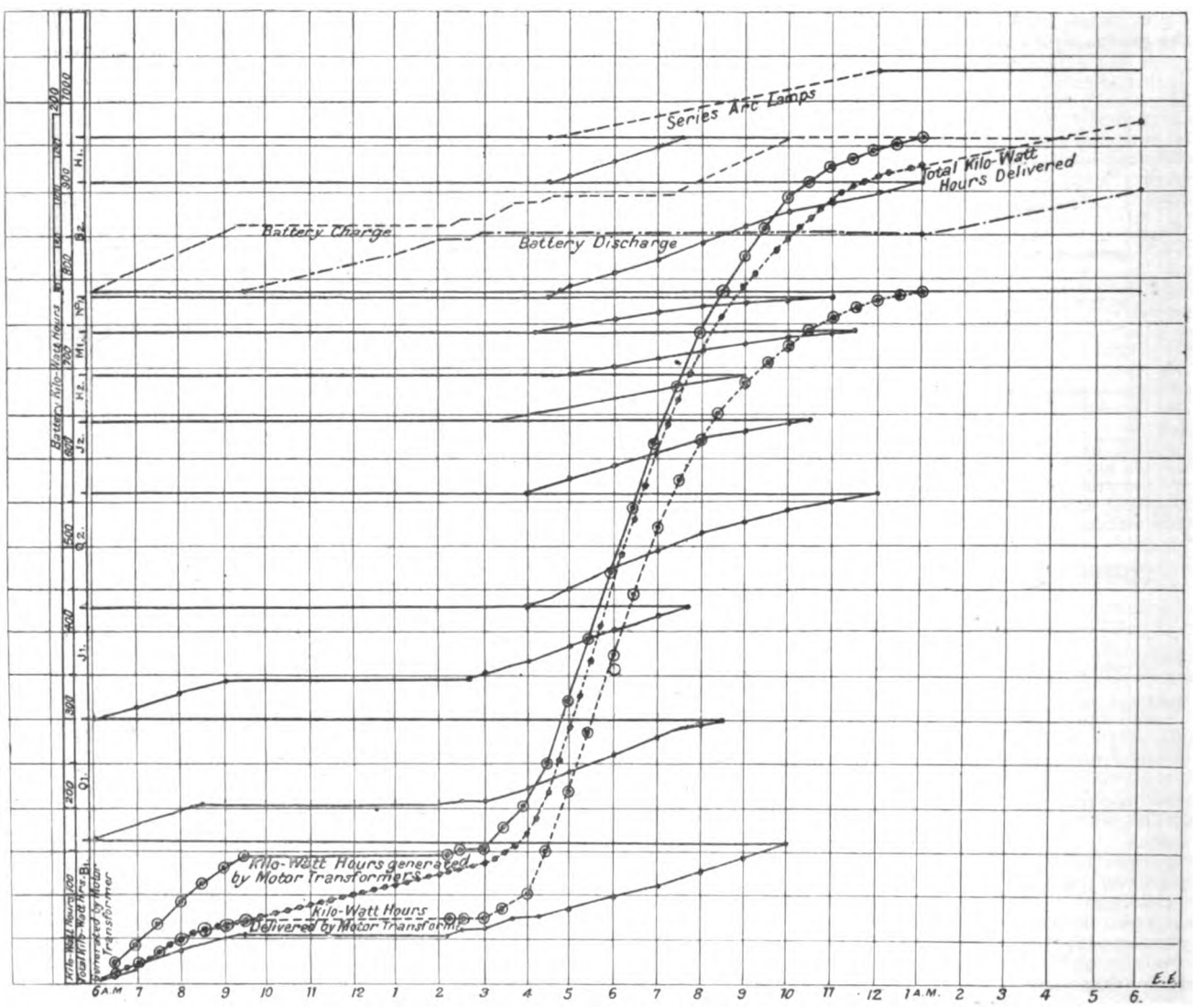
Series Arc Lamps
Total Kilo-Watt Hours Delivered
Battery Charge
Battery Discharge
Kilo-Watt Hours generated by Motor Transformers
Kilo-Watt Hours Delivered by Motor Transformers
6 A.M. 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12 1 A.M. 2 3 4 5 6.
E.E.

DIAGRAM T 158.—Oxford Electric Lighting—Diagram of 24-hour Test, December 22, 1896.

OXFORD ELECTRIC LIGHTING.

Date of test.....	December 22 and 23, 1896.
Duration of test.....	24 hours.

Generators at station.	No. 1.	No. 2.	No. 3.	No. 4.	Totals and means.
Total capacity..	80 kw.	80 kw.	80 kw.	100 kw.	260 kw., & one spare machine
Hours on circuit	4 hrs.	6½ hrs.	spare	14¼ hrs.	14¼ hrs.
Average output per hour	69·5 kw.	66·9 kw.	,,	57·9 kw.	107·9
Load factor.....	86·9	83·6	,,	57·9	67·9

Boilers at generating station.	No. 1.	No. 2.	No. 3.
Hours on load	8¾ hours	10¼ hours	spare
,, stand-by	15¼ hours	13¾ hours	,,
Coal used on load.....	2,360lb.	2,495lb.	,,
,, stand-by.....	1,025lb.	672lb.	,,

Total coal used	6,552lb.
Calorific value of coal	1,385 B.T.U. per pound.
Coal per kilowatt-hour generated.....	4·26lb.
Coal per kilowatt-hour delivered	6·68lb.
Battery at Broad-street	E.P.S. type L 35 — two batteries of 57 cells each.
Battery charge	1,220 ampere-hours = 172·0 kilowatt-hours.
Battery discharge	1,159 ampere-hours = 115·9 kilowatt-hours.
Battery excess charge over discharge	61 ampere-hours and 56·1 kilowatt-hours.
Battery mean volts during charge ...	141·0 volts.
Battery mean volts during discharge	103·8 volts.
Battery efficiency in ampere-hours ...	95 per cent.
Battery efficiency in kilowatt-hours—mean discharge volts = 103·8	69·4 per cent.

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Motor Transformers in Sub-Stations.

-	B1	B2	J1	J2	H1	H2	Q1	Q2	Q3	M1	N P1	Total
A	32·5	32·5	32·5	32·5	32·5	32 5	32·5	32·5	32 5	32 5	32·5	347·5
B	10·25	8·5	8·75	6·66	3·25	5·16	9·25	8·16	spare	7·25	6·75	—
C	15·4	16·5	14·5	13·2	16·9	8 2	15·2	15·6	—	7·0	6·3	—
D	47·4	50·8	44 6	40 6	52 0	25·2	46 8	48·0	—	21·5	19·4	—

A. Capacity in kilowatts. B. Hours on circuit. C. Average output per hour kilowatt. D. Load factor.

LEGAL INTELLIGENCE.

AN EDISON PATENT CASE.

In the Court of Chancery, on September 8, before Mr. Justice Byrne, the case of the Edison-Bell Phonographic Corporation, Limited, *v.* Locock was heard. Mr. Millar, Q.C., on the part of the plaintiff, moved for the committal of the defendant for contempt of Court in disobeying an order made by Mr. Justice Kekewich, on July 23, restraining him till judgment or further order from infringing the plaintiffs' patents for machines for the reproduction of sounds by means of wax cylinders. The interim order was made in the defendant's absence, though he had received due notice of it, and there was evidence that on August 3 he was exhibiting at the Royal Arcade, Weston-super-Mare, phonographs which were not made by the plaintiffs, or under their licenses, but which were said to have been manufactured in the United States, under patents of that country. He was instructed to press for a committal, because of the difficulty which the plantiffs had experienced in enforcing their rights. When they obtained an order against exhibitors, damages had not proved a very fruitful remedy, and the effect of an injunction had been to cause the machine to be transferred to another exhibitor.

Mr. Locock, the defendant, appeared in person, and expressed regret for what he had done, informed the Court that he not, since August 3, used one of the machines, and gave an assurance that he would not in future disobey the injunction.

Mr. Justice Bryne said under those circumstances he would not commit the defendant, but would only order him to pay the costs of the motion.

CONTRACTS FOR ELECTRICAL SUPPLIES

CONTRACTS OPEN.

Italy.—The Postal and Telegraph Department, Rome, invite tenders until September 14 for iron fixtures for telegraph poles.

Switzerland—Tenders are invited at Lausanne for a concession for erection and lease of electric works. Applications to be made to the Municipality before September 25.

Ploesti (Roumania).—Tenders are invited for lease of lighting the town by electricity for one or three years. Deposit, £120. Particulars may be obtained on application to the Municipal Authorities at Ploesti.

Lisbon.—Tenders will close on 23rd inst. for the supply of cables for lifts, for the Portuguese Railway. For particulars apply to 28, Rue de Châteaudun, Paris.

Paris.—The Managers of the Mont-de-Pieté invite tenders for an electric, acoustic, and telephonic installation. Tenders close September 25, at 1.30 p.m. For full particulars application is to be made to the Tribunal of Commerce, Paris.

Jassy (Roumania).—Contracts will close on September 18 at 4 p.m. for the electric lighting of the town of Jassy. Specifications, plans, and all particulars may be obtained at Paris, 80, rue de Varenne, at the Bureau des renseignements commerciaux.

Huddersfield.—Tenders are invited for the fitting up of the union offices, Ramsden-street, with the electric light, for the Guardians. Specifications may be obtained at the office of Mr. E. A Rigby, clerk, and sealed tenders must be sent to the Clerk by 10.30 a.m. on 13th inst.

Paris.—Tenders are invited for two large contracts for the supply of copper, iron insulated wire, and other materials for telegraphs and telephones. The tenders close on September 12 and 17 respectively. Full particulars may be obtained at the office of the Under Secretary for Posts and Telegraphs, 103, Rue de Grenelle, Paris.

London, W.C.—The Guardians of the Strand Union invite tenders for the installation of electric light at their offices, 15, Henrietta street and 29, Maiden-lane. Specifications of the work required may be obtained at the Guardians' Offices. 15, Henrietta-street, and tenders should be delivered to Mr. A. H. Maddocks, clerk to the Guardians, at the same place, on or before 14th inst., at 5 p.m.

Sydney (New South Wales).—Tenders are required by October 18, at noon, at the General Post Office, for supplies to the Telegraph, Telephone, and Post Office Departments, including iron, copper, and insulated wire, insulators, nails, screws, nuts, bolts, electric batteries with all accessories and chemicals, diaphragms, arc lamps, incandescent lights, 11,000ft. carbon for arc lamps, and various other appliances.

Leeds.—Tenders are required for the erection of an electric light installation in Kirkgate Market—two 30 b.h.p. gas-engines, two dynamos, and 40 enclosed arc lamps, and necessary wiring, etc.—for the Corporation. Plan and specification may be seen at the City Engineer's Office. Tenders to be sent to the Town Clerk's Office, endorsed "Tender for Electric Lighting," by noon on 10th inst.

Chertsey.—The Urban District Council invite tenders for an electric fire-alarm installation in connection with their No. 2 (or Addlestone) Fire Brigade. Particulars may be obtained on personal application to Superintendent Wood, Station-road, Addlestone. Tenders, with specification, and stating first cost and annual charge for maintenance, to be delivered to the clerk, Mr. T. E Harland Chaldecott, not later than 16th inst.

Nice.—The Secretary of State for Foreign Affairs has received a despatch from her Majesty's Consul at Nice, enclosing notices issued by the municipality of that city, inviting tenders for the lighting of the Nice Opera House by electricity. Tenders must be received at the Mairie of Nice by September 16, at 10 a.m. The estimate is £1,000. The despatch, with further particulars, may be seen at the Commercial Department of the Foreign Office any day between the hours of 11 and 6 o'clock.

Norway.—Her Majesty's Secretary of State for Foreign Affairs has received information from her Majesty's Consul-General at Christiania that tenders are invited by the Norwegian State Railway Administration for the supply of telegraph and telephone materials. Tenders will be received by the Administration up to 7 p.m. on September 22, 1897, and should be marked "Telegraf og Telefonmaterial," and addressed Tyrelsen's Expeditionskontor, Statsbanerne Christiania. Further particulars may be obtained on application at the Commercial Department of the Foreign Office between the hours of 11 and 6.

Russia.—Two concessions for the erection and lease of street railways are open for tender. These tramways may be worked either by electricity or any other means. Tenders for the works at Penza will close September 30. Particulars are to be obtained at the offices of the Municipal Administration. The second lot of contracts is for a similar undertaking in the town of Kontais, in the Caucasus. The municipal authorities will furnish applicants with particulars as to this work. For the benefit of intending contractors, we observe that they will save themselves time, and probably disappointment, if they will write their letters in French.

Halifax.—Tenders are invited for the supply and erection of a tramway switchboard. Specifications may be obtained on application to Mr. T. P. Wilmshurst, borough electrical engineer, Foundry-street, Halifax, on payment of £1. 1s, which will be returned on receipt of a bona fide tender. Tenders will only be considered from firms having experience in electric tramway switchboard. Tenders, endorsed "Electric Tramway Switchboard," must be sent to the town clerk, Mr. Keighley Walton, before 10 a m. on 20th inst. The person whose tender is accepted will be required to observe the fair contracts clauses adopted by the Corporation.

Ludlow.—The Corporation offers a prize of £20 for the best and most economical scheme of electric lighting for the borough. The scheme must deal exhaustively with the whole matter, and give definite information of the cost of steam and water power for the purpose of comparison with the total cost of the undertaking and working expenses. Schemes to be delivered at the offices of Mr. John Herbert Williams, town clerk, Ludlow, marked "Scheme for Electric Lighting," before 4 p m. on October 1. Should the Corporation employ the engineer whose scheme is awarded the prize to carry the work out, then the £20 will merge in the commission to which he would then be entitled to.

Whittingham.—Tenders are invited by the Lancashire Asylums Board for electric lighting and plant required at the new hospital and reception wards at the County Asylum, Whittingham. Plans and specification may be seen, and further information obtained, at the offices of Messrs. Simpson and Duckworth, architects, Richmond-chambers, Blackburn, and also at the offices of the consulting engineers, Messrs Fawcus and Clirehugh, Temple-chambers, Brazennose-street, Manchester, on and after 28th inst. General conditions, specification, and form of tender on deposit of £5. 5s., returned on receipt of bona fide tender. Tenders to Mr. J. P. Muspratt, County Offices, Preston, not later than first post on September 20.

Llandudno.—The Urban District Council invite tenders for the following work in connection with their electric lighting and dust destructor station: (Section A) water tube boilers; (B) condensing plant, steam plant, etc.; (C) steam engines and dynamos; (D) switchboard; (E) battery; (F) travelling crane; (G) underground mains, arc lamps, posts, etc. Copies of the specification, with form of tender and general conditions, can be obtained at the office of Mr. A H. Preece, A.M.I.C.E., 39, Victoria street, Westminster. Applications for any or all of the above must be accompanied by a cheque for £5. 5s., which will be refunded on receipt of a bona fide tender. Sealed tenders, marked "Electric Lighting Tender for Section —," must be delivered at the office of Mr. A. Conolly, clerk, Council Offices, Llandudno, by 10 a.m. on 22nd inst.

Plymouth.—The Corporation are prepared to receive tenders for engineering works in connection with the tramways of the borough, full particulars of which appear in our advertising columns. The contracts are divided into two—viz. (Contract No. 10) overhead trolley line, posts, brackets, etc.; (Contract No. 11) tramcars, trucks, motors, trolley arms, etc. Contractors may tender for either of the contracts, but not for a part of any contract. Copies of the conditions, specifications, and forms of tender, bound up together, may be obtained on deposit of £2. 2s., for each copy, which will be returned on receipt of a bona fide

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tender upon the prescribed form, and within the stated time. A copy of the drawing of posts will be sent to those wishing to tender for Contract No. 10. Sealed tenders, endorsed "Engineering Contract No. —," must be delivered to Mr. J. H. Ellis, town clerk, Plymouth, not later than October 2. The acceptance of any tender will be subject to the contractor paying the standard rate of wages obtaining in the district where the work may be carried on.

Hull.—The Corporation are advertising for tenders for the electrical equipment of their tramways, to the extent of about nine miles double track and half mile single track. It will be open to contractors to submit tenders for various systems, and the contract, which will not be divided, will include engines and generators, switchboards, feeders, poles, brackets, trolley wire, rail bonding, and all accessories, also the first instalment of cars (15 motorcars and five trailers). It is expected that the specification, lithographed plans of the routes, and other particulars will be ready for issue early in September, and copies, when ready, may be obtained from Mr. A. E. White, city engineer, Town Hall, Hull, by persons proposing to tender, upon payment of a deposit of £10, which will be refunded upon receipt of a bona fide tender and return of the papers and plans supplied. Cheques to be made payable to Mr. Thos. G. Milner, city treasurer. Tenders, endorsed "Tender for Tramway Equipment," are to be addressed to the Chairman of the Works Committee, and delivered at the Town Clerk's Office, Hull, before noon on November 5.

West Ham.—The West Ham Council require tenders for the wiring for electric lighting of the technical institute and public library, Romford-road, Stratford, E. Persons desirous of tendering are requested to send their names to Mr. Fred. E. Hilleary, town clerk, Town Hall, West Ham, by 6th inst., together with a deposit of a Bank of England note for £10, which will be returned after the tenders have been considered by the Council, and provided the tender is bona fide and has not been withdrawn. To each person making such deposit will be sent a copy of the plans, specification, and form of tender, prepared by Messrs. Gibson and Russell, 11, Gray's-inn-square, London, W.C. Sealed tenders, to be enclosed in endorsed envelopes supplied with the forms, to be delivered to the Town Clerk by 20th inst. The contractor whose tender is accepted, and with whom a contract is entered into, will be required to enter into a bond with sureties for the due performance of the contract, and he will also be required to pay to the whole of his workmen such rates of wages and observe such hours of labour as are recognised by the workmen's trades unions and in force at the time of signing the contract.

Barking Town.—The Barking Town Urban District Council are prepared to receive tenders for the supply and erection of the following plant: Section A.—Generating plant, boilers and fittings, economiser, feed pump, injector, etc.; steam dynamos, condensers, oil filter, fittings, etc.; steam, exhaust, feed, blow-off, and sundry pipes; valves, water-tank, etc. Section B.—Storage batteries. Section C.—Switchboard and all connections. Section D.—Overhead travelling crane. Section E.—Conduits and mains for private supply. Section F.—Mains for public lighting, and adaptation of existing lamps. Section G.—Arc lamps and posts. Tenderers are at liberty to tender for any section or sections, or for the whole of the sections, but not for part of a section. Successful tenderers will be required to enter into a contract to pay the trades union rate of wages and to observe the trades union hours of labour. The ground plan of plant, diagram of switchboard, plan of streets, etc., and specifications, with forms of tender, may be obtained at the offices of Mr. W. C. C. Hawtayne, the consulting engineer to the Urban District Council, Mansion House-chambers, 20, Bucklersbury, E.C., on payment of £2. 2s., which sum will be returned on receipt of a bona fide tender. Tenders, sealed and marked "Tender for Electric Lighting," addressed to the Chairman of the Urban District Council, Council Offices, Barking, must be sent in by noon on September 21.

Madras—Tenders are invited for the utilisation of water flowing from the Periyár Lake for purposes other than irrigation and not incompatible with the use of the water for drinking. The irrigating season extends over nine to ten months, during which time the discharge is likely to be from 1,100 to about 500 cubic feet a second, according to the demands for irrigation and the available quantity in the lake. Subject to the risk of interruption by accident or drought, supply can be given throughout the irrigation season. No supply can be guaranteed at other times, but, so long as water is available, the Government will be prepared to issue it in such daily quantities as may seem to it advisable with reference to the time which is likely to elapse before the supply is replenished by the setting in of the rains. The fall from the tunnel to the foot of the hills is approximately 900ft., and the distance measured along the course of the stream about 6,800ft. One cubic foot per second falling 900ft. is estimated to produce over 60 effective horse-power. Intending lessees should state the quantity of water required in cubic feet per second and the annual rent offered for each cubic foot per second. No rent will be charged for the first year from the date of the concession; for the second year the charge will be one-fifth, and an additional charge of one-fifth will be made every year until the full rent is reached. The whole or part of the concession may be surrendered on a year's notice being given. Lessees will construct at their own expense, on plans to be approved by Government, all the weirs and other works required to divert the water from the river below the tunnel. For further information, application may be made to the Chief Engineer for Irrigation, Madras, by whom tenders will be received up to October 31, 1897.

Port Elizabeth (Cape Colony).—The Town Council of Port Elizabeth (Cape Colony) invite tenders for lighting the streets and municipal buildings of Port Elizabeth by electricity, in consideration of the grant of a concession for the exclusive right of supplying electric current through the streets and roads of the town, to private houses, stores, etc., for terms of 5, 15, 20, 25, or 30 years respectively. There are approximately about 54 miles of streets in the town, as follows: main thoroughfare, 5 miles 1,196 yards; principal streets, 16 miles 1,433 yards; minor streets, 32 miles. The streets of the town are at present lighted by 380 gas lamps of reputed 16-c p. The municipal buildings consist of town hall, municipal offices, morning market, feather market, wool market, and museum. The main streets are to be lighted by arc lamps, and the side streets and municipal buildings by incandescent lamps. Tenderers must state at what sum per annum they are prepared to adequately light the streets and municipal buildings for the various periods mentioned above, if they are granted a concession for any one of the periods referred to. The concession will provide, inter alia, that the particular system and plant to be adopted by the concessionaires shall be subject to the approval of Council; the charge for supplying current to private houses shall not exceed 1s. 9d. per London Board of Trade unit; and that the Council will have the option of taking over the whole undertaking, etc., at a valuation to be made in case of difference by two arbitrators or their umpire at the end of the period of the concession at the then value of the plant and mains. Tenders, endorsed "Port Elizabeth Electric Lighting," should be delivered to the agents of the Municipality, Messrs. Davis and Soper, 54, St. Mary-axe, London, E.C. (from whom further information may be obtained), on or before September 21.

BUSINESS NOTES.

Wallington.—The Parish Council will ask the next parish meeting to consent to an expenditure of £600 for public lighting.

Cork.—We are informed that the work in connection with the proposed electric tramways in Cork is to be taken in hand almost immediately.

Weybridge.—The Council have refused an application by the National Telephone Company for permission to erect a lines of poles on the roadway.

Zurich (Switzerland).—The Lower Municipal Council has asked the higher authority for a credit of £44,000 for the extension of the municipal electrical works.

Hastings.—The electric light company has acceded to the Lighting Committee's request to extend the period for lighting the front line to September 30.

Dundee.—A committee has under consideration the extension and alteration of motive power of the tramways, which are to be taken over by the municipality.

Leatherhead.—The Urban Council have decided to present a memorial to the Board of Trade applying for a provisional order under the Electric Light Act, 1882.

Blackpool.—The Town Council decided on Tuesday night by 11 votes to 7 that the overhead electric system be substituted for the conduit system now in use on the tramways.

Commercial Cable Company.—The directors of the Commercial Cable Company have declared a quarterly dividend of 1¾ per cent. on the capital stock, payable on October 1.

Change of Address.—Messrs. Dick, Kerr, and Co., the tramway engineers and contractors, have moved the London offices from 101, Leadenhall-street, E.C., to 110, Cannon-street, E.C.

Barking.—The District Council have decided to apply to the Local Government Board for power to borrow £15,000 to carry out a scheme for the public lighting of the town by electricity.

Brighton.—Electricity mains are to be laid, at a cost of £194, £100, and £200 respectively, and the surveyor has been instructed to report to the Council upon the lighting of Castle and Stone streets.

St. Albans.—The Corporation will at its next meeting discuss, and probably decide upon, the question whether a provisional order be obtained in connection with the proposed electric lighting of the district.

West Hartlepool.—The Council have decided to purchase 3½ acres of land in the vicinity of Burn-road for a site for a refuse destructor and for the erection of a generating station for electric lighting purposes.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended September 5 amounted to £1,382, as compared with £1,212 in the corresponding week of the previous year, being an increase of £170.

Edinburgh.—At a meeting of the Electric Lighting Committee of the Town Council the engineer reported that the applications for electric light since May 18—the close of the financial year—amounted to 24,663 lamps of 8 c.p.

Chingford.—The Gilbert Arc Lamp Company, Limited, have taken extensive works here for the manufacture of their arc lamps, dynamos, and other specialities. The buildings are being added to and put in order as quickly as possible.

Cricket.—The teams of the central vestry stations of Shoreditch and Chelsea played their match last Saturday. Shoreditch won by 43 to 37 in the first innings, but were only saved from defeat in the second innings by the watch.

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Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended September 3 were £2,543. 10s. 1d., compared with £2,374. 0s. 2d. for the corresponding period of last year, being an increase of £169. 9s. 11d.

Wormit.—A public meeting was announced for September 8, when a scheme for the lighting of the village by electricity was submitted. This, it was contended, could be accomplished by utilising the rise and fall of the tide in driving dynamos.

Whitehills.—Telephonic communication was on Monday opened between Banff and Whitehills. The public have access to the instrument at Whitehills on payment of the small charge of one penny for a conversation of five minutes' duration.

Accident.—With regard to the accident which occurred at the Borough Station of the City and South London Railway on Friday last, we note from the coroner's enquiry that the fact of the railway being worked by electricity was in no wise connected with the occurrence.

Peterborough.—The Peterborough Electric Light and Power Company asked to be allowed to treat with the Corporation for the transfer of the powers obtained by the Corporation in the matter of the electric light. The matter was left to the town clerk and borough engineer to report upon.

City and South London Railway.—The returns for the week ended September 5 were £875, compared with £848 for the corresponding period of last year, being an increase of £27. The total receipts for the half-year 1897 amounted to £9,027, compared with £9,181 for the corresponding period last year, being a decrease of £154.

Rochdale.—At the Town Council meeting a resolution was passed adopting the report of Mr. E. M. Lacey, the consulting electrical engineer, on the proposed electrical works for the borough. The estimated cost is £22,000, the cost of working (including capital) £3,120, the estimated profits £4,004, which leave an annual surplus of £884.

Montrose.—The *Montrose Standard* contains the following under the heading "What Montrose Folks are Saying": "That the Town Council's electric light deputation returned from England in detachments. That 'the play's the thing' when seen in a first-class theatre fitted with the electric light. That the Bailie may have some scheme to propound for getting electric footlights in the burgh hall stage."

Maidenhead.—The committee recommended at the quarterly meeting of the Town Council that the town clerk be authorised to take the necessary steps for obtaining a provisional order for electric lighting, and, further, that Messrs. Sharpe, Parker, and Co. (Association of Municipal Corporations) be employed as parliamentary agents in the matter. The latter point was deferred until the next meeting of the Council.

Wallasey.—The minutes of the Gas, Water, and Electricity Committee, presented at the ordinary monthly meeting of the Wallasey District Council last week, contained a resolution that the sum of £15 000 be borrowed to lay an extra electric plant for the supply of 75,000 units per annum for not less than three years at 3½d. per unit to the New Brighton Tower Company, the supply to be given by March 31, were approved.

Electricity in Nubia.—Speaking of Wady Halfa the *Times* correspondent says: "The new Halfa is, indeed, a triumph of engineering enterprise; strange, indeed, it seems and incongruous, standing as it does amid the sands of this remote Nubian desert, a busy, bustling place, noisy with the clanging of hammers on metal, etc. The workshops are well built of burnt bricks, and will shortly be lit throughout by electricity."

Manchester.—Mr. Alderman Higginbottom, chairman of the Electricity Committee of the Manchester Corporation, Mr. J. Phythian, deputy chairman, and Mr. C. H. Wordingham, electrical engineer, have left Manchester on a visit to the Continent to inspect various electrical workings. They purpose visiting several towns in France, Germany, and Belgium, and will take special note of all appliances for electric traction.

New Companies.—A company has been formed to acquire certain rights of the Bermuda and Halifax Cable Company with the object of extending and working that cable to Jamaica *vid* Turks Island.—The Ventnor Electric and Power Company, Limited, has been registered with a capital of £15,000 with the object to carry on the business of electricians, electrical engineers and contractors, electrical apparatus manufacturers, etc.

Walsall.—Considering the fact that municipalities have not only to pay the interest on the capital and the working expenses, but have to provide a certain amount annually for a sinking fund, the result of the first year's working of the electric lighting installation in Walsall is very satisfactory indeed, the deficit, after all capital charges have been paid, being only £445. Next year this amount will, we believe, be easily wiped off the debit side.

Bray.—A deputation of ratepayers waited upon the Commissioners last week. The use of the town hall was granted to them for a meeting on condition that none but ratepayers should be admitted to the meeting except the gentlemen promoting the tramway project. Notice of motion was given for the next meeting of the Council to the effect that the pier and tramways schemes be separated, and the tramways scheme allowed to take precedence.

St. Helens.—Colonel W. Langton Coke, M I.C.E., an inspector of the Local Government Board, has held this week the enquiry announced in our last issue into the application of the St. Helens Corporation to borrow £67,328 for several works which have been decided upon by the Council. This sum includes an item of £17,000 required for the extension of the electricity works and the laying down of additional plant for the production of electric light. It appears that there is no opposition to this part of the scheme.

Fire.—A fire occurred in the Science Library at the South Kensington Museum on Tuesday evening, arising from a piece of carbon that fell from one of the arc lamps. The library was full of readers at the time. The fire was at once extinguished. There is absolutely no excuse for these fires caused by the dropping of a piece of carbon out of the arc lamps, as a little foresight on the part of the engineer will easily prevent any such accidents.

Edinburgh.—The first meeting of the Town Council after the holiday vacation was held on 7th inst. The Cleaning and Lighting Committee and the Electric Lighting Committee recommended the introduction of the electric light into Portobello. In opposition it was said that the Council proposed to spend £8 500 this year in Edinburgh for public electric lighting, and in these circumstances there was no great call for the light being extended to Portobello at this moment. Finally, the motion was carried by 24 to 17.

Darwen.—For the monthly meeting of the Darwen Town Council the following notice of motion is contained in the agenda: "That inasmuch as an offer for the supply of electricity has been sent to the town clerk, and by him passed over to the Electrical Lighting Committee, and by them withholding the contents of such offer from the remaining members of the Council, it is proposed that the Electric Lighting Committee's report be not adopted until such time as the other members have had an opportunity to consider the same."

Coventry.—The Council having referred back to the Electric Lighting Committee their report with certain objections, as noticed in our issue of August 20, that body has now submitted modified proposals. The committee will on the next occasion recommend that the electric lighting of the streets be not proceeded with, thus saving £2,000, and that a further saving of about £5,000 be effected by only laying certain cable mains according as the necessity arises. By these proposals the suggested expenditure of £37,900 will be reduced to £31,000.

Formby.—At the last monthly meeting of the Parochial Committee, the following resolution was adopted: "That the Formby Parochial Committee be requested to call a public meeting of the township to decide, by poll or otherwise, whether it is advisable or not to light all or any of the roads of the township." It was stated that the committee were in correspondence with two electrical firms upon the subject. The Chairman said that in the opinion of some people who had a knowledge of the subject, electric light would be the cheapest illuminant.

Saddleworth.—At the fortnightly meeting of the District Council a letter was read from Messrs. Deacon, Gibson, Metcalf, and Goddard *re* the proposal of a public company to obtain powers for the supply of electricity to the Saddleworth area The Chairman said they should be very careful about conceding monopolies of this kind. It was stated that the representative of the company would like to consult with a sub-committee of this Council upon the suggestion that no harm could come from an interview. A committee was appointed for that purpose.

Driffield.—At a meeting of the Rural District Council on the 8th inst. a letter was read from Messrs. Harland and Sons, solicitors. Bridlington, agreeing to certain modifications suggested by the Council in regard to the proposed light railway from Beeford to Bridlington. A resolution was adopted approving of the scheme as likely to be of great benefit to the district. The chairman of the Highway Committee and the clerk of the Council were appointed to represent the Council at the enquiry, which it is expected will be held at Bridlington.

Cosely.—At a meeting of the Council this week it was reported that negotiations had been proceeding with the South Staffordshire Power and Blast Furnace Company, Limited, the Midland Electric Corporation for Power Distribution Company, and the Imperial Electric Lighting Company, with regard to the electric lighting of the district. There was no time to lose if the Council considered it advisable to obtain an order themselves, as it would entail a large amount of work. Further consideration of the question was adjourned till next week.

Darlington.—The electric lighting scheme is estimated to cost £20,000. At the last meeting of the Town Council, a statement was made to the effect that unless the Corporation put down an electric installation the North-Eastern Railway Company would provide an installation for themselves. The Gasworks Committee presented a minute on the subject, stating that further consideration had been given to this subject, and that a sub-committee had been appointed to gather information and report on the matter. After a lengthy discussion this minute was adopted.

Wrexham.—At the quarterly meeting of the Town Council a communication was read from the Local Government Board stating that the Board must defer their decision upon the application of the Town Council for sanction to borrow £8,200 for the purchase of the Willow Brewery premises for electric light station, baths, gymnasium, etc., until they were furnished with an approximate estimate of the cost of providing these various institutions. It was resolved to engage Messrs. Lockwood and Barker, architects, Wrexham and Chester, to prepare the estimate asked for.

Bristol.—The abstract of the accounts of the Corporation of Bristol, so far as they relate to the Urban Sanitary Authority, has just been published on the lines which Mr. Crompton, F.S.A.A, adopted a few years ago. The Electrical Committee have spent £3,826, and the accounts show a profit of £8,568 on the working expenses for the year. After taking into account the

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interest and repayment on account of loans, a net profit of £1,477 remains, which, added to the credit balance at the commencement of the year, produced a surplus on March 25 last of £3,964.

University College, Nottingham.—The courses of instruction in mechanical, electrical, and civil engineering of this college, extending over two or three years, commence on October 11, under the direction of Prof. W. Robinson, M.E., A.M.I.C.E., M.I.M.E. The mechanical and electrical engineering laboratories are thoroughly equipped for practical and research work; also those for practical physics, chemistry, and metallurgy. The workshops are open for students during September, when early applications for admission should be made. Prospectuses will be supplied free upon application to the secretary.

Datchet.—The Parish Council have held an indignation meeting, at which they passed a resolution with regard to the refusal of the Conservators to provide telephonic communication between the locks of the Thames to regulate the flow of the water, as follows: "That the Conservators are regardless of the wishes and opinion of the local authority most deeply interested in the avoidance of floods," and resolved to ask the President of the Board of Trade to exert his influence to obtain a reversion of the decision of the former body. After the floods of 1894 H.M. the Queen expressed an opinion in favour of some steps being taken to avert future floods.

Sheffield.—As stated in a previous issue, the Corporation, having purchased the tramway system in the city, have decided to introduce the overhead electric system in an experimental way. The routes selected were Nether Edge (a suburban district) and Attercliffe (a working-class neighbourhood). The former now stops at Moorhead, and the latter at Lady's Bridge. It has been decided to connect the two by continuing the rails along Penistone-street, Fargate, High-street, Haymarket, and Waingate—the central thoroughfares of the city. The Council propose to greatly extend the tramway system in the city as rapidly as possible.

Halifax and Bermuda Cable Company, Limited.—The report for the year ended June 30, 1897, states that the cable receipts in the year were £3,742, as compared with £3,339 in 1895-96. This increase is due to the general improvement of trade in Bermuda. The net result of the year was a profit of £952, as compared with £492. Offers for the sale of debentures to the trustees were invited in December and June last, when £3,900 of debentures were acquired and cancelled at a cost of £3,578. The profit of £952 and the sum of £3,900 on account of debentures redeemed during the year, are applied to writing down the capital expenditure.

Hoole.—At the last Council meeting the question of lighting was discussed. The report of the recent meeting of the Chester Gas Company was referred to, in which it was stated that the chairman, in response to a question asked by a shareholder about the lighting of Hoole, said the gas company must first be approached by the local authority on the subject. It was proposed that the Council ask the gas company to put incandescent lights on the Hoole-road. Others said that if they went in for improved lighting in Hoole-road, the best plan would be for them to approach the city in regard to the electric light. No definite decision was arrived at.

The Laundry Exhibition.—By one of those strange accidents which lay in wait for the most wary, we made an important omission in our report last week of this exhibition. We gave a list of electrical engineering firms which were exhibiting there, and this list was intended to be complete, but we have discovered since that we made no mention of one of the most important firms there. We allude to Messrs. F. A. Glover and Co., who had a very large and varied display of electrical apparatus and fittings. Messrs. Glover were, too, the only firm who showed electrical irons in actual operation, and their stand merited and excited a considerable amount of attention.

Audenshaw.—The District Council have had considerable difficulty about the acquisition of the necessary land for the proposed electric tramway. At the last monthly meeting the following letter was read: "Dear Sir,—I have received your letter. I shall advise my directors, if we cannot get the necessary frontagers' assent either by negotiation or by public pressure, to go for a Bill in Parliament to get compulsory power.—Yours faithfully, the British Electric Traction Company, Limited, Great Winchester-street, London, August 31, 1897." The feeling in the Council is strongly in favour of compelling the company to widen the road in question (Hooley-hill).

Appointments Vacant.—We beg to draw attention to various vacancies advertised in another column, and note particularly that the Northampton Institute, Clerkenwell, London, E.C., invites applications for a junior demonstrator in electro-technics and a physics lecture assistant. The latter is to give his full time to the institute; the former is required for two evenings only. Forms of application and particulars as to salaries, etc., may be obtained by writing to the office of the institute, St. John-street-road, Clerkenwell, London, E.C. Applications are to be made in writing on or before 1 p.m. on Saturday, 25th inst., to the principal, Prof.. R. Mullineux Walmsley, D.Sc, etc.

Brighton Municipal School of Science and Technology.—The day section of the Municipal School of Science and Technology will be opened this month, and will embrace the following departments—viz., mechanical engineering, physics and electrical engineering, chemistry and metallurgy, and natural science. In each of the above departments courses of instruction covering a period of three years for students not under 14 years of age will be arranged. Also courses for matriculation, intermediate, and final B.Sc., and preliminary M.B. examinations of London University. Tuition fee, 15 guineas per annum. Further particulars may be obtained from the principal, Mr. C. H. Draper, B.A., D.Sc. (Lond.).

Liverpool.—The city electrical engineer has submitted for the consideration of the Lighting Committee a report, in which he proposed that the future demand for electrical energy should be provided for in the following way: That sites should be secured, preferably at Pumpfields and Edgehill, for two generating stations, each with sufficient space to contain plant of 1,500 h.p.; that the stations should be designed for construction in sections as the demand for electrical energy increases; that the system of generation and distribution should be direct current not exceeding 550 volts pressure, except for the outlying districts, and that the engines should be compound or triple expansion, with condensing apparatus, each capable of developing 1,000 h.p. at most economical load.

Norwich.—Various important items are to be discussed at the Council meeting in Norwich this week. The first item is to require the Norwich Electric Tramways Company, Limited, to give notice on or before October 1, 1897, to apply in the next session of Parliament for authority to construct an extension of tramway No. 9, together with any street widening in connection therewith which the Corporation may require; and also for authority to widen St. Andrew's Broad-street. Further, to consider the nomination of a committee to approve of the price of the lands, buildings, or manufactories proposed to be purchased for the purposes of the new streets and street widenings. Also to consider the advisability of delegating to a committee the powers and authorities given to the Corporation by the Norwich Electric Tramways Act, 1897.

Perth.—As reported in a previous issue, a special meeting of the Town Council was held some time ago to meet Mr. Gripper, managing director of Edmundson's Electricity Corporation, Limited (who had offered to attend and give the Council any further information they might desire on the subject of electric lighting), and who gave certain information about various points. Further consideration of the subject was adjourned. On August 23 last, Mr. Thomas Barton, M.I.E.E., Blackburn, met the special committee in charge of this matter. He gave an interesting dissertation on the subject of electric lighting and the destruction of refuse, and answered a variety of questions with reference to the installation of electric light and the construction and erection of a station and plant in Perth. It being reported that Mr. Barton, who had attended the meeting of committee on Monday evening, was to send in a report on the introduction of electric lighting in Perth, the meeting adjourned further consideration of the subject until Mr. Barton's report should be before them.

Lincoln.—The *Nottingham Daily Guardian* of the 8th inst. has the following report of the Town Council: A meeting of the Council was held last night, the Mayor (Mr. T. Wallis) presiding. A discussion was raised by Mr. Udale as to whether the Corporation had obtained the consent of the Local Government Board to purchase the land for the purposes of the electric light. The Mayor replied that the Council thoroughly understood that they might buy it. Mr. Udale said it was irregular. Alderman Page contended that the matter had been confirmed by the Corporation. There was nothing irregular. Mr. Udale contended that the consent of the Local Government Board was necessary before land could be purchased outright. Alderman Page wanted to know whether it was regular on the part of Mr. Udale to raise these questions month after month, when the Corporation had confirmed its actions. The deputy town clerk (Mr. H. K. Hebb) said of course it was the proper course to wait until they received the consent of the Local Government Board, but the Council were satisfied to purchase the land and pay for it out of the general district rate. Mr. Turner: It is technically irregular. The Mayor said that was not so, as it was perfectly understood and sanctioned by the Corporation.

Bexhill.—At the fortnightly meeting of the Urban Council on Monday last a discussion on the proposed electric lighting scheme took place. The committee reported that they had made arrangements with Mr. Walter Whiteman for a provisional contract for purchasing half an acre of land in Reginald road for £500 as a site for the proposed works. They also stated that they had had an estimate from Mr. Preece of £19,500 for an installation, including cost of site etc. It was resolved that application be made to the Local Government Board for sanction of a loan of £20,000 to cover the cost of the electric lighting scheme, according to the plans and estimates prepared by Mr. Preece. The mover remarked that the committee, which consisted of the whole body, had applied for and obtained a provisional order. They had worked out plans and specifications, and the only thing that now remained was the question of the site. The one upon which they had decided was a good one. There was plenty of water close by, and now the Council were in a position to ask for the sanction of the loan. As one of the conditions under which the provisional order was granted was that certain roads should be lighted, it was necessary that they should make their application without any further loss of time. Although it might not be made to pay the first year, in a short time it would pay them handsomely, and help the rates considerably, besides giving them a better light. Considering the rapid way in which the town was growing, and the prospects of continued growth, it was a matter of necessity, and many people would take the light.

Southend.—The Electric Lighting Committee have obtained a report from Prof. Kennedy, and will recommend to the Council at a special meeting convened for the 22nd inst. as follows: (1) That

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the Corporation do themselves undertake the supply of electrical energy pursuant to the Electric Lighting Order, 1891. (2) That Prof. Kennedy's report of May 8, 1896, and the suggestions therein contained be adopted. (3) That a portion of the Corporation's land at the rear of London-road be utilised as a site for the station. (4) That this committee be empowered to take either of the following courses—viz., to invite applications for the appointment of permanent electrical engineer at a salary of £250 per annum, and that it be the duty of such engineer, under the instructions of this committee, to prepare plans, sections, drawings, and specifications, and to supervise the carrying out of the work, or to instruct Prof. Kennedy to prepare plans, sections, drawings, and specifications, and to superintend the carrying out of the work pursuant to the terms of his agreement with the Corporation. (5) That application be made to the Local Government Board for sanction to borrow such amount (not exceeding £15,000, without further authority of the Council) as will be necessary to carry out Prof. Kennedy's report. (6) That it be referred to the Law and Parliamentary Committee to oppose (if the necessity arises) any applications by either of the companies before mentioned, or by any other persons, for powers to supply electrical energy and current within the borough, and also to oppose any application that may be made to the Board of Trade for the revocation of any of the powers vested in the Corporation by virtue of the Southend Electric Lighting Order, 1891, and, if requisite, to apply to the Board of Trade for an extension of time within which to comply with the provisions of the order.

Isle of Man.—The capital of the Isle of Man Tramways and Electric Power Company, Limited, is being increased to £300,000 in order to enable them to proceed at once with the extension of the electric tramway from Laxey to Ramsey, for which they have received the sanction of the House of Keys. This will complete the line from Douglas to Ramsey, a distance of 19 miles. The capital to be expended upon the extension will be kept entirely distinct from any expenditure upon the other system. The revenue and expenditure will also form a distinct account, as the balance of the revenue of the extension will be available, after the establishment of a reserve fund and after providing for renewals, for payment of interest upon the 4 per cent. debentures, the 5 per cent. preference shares, and for dividends upon the ordinary shares. During the three years of the existence of the company dividends have been paid at the respective rates of 7½, 8, and 8 per cent. A deputation which was appointed some months ago by the Town Council of Douglas to visit Paris Dresden, Berlin, Brussels and other Continental cities, and inspect the various systems of electric and other traction in use, have issued their report, which is drawn up by the town clerk of Douglas, Mr. T. H. Nesbitt. After dealing with various systems, the deputation sums up in favour of the overhead electric trolley system for the Douglas Promenade. A strong reason advanced in favour of the adoption of that system is that poles carrying overhead wires can also be used for the electric lighting of the town. At a special meeting of the Douglas Town Council held on 7th inst., the adoption of the recommendation of the special committee that the Council approve of the system of overhead electric traction being adopted by the tramways company in connection with Douglas Bay tramway was proposed. The recommendation was opposed on the ground that the promenade would be disfigured by poles that carried wires. The debate was adjourned for a month.

Selly Oak.—The new infirmary, which was opened this week, contains accommodation for about 300 beds for patients and officials, whilst provision has been made for a future extension of a similar number. In the centre are the one storey kitchen block and administrative buildings, which are connected to the building by covered ways. The doctors' rooms, nurses' general sitting-room, sewing-rooms, matron's rooms, steward's stores, dispensary, telephone exchange room, and nurses' and servants' residences are in the centre and under the supervision of the matron, with lavatories, bathrooms, etc., complete. This portion of the building is not made too large, because when the extension is made in the erection of the other pavilions a detached nurses' residence will be erected adjoining. The cooking kitchen, sculleries, pantries, stores, etc., are at the rear of the administrative block, centrally placed, and easy of access from the male or female portion of the block. Adjoining the central or administration block, and off the main corridor, are placed the receiving wards for male and female patients. The pavilions are axially arranged nearly north and south, with fire and sound proof floors. It was originally intended to heat the new building from the workhouse boilers, but, in consequence of the Local Government Board's requirements, the Guardians have built a boiler-house, engine-house, dynamo-rooms, laundries, and water-tower at the rear of the new building, together with three large boilers and a tank in the water-tower capable of holding a sufficient supply of water, which is pumped from the well in the workhouse. Adjoining the boiler-house is a large coal-store. Near to a high chimney shaft, built to carry the smoke away from the new building, is the engine and dynamo room, in which are placed powerful steam-engines to create the electric supply for lighting the whole of the rooms in the infirmary, and also the arc lamps to illuminate the grounds at night when necessary. No gas-pipes are laid in any portion of the building, which is entirely dependent on the electric light, there being sufficient storage in the accumulator-house for one night's supply should the machinery fail. Adjoining are the laundry buildings, and the disinfector is at the entrance. The whole of the buildings are fitted up with the most modern appliances, and the wards and corridors are fitted with telephones and call bells, so arranged that in case of necessity a nurse, practically at the patient's bedside, can almost instantly find and communicate with the doctor, matron, or other official. The total cost of the infirmary is estimated at from £45,000 to £50,000. The buildings, which have been built by Mr. Thomas Rowbotham, of Coventry-road, from the designs of Mr. Arkell, are a departure from the generally acknowledged workhouse style, the idea being to make the rooms light and cheerful for the patients, and also to render the surroundings pleasing and elevating.

Bath.—The question of electric tramways is being agitated. Mr. Sydney Walker, M.I.E E., etc., in a letter to *Keene's Bath Journal*, recommending the adoption of the system both for the streets and the hills, is pointing out the advantage to be derived from the same by invalids, who now lose a large portion of the resuscitating effects of the water, and of the air and scenery of the hills, owing to the great exertion involved in climbing the latter. He further states that "many of the towns that have adopted the electric light are now arranging for the adoption of electric traction for their tramways, since it not only promises a cheap, rapid, and profitable tramcar service, but also an additional revenue to the electric light undertaking. In all town electric lighting stations one of the great difficulties in the way of a cheap supply, and a profitable undertaking, is the fact that while the boilers, some of the engines, and attendants have to be kept at work for the full 24 hours, the call upon the current is very small except for a few hours during the evening. The establishment charges also have to be borne almost entirely by the current supplied during these few hours, while the interest on the expensive plant is thrown on the same shoulders. The consequence is that the cost of generating the current, and therefore the price at which it can be sold, is very much higher than it would be if a consumer could be found who would take current during the day. Such a consumer is the electric tramcar. In America many of the street railways, as tramlines are called there, have been converted from heavily losing concerns to remarkably profitable ones, notwithstanding the heavy cost involved in the conversion of the lines. Further, the ratable value of all the towns where electric tramcars have been adopted has gone up very considerably. Bath appears to me to be particularly suited for electric traction on account of the great strain upon the horses, both going up and coming down the hills. The cost of electric traction is only a fraction of the cost of horse traction; and, in addition, as the cost for driving in descending the hills would be nil, the actual cost of the double journey, up and down, would only be that of the ascent. The arrangement is probably well known to most of your readers. One or two electric motors, capable of exerting the necessary power when supplied with current, are placed under each car, and current is delivered to them from a wire carried on ornamental brackets overhead, returning to the generating station by means of the rails upon which the cars run. Light cars are run at very frequent intervals, supplemented by 'trailers,' as they are termed, at busy times, with the result that the traffic, as experienced in those towns that have adopted it, is enormously increased above that ruling with horse traction. The great feature of the system is that, unlike the horse and the steam locomotive, the power that can be exerted is absolutely unlimited within the design of the motors employed, the generating station, and the distributing cables. The power is there, in the cables, ready to be called when required, and not called and not costing anything when not required. It is doubtful if the whole of the plant at the lighting station could be employed economically for traction work, but certainly the boilers, some of the engines, and all the attendants could, so that by proper arrangement a great boon might be afforded to residents and visitors, and a source of revenue created."

Tees-side Tramways.—Norton, Stockton, Thornaby, Middlesbrough, Linthorpe, the docks, and North Ormesby will shortly be joined together by the Tees-side tramways. The construction of the new system, which is to be worked by electricity, was begun last week, and Mr. Clifton Robinson, C.E., the engineer and general manager of the Imperial Tramways Company, hopes to have the whole undertaking completed before the end of the spring of 1898. The scheme provides for not less than 16 miles of track, covering nearly 11 miles of street. The line will be worked by trains of cars, including motorcars and trailers, each train furnishing sitting accommodation for 100 passengers. They will run with a headway of five-minute intervals for 16 hours per day, early cars being run throughout the whole system for workmen. The population of the district to be served is as follows: Norton, 4,000; Stockton, 60,000; Thornaby, 20,000; Middlesbrough, 85,000; and North Ormesby, 9,000; or a total of 178,000. The *Middlesbrough and Stockton Daily Telegraph* publishes an interview with Mr. Robinson, in which he states that the work was started last week with 100 men, another 100 are to be put on this week, and that he will keep on engaging men until probably 500 men are at work. They were getting 60,000 tons of Cleveland grey slag for concrete, 3,000 or 4,000 tons of cement from Newcastle, points and crossings from Sheffield, 2,000 or 3,000 tons of rails from Leeds. The *débris* from the works is also being carted to various places which have been assigned by the local authorities for filling-up purposes. The whole of the present tramways will be removed *en bloc*. The present rails are simply of the ordinary character, of 40lb. to the yard, laid on cast-iron chairs. The present foundations will be excavated so as to form a deeper bed for the new form of construction, and will go down to 14in. Then 6in. of solid concrete will be laid, beaten hard to level with an inch of soft sand and cement, upon which will be laid a 7in. girder rail weighing 92lb. to the yard which will be tied for 10ft. with steel tie bars, adjusted properly and gauged to 3ft. 6in., and thoroughly fished at the points. Then every 100ft. they are cross banded

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with copper bands, extending over both tracks in order to make a complete circuit between the positive and the negative of the poles at the dynamos in the power-house. The paving will be laid with whinstone setts, pointed with cement, top dressed, beaten to level, and left to consolidate, which takes about a fortnight. That being so, and everything being conducted in sections, it will be seen that there will be very little inconvenience indeed to the ordinary traffic. They were putting in a double line at Norton without interfering with the traffic in any way. "The overhead trolley system, which is the best known system of electric traction," Mr. Robinson continued, "is the most efficient, mechanically, electrically, and commercially. From Norton to Thornaby, a distance of 3½ miles, will form a complete section of double-track tramway throughout. From the Thornaby end over the Victoria Bridge at Stockton there will be side poles and brackets, after which there will be centre poles right along Bridge-street and High-street, Stockton, as far as Bishopton-lane. From there on to Norton there will be side poles and brackets again. In Middlesbrough, in the extension through Corporation-road to Ormesby, there will also be centre poles, and, in fact, in all the broad streets. There are long stretches of down line, broad thoroughfares, and easy curves, with very little gradients whatever—features that are essentially favourable to the best results being attained by electricity. The power-house will be located at the depôt of the company in Bridge-road, Stockton, which will be enlarged, an adjoining triangular piece of land having been purchased by the company having a frontage to the river, where colliers can discharge. The plans of the new station here are being rapidly prepared, provision being made for the electrical installation, boiler plant, machinery, workshops, etc. We shall try to get the scheme completed within the next nine or ten months, and when the tramways get into operation they will be found to be the most comprehensive and thorough system of electric tramways constructed in Great Britain, everything being replete with the latest improvements. We have got the benefit of the experience of all the other installations that have preceded this, and the assistance of experts from various quarters of the world. The cars are specially designed, and will be of the most improved type of the 60 passenger car on eight wheels, ensuring easy motion and thorough and easy adjustment to all curves on the road."

PROVISIONAL PATENTS, 1897.

AUGUST 30.

19955. Improvements in and relating to sleeves or sockets chiefly designed for simultaneously connecting globes, reflectors, and the like to electrical incandescent lamps. Curt Bartenstein, 45, Southampton-buildings, Chancery lane, London.

AUGUST 31.

19959. Process and apparatus for electro-thermally treating materials. Hudson Maxim, 377, Norwood-road, London.

19995. Improvements in means for effecting magnetic transmissions. Gustav Engisch and Theofile König, 47, Lincoln's-inn-fields, London.

20003. Improvements in electric light arc lamps. Andrew Casey, 18, Fulham-place, Paddington, London.

SEPTEMBER 1.

20092. Improvements in electric lamps for use in mines and for other purposes. Thomas William Allan and Andrew George Adamson, 154, St. Vincent-street, Glasgow.

20145. Improvements in accumulator plates. Arthur Lehmann and August Mann, 18, Southampton-buildings, Chancery-lane, London.

SEPTEMBER 2.

20166. Improved indicating apparatus for electric lamps. James Marr, 3, St. Nicholas-buildings, Newcastle-on-Tyne.

20174. Improvements in incandescent gas, electric light, and oil lamps' hanging pendants and brackets for advertising purposes. Lionel Edwards Wood, Thomas Birch Davis, and Arthur Mawson, 62, Summer-row, Birmingham

SEPTEMBER 3.

20234. Improvement in electrical apparatus for signalling to and from a railway train or locomotive. Robert Burn, Alfred Charles Brown, and Leonard George Tate, 50, Old Broad-street, London.

20263. Improvements in electric high and low tension fuse heads for blasting purposes. William Albert Malson and Sidney Richard Malson, Bank-buildings, George-street, Sheffield.

20316. Improvements in electric fire-engines. George Cecil Dymond, 6, Lord-street, Liverpool. (George W. Cox and Elmer E. Smull, United States.)

20317. Improvements in or relating to dynamo-electric machinery. Conrad Ludvig Rosenqvist, 322, High Holborn, London.

20325. Improvements in electric light fittings. Albert Edward Salt, 18, Southampton-buildings, Chancery-lane, London.

SEPTEMBER 4.

20334. Improvements in telegraphy. Alan Archibald Campbell Swinton, 18, Southampton-buildings, Chancery-lane, London.

20394. An improved arrangement for strengthening electric currents. Moriz Reichsritter von Leon, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

20398. An improved electric meter for alternating and continuous currents. Prosper René Blondlot, 45, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1896.

18046. Electric accumulators or secondary batteries. Brophy and Andrews.

21668. Centrifugal contact apparatus for effecting the connection of the armature windings of rotary-phase electromotors on the attainment of a certain speed. Siemens Bros. and Co., Limited. (Siemens and Halske.)

22513. Telegraph cables and their connections. Barr and Phillips.

22530. Means for controlling and effecting combinations in the stops of electro-pneumatic organs. Hill.

22584. Wall sockets for electric lighting and like fittings. Byng.

22595. Electric accumulators. New.

22600. Method of, and means for, electrically connecting railway rails. Scott.

22796. Electrical indicators. Stikeman and Wilson.

22947. Electrical joint. Gomess.

26246. Trolley mechanism for electric tramways. Cie. de l'Industrie Electrique. (Date applied for under International Convention, May 16, 1896.)

1897.

12549 Plates for accumulators. Majert.

12714. Insulating and carrying frame for accumulator electrodes. Schneider.

15503. Electric arc lamps. Imray. (The General Incandescent Fire Light Company, Limited.)

16054. Electric controllers The British Thomson-Houston Company, Limited. (Macdonald.)

16304. Electrical tumbler switches. Gover and Proctor.

16361. Accumulator plates for secondary batteries. Jungner.

16362. Electrodes of electric accumulators. Jungner.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	9½-9¾
Brush Company, Ordinary	5	¾-1¼
—— Non. Cum., 6 per cent. Pref.	2	1½-1¾
—— 4½ per cent. Debenture Stock	100	103-107 xd
—— 4½ per cent. 2nd Debenture Stock	100	94-98
Callender's Cable Company, Debentures	100	108-113
—— Ordinary	5	6½-7½
Central London Railway, Ordinary	10	9¾-10¼
——	6	5½-6½
Charing Cross and Strand	5	12½-13½
Chelsea Electricity Company	5	10-10¼
—— 4½ per cent. Debentures	100	110-113
City of London, Ordinary	10	23½-24½
—— 6 per cent. Cumulative Pref.	10	17-18
—— 5 per cent. Debenture Stock	100	130-135
City and South London Railway, Consolidated Ordinary	100	66-68
—— 4 per cent. Debenture Stock	100	138-140
—— 5 per cent. Pref. Shares	10	15½-15¾
County of London and Brush Provincial Co., Ordinary	10	12¾-13½
—— 6 per cent. Cum. Pref.	10	15½-15¾
—— 4½ per cent. 2nd Debenture Stock	10	15-15½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1½ 2
—— 5 per cent. Debentures	—	89-94
Edison and Swan United Ordinary	5	2½-2¾
—— 5 per cent. Debentures	5	4-4½
Electric Construction, Limited	2	1¾-2
—— 7 per cent. Cumulative Pref.	2	2¾-3¼
Elmore's Copper Depositing	1	⅛-¼
Elmore's Wire Company	2	¼-½
W. T. Henley's Telegraph Works, Ordinary	10	18½-19½ xd
—— 7 per cent. Preference	10	18-19 xd
—— 4½ per cent. Debentures	100	109-114 xd
House-to-House Company, Ordinary	5	9-9½
—— 7 per cent. Preference	5	10¾-11½
India Rubber and Gutta Percha Works	10	21-22
—— 4½ per cent. Debentures	100	105-108
Kensington and Knightsbridge Ordinary	5	13½-13¾
—— 6 per cent. Pref.	5	8¼-8¾
London Electric Supply	5	1¾-2
Metropolitan Electric Supply	10	17-18
—— 4½ per cent. First Mortgage Debenture Stock	100	116-122
National Telephone, Ordinary	5	6⅜-6⅝
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	15-17
—— 5 per cent. Non. Cum. Third Pref.	5	6-6½
—— 3½ per cent. Deb. Stock	100	105-110
Notting Hill Company	10	15-16
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8-8½
—— £4½ shares	4½	7½-7¾
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	104-106
St. James's and Pall Mall, Ordinary	5	16½-17½
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	37-40
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	8	10¾-11¼
Westminster Electric Supply, Ordinary	5	14½-15½
Yorkshire House-to-House	5	8-8½

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NOTES.

The South Africa Telegraphs.—Dr. Jameson is now directing the construction of the Transcontinental telegraph line, *vid* Umtali and Inchanga, to the Zambesi. The Mazoe-Darwin route has been abandoned.

The Telephone at Kimberley.—After several false attempts, the inhabitants of Kimberley have at last succeeded in getting the telephone. The wires are at present overhead, but we hear that it is intended ultimately to carry them all underground.

Electric Locomotives in France.—We learn that the electric locomotive will be an accepted and working factor of the Western Railway of France from the beginning of next year's summer service, which begins in the second half of May.

Post Office Telegraphs.—A notice has been issued by the Postmaster-General stating that on and after October 1 reductions will come into force in London in respect to the rates for private wires, and in the provinces in respect to private wires and Post Office telephone exchange wires.

Dynamos on Board Ship.—The Board of Trade has recently issued instructions to marine surveyors to see that the dynamo-electric machinery on English passenger steamers is placed sufficiently high up in the vessel to prevent it being interferred with in the event of the partial flooding of the compartment in which it is situated.

Indian Railway Electric Light Installation.—A successful trial trip was made recently on the South Indian Railway of a carriage lighted by electricity. The carriage was a composite bogie, 40ft. long, fitted with 13 lamps, the first-class compartment having two lamps in the roof and two at one end, giving a brilliant, cool light. This is said to be the first electric lighted railway carriage in India.

The Argentine Industrial Exhibition.—The arrangements for an industrial exhibition in Argentina next year are rapidly progressing. A site has been secured, and contracts will be shortly issued for the erection of an iron building to cost about £17,000. The committees have been appointed, and they have decided to publish statistical bulletins of national industries, which will serve as a basis of competition for the Paris Exhibition.

High-Voltage Transmission Schemes.—We note from the American Press that the projects for high-voltage transmission schemes are still on the increase. The Stanley Electric Manufacturing Company have secured the contract to instal a three-phase electric power transmission system; and included in the equipment are three special three-phase Stanley generators, switchboard apparatus, and transformers for stepping up to 15,000 volts for transmission 15 miles, and down again to 2,000 volts for the large induction motors, also to still lower voltage for the smaller motors.

Wireless Telegraphy Experiments.—The series of experiments in wireless telegraphy which are to be made at Dover were commenced this week, the operations being conducted under the direction of Mr. Gavey, the principal technical officer of the General Post Office. A party of the telegraph section of the Royal Engineers are engaged in connection with the operations. The principal centre of observation and the point at which the transmitting instruments are placed is Fort Burgoyne, on the Deal road, just north of Dover Castle. The present experiments are being conducted in the interest of the General Post Office. The experiments, which are likely to extend over a considerable period, have so far been attended with varying success.

The Engineering Strike.—The engineering strike at Sheffield is greatly interfering with the development o the electric lighting industry. The Sheffield Electric Light Company announces that, as it is impossible to obtain the delivery of engines and dynamos ordered some months ago, the company is compelled to refuse further orders from customers. The demand for electricity has increased enormously since last year, and the strain upon the existing machinery is so great that the company declines t jeopardise the general supply by accepting additiona customers. American and Continental engines are to be introduced next year.

Nationalisation and Municipalisation.—At the Trade Union Congress held last week in Birmingham, a resolution was adopted expressing the opinion of the congress that it was essential to the maintenance of British industries to nationalise the land, mines, minerals, royalty rents, railways, waterways, and docks, and municipalise all water, artificial light, and tramway undertakings within their several authorities, instructing the Parliamentary Committee to promote and support legislation with the above object, and further impressing on the Parliamentary Committee the urgent necessity of some measure being constantly kept before Parliament dealing with the nationalisation of the mineral royalties of this country.

The Telephone Tariff in Switzerland.—Since January 1, 1896, the price of telephone subscriptions in Switzerland has been considerably reduced. A federal law fixed the charge at £4 the first year, £3 the second, and £1. 10s. the third and following year, but every conversation after the first is subject to a fixed price of ½d. The effect of those reductions has been a considerable increase in the number of subscribers, for the number in 1896 was 4,555, as against 3,343 during the preceding year, but although the subscribers increased, the receipts decreased. This deficit will probably be turned into a profit on the second year's working. The number of communications per subscriber fell to 529, as compared with 608 in 1895.

North-East Coast Institution of Engineers and Shipbuilders.—We have received a copy of Part 10 of vol. xiii. of the *Transactions* of this institution, which contains the title, constitution, by-laws, list of officers, members, etc. At the end are published memoirs of William Archbold, Edwin Graham, Thomas F. Irwin, Hugh Macoll, and William Putnam. Some of our readers will remember that Mr. Archbold was for a few years chief draughtsman with Messrs. Ernest Scott, Mountain, and Co., Limited, of Newcastle. At the time he was seized with his fatal illness, he was engaged in a series of experiments which had for their aim a great development in the use of electricity in its application to motive power for machinery.

Santiago (Chili).—The Allgemeine Elektricitäts-Gesellschaft, in conjunction with several banking firms, and a group of the Electrical Undertakings Company's Union, together with Messrs. Wernher, Beit, and Co., of London, have made use of the option they held for the concession of the tramways and electrical works in Santiago, in consequence of having received a favourable report from the commission of European experts which they sent out. The existing lines which now fall in to the municipality are transferred by them to the new company. The price of the existing lines, the water power of the Maipo River, and the construction of about 73 miles of railway lines and of the electricity works, is estimated at £1,050,000.

Telephone Enquiry.—The enquiry into the telephone service at Glasgow will deal with the efficiency and adequacy of the service and the reasonableness of the

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price charged. With regard to the adequacy of the service, the instruction given is to ascertain whether all the inhabitants who desire to join the exchange system are afforded facilities for doing so without undue conditions as to wayleave or otherwise, and whether there is a sufficient number of call offices to meet the reasonable requirements of the public. If there is either inefficiency or inadequacy, or if the price is too high, then the instruction is to find out how far this is due to any refusal of facilities on the part of local authorities, and in that event to determine whether it is expedient to grant the corporation a license.

Electric Depilation.—We would again warn electrical engineers, and especially those interested in X-ray apparatus, against experimenting on the action of these rays in removing superfluous hair without a previous knowledge of the effects to be expected. A case has come to our knowledge lately in which a doctor placed a lady patient in the hands of an electrical engineer to see whether by using X rays he could remove a superfluous growth of hair from her face. By way of trial the lady was placed opposite a tube for 20 minutes at a time on four consecutive days, and at the conclusion of this experience she declared that she felt absolutely no effect. However, at the end of the week she discovered that not only had the rays been very effectual as a depilatory agent, but they had removed the skin as well.

Producing Ozone Electrically.—In the *Journal* of the Society of Chemical Industry M. Andreoli remarks that, though theoretically one should be able to produce a kilo of ozone per electric horse-power, in practice only 10 or 12 grammes are obtained. By improvements, however, in apparatus for the production of ozone, M. Andreoli is now able, he contends, to increase the amount to 30 and in some cases even 50 grammes per horse-power, making the cost about 3s. a kilo. This, if a practical thing applicable on a large scale, is important. Based on these results, experiments are to be made by him in various directions to ascertain the value of the process in commercial affairs, such as the purification of drinking water, the cleansing of beer casks, preparing wood for instruments and furniture, bleaching of starch and dextrin, oxidation of drying oils, purification of wine and brandy, etc.

Languages.—Many persons who were interested in the departure that Mr. Howard Swan took in starting language classes on a new and improved method, called the series method, will like to know that various classes in French and German (and, we believe, Greek if anyone wishes it) start in September at Howard House, Arundel-street, Strand. Anyone can have a specimen without charge, and, even if they do not stop, we can answer by experience they will learn something and be entertained at the same time. We believe the enterprise has very largely helped to change and vivify methods of teaching languages in schools throughout England, and has been already taken up in Germany; and, as it will be remembered that Prof. Ayrton once gave a whole presidential address on this question of languages, it cannot be said that the importance as affecting engineering students and engineers is not rightly recognised.

Theory of Lead Accumulators.—In the *Journal* of the Chemical Society is published an abstract of a paper by Mr. C. Liebenoff, who has made experiments with the object of proving the existence of lead dioxide in the ionic condition, as required by his theory of lead accumulators. In a vessel which contained a normal solution of a caustic alkali saturated with lead oxide, three cylinders, the lower ends of which were closed membranes, were placed, and these were filled with normal alkali to the level of the solution in the containing vessel. Electrodes were placed in the first and third cylinders, the centre one serving for the estimation of the lead entering the cylinders by diffusion. After a current had been passed for some time lead was found in quantity round the positive electrode, but was practically absent at the negative electrode. The compound $Pb(OK)_2$ gives, therefore, the ions $2\overset{+}{K}$ and $\overset{--}{PbO_2}$. This result was confirmed by other experiments.

Electric Lighting Plants for the Yukon.—The California Electrical Works, San Francisco, recently sold to Captain N. C. Rideout, who will establish a trading post in Dawson City, a 120-light Eddy generator, which he will use for commercial lighting. The General Electric Company recently sold a 4½-kw. generator to the Alaska Commercial Company, which will be used to light a machine and repair shop in St. Michael. Joseph La Due, the fortunate owner of the Dawson town site, has expressed his intention of installing an electric central station. The first generator shipped from San Francisco to the Yukon mining region was a Westinghouse alternator, which will supply a number of incandescent lights and a searchlight, to be used on a steam barge while ascending the river. The plant was ordered by Wm. D. Wood, president of the Seattle and Yukon Trading Company. His plan is to let the barge freeze fast in the ice, and illuminate the darkness of Dawson during the winter. Owing to the high latitude, no artificial light is needed in the summer.

Waste in Competition.—Mr. John Walton Bourke, writing in *Electrical Engineering*, of Chicago, holds the rather extraordinary theory that the ultimate loss from "injudicious agitation and wild-cat competition" far exceeds any temporary benefits derived. He thinks that a pioneer company should have the monopoly, or, as he calls it, an "exclusive franchise," for although a "certain class of pseudo-reformers are constantly clamouring against the 'exorbitant charges' for the service rendered by gas, electric light, street railway, and telephone companies," and encourage "the formation of competing companies under the mistaken idea that they are public benefactors," he argues that the invariable outcome of a rate war has been the purchase of the competing plant, or a pooling of interests, bringing about a worse state of things than existed before. That may be the way they do things in the record-breaking city of Chicago, but in slow-going England we are still old-fashioned enough to derive comfortable and substantial benefits from our healthy competition.

Electrical Sport.—Mr. James F. Hobart contributes to the *American Electrician* what we presume is the first of a series of articles on this subject. He considers that electricity affords an opening for "more uproarious fun to the square inch" than anything else, and that it is very easy to rig up things in a dynamo-room to astonish visitors who might drop in. This new employment for a municipal electrical engineer is, we fancy, one which will scarcely commend itself to English corporations. As an instance of this, Mr. Hobart's first experiment to delight the visitors to an electric lighting station consists of suspending a thin wire down the length of the engine-room, and at a given signal to switch this wire across the terminals of a high-voltage machine. A No. 36 copper wire is recommended by the author, and we are told that the wire will be burnt with a flash like that of lightning. We rather doubt if the persons responsible for the maintenance of central stations will contemplate with serenity the scattering of molten globules of copper over their apparatus.

Hoisting-Magnets.—The *Electrical Engineer* of New York gives a description, accompanied by excellent illus-

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trations, of a hoist magnet, worked in connection with an electric travelling crane. The double-pole magnets in use at the plate mill of the Illinois Steel Company can handle with safety five tons, and only take about four amperes with a 240-volt current. Considerable difficulty was at first experienced in picking up only one plate at a time, as the magnetism was carried through several plates. This, however, was found to be a question of operating the switch. After the magnet has been lowered on to a pile of plates and several plates have been taken out together, the operator breaks the current for a moment, and one or two plates drop off at each break. It is said that enough residual magnetism remains in the plates next to the magnet to hold them until the current is again switched on. A concentric pole magnet has been constructed for handling hot plates and ingots, and there has been no difficulty in handling a 6,000lb. or 8,000lb. ingot at a low red heat.

A Sextuplex System of Telegraphy.—The *Daily Chronicle* says that Mr. Thomas B. Dixon, a native of the State of Kentucky, has succeeded, as he recently demonstrated in Boston, in achieving the sending of six messages on a single wire. This result has been obtained as the outcome of work which was begun as far back as 1891, and the first partly successful test was not achieved until two years ago, since which time Mr. Dixon has been perfecting his apparatus. He makes the same division as in the quadruplex system—namely, two giving one-third of the current to one set of instruments and two-thirds to the other, the pulsation being so arranged as not to conflict. The test at Boston was over a loop to New Haven and back, and during several minutes' sending and receiving no breakage or interference was seen. Two sides of the sextuplex can be used as a quadruplex, and such a test on a loop from Boston to Buffalo and return, and to New Haven and return, a distance of 1,300 miles, has actually been made, thus proving its advantages over the ordinary quadruplex system, the limit of the successful working of which has been from 500 to 600 miles.

Motorcars in Ceylon.—There was talk some time back of introducing motorcars into Ceylon for Government service. Mr. A. Murray, of the Public Works Department, has, however, just presented a report on the subject, in which he says: "The introduction of oil-motor road carriages to Ceylon must, I fear, be postponed until their cost is less prohibitive, and the working of them is a more assured success than at present. During my recent stay in England I had exceptional opportunities of testing their capabilities at the frequent exhibitions at the Crystal Palace. They possess two serious defects—one is the severe vibration when the motorcar is at rest or on the point of starting or slowing down, and the other the nauseating smell of oil. A trip on the ss. 'Lady Havelock' in the face of the south-west monsoon is preferable to a journey on an oil motorcar as at present constructed." Mr. Murray does not seem to have had an opportunity of inspecting electric motorcars, otherwise he might have taken a more hopeful view of mechanical locomotion. At any rate, electric motorcars do not possess those two serious defects that he mentions, and as regards the cost, the progress of invention will reduce that in the course of time in the same way that it has cheapened everything else.

Gas Batteries.—Mr. W. E. Case's contribution to the British Association meeting at Toronto on "Some New Forms of Gas Batteries and a New Carbon-Consuming Battery," will be found elsewhere in this issue. This paper is the more valuable from the fact that experiments only are described, and that the author does not theorise to any great extent. He claims from the analysis of the solutions used in the gas battery that he succeeded in charging carbon to CO_2 at normal temperatures without the application of heat, and with the production of electrical energy. This operation is what is required if we are to obtain electricity direct from carbon without the intervention of a boiler, steam-engine, etc. As far as we can understand from Mr. Case's paper, his results up to the present are more of the scientific order than of the commercial. With the gases he used, comprising chlorine, carbon monoxide, and marsh gas, the author was always troubled with polarisation; in fact, the phenomenon of the gradual increase of the E.M.F. for a period lasting over 12 hours and over, is in itself an evidence that suitable working conditions have not been obtained. Nevertheless, Mr. Case's contribution to our knowledge on the subject is worthy of every appreciation, and we trust that the results of his future experiments will be soon published.

Electro-Harmonic Society.—A smoking concert is to be held on Friday evening, September 24, 1897, at the St. James's Hall Restaurant (Banquet-room), Regent-street, at eight o'clock. The following is the programme: duet in canor, "Friendship" (Marzials), Mr. George Aspinall and Mr. R. E. Miles; songs, (*a*) "All Souls' Day" (Lassen), (*b*) "To Anthea" (Hatton), Mr. R. E. Miles; humorous sketch, Mr. Robert Ganthony; pianoforte solo, "Gigue" (Chaminade), Mr. Alfred E. Izard; song, "The Dreamers" (Edith Cooke), Mr. George Aspinall; recitation, "Agatha's Perfidy" (Anon), Mr. W. G. Churcher; violoncello solo, "Czardas" (Fischer), Mr. Bertie P. Parker; humorous sketch, Mr. George Schneider; duet, "Introduction and Polonaise for Pianoforte and 'Cello" (Chopin), Mr. B. Parker and Mr. Alfred E. Izard; songs, (*a*) "Winds in the Trees" (G. Thomas), (*b*) "Montrose's Love Song" (M. V. White), Mr. R. E. Miles; humorous sketch, Mr. Robert Ganthony; violoncello solos, (*a*) "Idyll" (Noel Johnson), (*b*) "Tarantelle" (Dunkler), Mr. Bertie Parker; recitation, "The Close Finish" (Anon), Mr. W. G. Churcher; song, "She is Far from the Land" (Lambert), Mr. George Aspinall; humorous sketch, Mr. George Schneider.

The Enclosed Arc.—Messrs. Freedman, Burroughs, and Rapaport read a paper before the annual meeting of the American Institution of Electrical Engineers at Eliot, in which they gave the results of a series of exhaustive experiments on the working of the enclosed arc lamp. They point out that the enclosed arc takes on an average five amperes with a potential difference of 80 volts across the arc, and that in general use the difference between the 80 volts and the voltage of the supply circuit is usually wasted in resistance. Comparing the life of the carbons in enclosed and open arc lamps, the authors conclude that with the enclosed arc the carbons last from 15 to 20 times longer than in the open arc. Some useful figures are to be obtained from the authors' measurements of candle-power, as compared with the watts supplied to the lamp. They conclude that with inner and outer clear glass globes the energy used per candle-power is equal to ·5 watt; with the inner globe of opal glass and the outer of clear glass this figure rises to from ·56 to ·60 watt per candle-power. If the outer globe is also of opal glass, from ·9 to 1 watt per candle-power are required. The efficiency with the holophane globe was found to be a little less than with the ordinary clear glass globes. The amount of light cut off by the carbon deposits on the inner globe was found to increase with the length of run and to differ with different horizontal portions of the inner globe. The diminution of light was found to vary from 14 to 60 per cent. from different parts of the globe and in different

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lamps. The polar curves for light given by the authors will be found very useful.

Electric Lighting for Loading and Discharging. The Antwerp correspondent of the *Liverpool Journal of Commerce* says: "For some time there has been a desire expressed that the electric light should be used for loading and unloading vessels at night, owing to the many serious fires which have taken place at frequent intervals from the upsetting of the old-fashioned oil-lamps, which have been used since time immemorial. Last evening the first experiments with this object in view took place at dock No. 5. Five arc lights impelled by the hydraulic power of the *entrepôt* lighted up the quay. Two steamships, the 'Hero,' of Bristol, and the 'Ville de Nantes,' were being discharged. When the work is not going on the lamps are hung on arms connected with the cranes, but when the vessel is being worked after dark the lamps are carried about and hung at points where they can throw the most light into the hold, thus enabling the men to work as in broad daylight, and the Custom House officials and tally men take their notes with perfect ease. Besides these advantages, the danger of fire is reduced to a minimum as compared with the present system of lamps, which were so often falling into the holds and setting fire to the cargo. It is hoped that after this experiment, which has proved so successful, the entire quay system will be furnished with these portable arc lamps." We may remind this worthy correspondent that the system he describes unfortunately does not possess the merit of novelty. The London Docks were lighted by a similar system years and years ago, and we believe that the first experiments in quay lighting by electricity were made there. Of course, there is this variation of detail, that in those days each arc lamp had its own machine, but the principle was identically the same.

Electric Traction Anticipations.—It is interesting at the present moment to refer to such prognostications as the following, from René Tamine's work on "Electric Accumulators," published in 1885: "When, in the course of time," he says, "central stations for the distribution of electricity have received an important extension, an interesting and economical application for accumulators will be found in the traction of vehicles. How many people, in fact, are most anxious to possess a carriage and horses—to become 'carriage people,' according to the vulgar expression. But the horse, unfortunately, must be fed every day, and necessitates the keeping of an extra servant. And if, in consequence of daily avocations, the carriage can be utilised only a few times a week, it is easy to understand that the cost of each excursion may be very considerable. But suppose the electrical distribution to be organised for the supply of private individuals, precisely as in the case of gas. And supposing, moreover, that you have at your house an electric tricycle or a carriage for two or four persons, and that the day is fine and a suitable one, you can arrange in the morning for an afternoon excursion in your carriage. It will be necessary only to turn on a simple electrical switch in order to charge a battery of accumulators stowed away in the otherwise non-utilisable portions of your carriage. Knowing approximately the quantity of energy you will require for a run of two, three, or four hours, it will be easy to regulate the charge accordingly. The cost of the electrical power will become very moderate, and it is very probable that this application, after being a luxury for the few, will end by becoming a common necessary of life to a great many of us. We will keep at home our electrical tricycle, our dockar, our landau, etc. What the future may have in store for us may be expressed by a big note of interrogation."

Wages of Belgian Engineers.—The Engineering Employers' Federation state in a circular issued on September 6: "As Mr. Barnes and Mr. Burns do not believe in the bogey of foreign competition, the following statement of the wages paid and the hours worked in engineering establishments of one of our greatest competitors—Belgium—may open the eyes of the Amalgamated Society of Engineers. The rates fixed are per hour for each hour worked, but in the list below the wages are cast up for the full working week: Liège.—Fitters, 18s. 4d. to 22s. 6d., 60 hours per week; turners, 18s. 4d. to 28s. 9d., 60 hours; machinemen, 13s. 9d. to 18s. 4d., 60 hours; ship labourers, 12s. 6d. to 15s., 60 hours. Antwerp. — Fitters, 21s. 3d. to 26s. 3d., 60 hours per week; turners, 21s. 3d. to 26s. 3d., 60 hours; labourers, 15s. to 18s. 4d., 60 hours; boilermakers, 23s. 9d. to 26s. 3d., 60 hours; joiners and carpenters, 18s. 9d. to 21s. 3d., 60 hours. The working day is from 7 a.m. to 6 p.m., for six days, less one hour per day for dinner; 60 working hours per week. In some places work stops at 4 p m. on Mondays, but in these cases only 58 hours are paid for. Ghent—Head erectors, 28s. 9d., 66 hours per week; erectors, 23s. 3d., 66 hours; fitters and turners, 18s. 3d. to 22s., 66 hours; slotters and planers, 12s. 4d. to 19s. 3d., 66 hours; moulders, 8s. 3d. to 20s. 8d., 66 hours; labourers, 12s. 4d., 66 hours. The day averages 11 hours, sometimes six hours being worked before and sometimes after dinner; stoppage two hours earlier on Mondays takes two hours off the pay. Overtime at Antwerp counts after 12 hours' work. Night work gets time and a half. Belgian employers use precisely the same machines as we do, and get 12 hours' work per week more out of them than the Amalgamated Society of Engineers would permit here."

Associated Chambers of Commerce.—A strong gathering of delegates to the special meeting of the Associated Chambers of Commerce of the United Kingdom took place at Middlesbrough on Tuesday under the presidency of Sir Stafford Northcote. The president directed attention to a matter on the agenda paper dealing with "Closer Relations between the Mother Country and the Colonies." The whole country seemed to have approved of the action the Government had taken in this matter. He hoped and believed that the general result of the policy of the Government would be to largely develop our trade with Canada and to move Australia to foster closer commercial relations with the mother country. His own idea was that Imperial federation must have its origin in and be based upon closer elementary relations between the mother country and her colonies and dependencies. A matter of the utmost importance to the association was contained in a private communication which had come into his hands from the Board of Trade. There had been two circulars sent him. One of these had to do with the establishment of a Commercial Intelligence Committee, which would meet on Tuesday, October 12, noon, at the Board of Trade, and it would receive evidence from any person connected with the Chambers of Commerce who desired to tender it. The second suggestion made was that the association should co-operate with the Government in the work and expense of sending out delegates to enquire into the possibilities of developing trade with Central and South America. He could quite understand that it might be the view of some members of Chambers that they had already employed their own commercial travellers and representatives in this direction for the purpose of pushing trade in these regions; but whatever idea was entertained, he assured them that the Board of Trade had at last taken a distinct step towards the recog-

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nition of the authority of their association, and they were now putting forth a challenge as to whether it could justify its existence. A resolution was passed appointing a delegate to act with the Board of Trade.

The Use of Electricity in Vienna.—The Chamber of Commerce of Vienna in their annual report for 1896 describe the development of electric light and power transmission in that city, and quote interesting returns from three firms. The first is the Allgemeine Oesterreichische Electricitaetsgesellschaft, who have a length of cable of about 52 miles, supplying about 3,074 customers. There are 69,502 lamps, and 2,811 arc lamps and 341 motors, equal to 199,264 normal 30-watt lamps. The number of motors has increased considerably, chiefly on account of their being used for lifts in private houses. The International Company has about 3,630 customers, taking about 75,000 lamps of 16 c.p., including about 1,900 arc lamps, and 163 motors of 285 h.p. total. The central station is now increased to a capacity of 8,500 h.p. as compared with 7,200 h.p. in the previous year, and the length of cable is about 116 miles. The number of customers is 2,938, using 6,932 kw., and there are 181 arc lamps, and 129 motors, 215 aggregate h.p., on the supply. The electric railway which this company fitted out is being extended from about five miles (its present length) to about seven miles. The great scheme for an electric railway which was started in 1895 has up till now only resulted in an experiment. A section of line formerly used for horse traction has been converted to electric traction, and the experiment has answered so well that the Municipal Council decided to acquire the concession for the construction of all electric lines, and are even now considering various offers for the equipment of the lines. The third company whose returns are quoted in the Chamber of Commerce report is the Wiener Elektricitats-Gesellschaft, who have laid about 23 miles of cable, supplying 41,140 lamps and 275 motors with a total output of 708 h.p. The total kilowatt capacity of the three stations for the year was 15,887, against 12,385 for the previous year, an increase of 3,502 kilowatts. There is a very rapid increase noted in the use of electric motors. Since May, 1896, the three companies had had in use a tariff for single-phase current which was cheaper and simpler than the former tariffs. For one kilowatt-hour the charge is 8d. up to 60 hours, and above that figure the cost is fixed at 5d. per hour. For industrial uses the charge is from 5d. to 2½d.

Electric Traction.—We have been pleased to note that the English contracts for electric tramways are being placed more frequently with English contractors, and that in certain cases the English contractors have obtained important contracts abroad in the face of the direct opposition of agents from America. This state of affairs is gratifying to the profession, but the fact that the majority of the material used, even by English contractors, is obtained from America, is to be deprecated. The reason for this is to a certain extent to be found in the fact that the severe competition in America has reduced the prices; but, on the other hand, it is also the fact that in some departments the English manufacturers are not sufficiently prompt to take up the requirements of the new industry. We were informed, for instance, the other day by a large contracting firm that the steel poles for the construction of an important electric tramway they were equipping had been ordered from an English firm at prices which compared favourably with those of American goods. The order having been placed, considerable trouble arose from the delay in delivery, and the organisation of the line was seriously impeded from this cause. Delays of this kind naturally tend to keep the trade out of the country. Another point we have noticed recently, when inspecting new traction plant, is that the American engine builders have paid particular attention to the design of their engines for traction work, whereas the tendency of the English manufacturers is to supply an engine which has been found suitable for electric lighting purposes. It by no means follows that this engine will be suitable for traction work, because the rapid way in which the load varies and the short duration of the periods of extremely heavy loads strain both the engine and its governing arrangments most severely. If our manufacturers will keep themselves to the fore in matters of detail of this kind, we see no reason why the present procedure of ordering goods from abroad should continue. The boom in electric traction which is now commencing will then benefit the English profession and enable the manufacturers to hold their own in Colonial tramway equipment. Not only in English-speaking countries, but on the Continent electric tramway schemes are being decided upon every day, more particularly, perhaps, in the mountainous regions and other places where there is a plentiful supply of water.

The Starting of Electric Tramcars.—The innovation in use on the Dover tramways of placing an energy meter on each of the tramcars in order to ascertain if the drivers handle the controllers properly was described in our last issue. A letter by Mr. G. W. Knox in the *Street Railway Journal* for September illustrates how necessary some such means of controlling the drivers is. Mr. Knox argues that after the drivers have been instructed as to the correct way of using the controlling apparatus, they commence experimenting on their own account. They find that by throwing the controller handle sharply round from "on" to "off" no bad results are immediately experienced, and that by so manipulating the controller they save themselves the worry of gauging the correct time of pausing at the notches. They also find that they accelerate the cars more rapidly by this means, and therefore they think they are doing rather a smart thing in driving Mr. Knox has made experiments as to the actual consumption of energy, etc., when the cars are started in this way, and gives the following figures. In starting the cars under the correct procedure the full power is not turned on for 10 seconds, and the full speed of the car is attained in 12 seconds, or when a distance of 150ft. has been traversed. The maximum consumption of current on the line in question was 60 amperes, giving a drop of 20 volts, with an average consumption of 24·7 h.p. On the other hand, when the controller was rapidly moved round the full power was switched on in four seconds and the maximum speed attained in 9½ seconds, the car having then travelled some 85ft. The maximum current consumed in starting Mr. Knox found to be 140 amperes, giving an 80-volt drop in the pressure of supply. The average horse-power used was thus 43·3. The comparison between the maximum horse-power used is even more striking. With the rapid switching on of the current some 80 h.p. was taken, whereas with ordinary care 38½ h.p. only was required. The cost to the company of working when the controllers are misused is considerable, but the accompanying depreciation of the motor is likely to be even more serious. Mr. Knox also points out that the majority of the accidents on tramcars occur either in starting or stopping, and that the exceedingly rapid acceleration of the car (and the sudden jerk caused by the rapid switching on) when the driver puts the current on quickly is a likely explanation of a number of accidents which have occurred. Another source of waste when the controller is misused is the slipping of the wheels on the track.

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THE BALLISTIC GALVANOMETER IN THEORY AND PRACTICE.

BY ELLIS H. CRAPPER, A.I.E.E.

(Continued from page 309.)

§ 8. *Determination of the Constant of a Ballistic Galvanometer by the Condenser Method.*—This method is specially recommended because of its simplicity and convenience. It further has the merit of being very accurate, and consists in measuring the throw of the galvanometer needle when a condenser of known capacity and charged to a known difference of potential is discharged through the galvanometer.

On account of the importance of this method we shall briefly explain the terms condenser and capacity. For our purpose we shall consider a condenser as an arrangement of conductors and insulators, placed relatively to each other so that a definite acccumulation of electricity is required to raise the difference of potential between the conductor by unit amount. The capability of such a device to hold a charge of electricity is known as its capacity. The capacity of a condenser is measured by the ratio of the quantity of electricity, Q, to the difference of potential, E, to which this quantity of electricity charges the condenser. This ratio is constant for any particular condenser; and, in fact, is the numerical value of the capacity of the condenser. That is,

$$C = \frac{Q}{E}. \quad \therefore Q = C \times E \quad . \quad . \quad . \quad (16)$$

where C is the capacity of the condenser.

Standard condensers usually consist of parallel conducting plates separated by some suitable insulating medium or dielectric, and it may be readily shown that the capacity of a condenser is directly proportional to the area of the conducting plates and to the specific inductive capacity of the dielectric, and inversely to the distance between the plates or thickness of the dielectric. That is,

$$C = c \cdot \frac{A}{4\pi t} \quad . \quad . \quad . \quad . \quad . \quad (17)$$

where A is the area of the plates, c the specific inductive capacity of the dielectric, and t the thickness of the dielectric. It is therefore obvious that by making A large and t

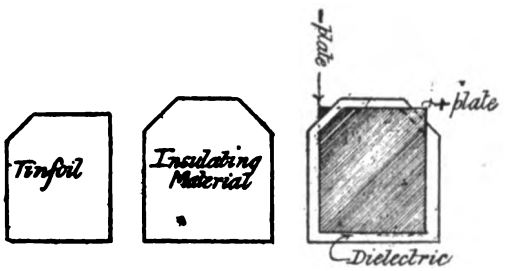

FIG. 3.

very small, the capacity is increased. For this reason a large number of parallel plates of tinfoil or other thin conducting sheets are arranged alternately with very thin sheets of mica, paraffined paper, etc., so as to form a pile. The first, third, and fifth plates, etc., and the second, fourth, and sixth plates, etc.—that is, the alternate conducting plates—are connected together and form two sets of plates, and these are connected to two brass pieces or poles on the outside. These form the terminals of the condenser, and when these poles are connected to the terminals of a battery the condenser is charged, one set of plates receiving a quantity of positive electricity whilst the other is charged with an equal amount of negative electricity. The two brass pieces forming the poles or terminals of the condenser may be connected by a plug (see Fig. 6 below) so as to bring the two sets of plates to the same potential, and thus discharge or short-circuit the condenser. When not in use, the condenser should be short-circuited by the plug. The method of building up a condenser is shown in Fig. 3, whilst a diagrammatic sketch of the arrangement of the conducting plates is given in Fig. 4. Figs. 5A, 5B, show the usual methods of representing a condenser symbolically.

As we have already stated, the capacity of a condenser is measured by the quantity of electricity which produces unit difference of potential, and in practical units a condenser has *unit capacity when it requires one coulomb to raise its potential one volt.* The practical unit of capacity is termed the farad, and since

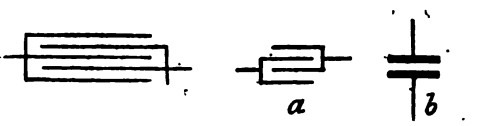

FIG. 4. FIG. 5.

$$C\ (\text{farads}) = \frac{Q\ (\text{coulombs})}{E\ (\text{volts})}$$

$$= \text{a constant ratio} = \frac{\text{charge on one plate}}{\text{D.P. between the poles}}$$

$$\therefore \quad 1 \text{ farad} = \frac{1 \text{ coulomb}}{1 \text{ volt}} = \frac{10^{-1} \text{ C.G.S. unit of quantity}}{10^{8} \text{ C.G.S. unit of pressure}}$$

$$= \frac{1}{10^{9}} \text{ C.G.S. unit of capacity.}$$

For practical purposes, however, the farad is too large, and a condenser having this capacity would require to be of enormous dimensions, consequently the one-millionth part of a farad, or one microfarad, has been adopted as the working practical unit of capacity. A condenser with a capacity of one microfarad thus requires 0·000001 coulomb to charge it to one volt. For testing purposes, standard condensers of $\frac{1}{3}$ microfarad capacity, of the form shown in Fig. 6, are much used, since this value is approximately equal to the capacity of one nautical mile of the Atlantic cable. When the insulating material is mica, a $\frac{1}{3}$-microfarad standard condenser contains about 1,200 square inches of tinfoil.

From what has been said it is obvious that by using a cell or cells of known E.M.F. for charging standard con-

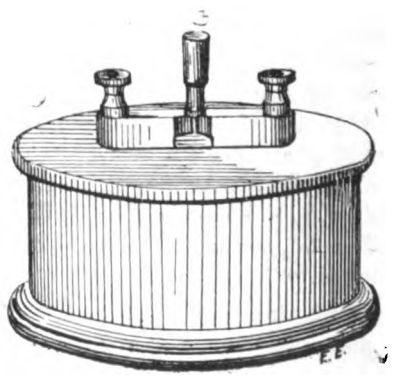

FIG. 6.

densers we can obtain a definite and known quantity of electricity, which, when discharged through a ballistic galvanometer, is measured by the throw of the galvanometer needle. And since

$$Q = C \times E \text{ and } Q = k \sin \frac{\alpha}{2}\left(1 + \frac{\lambda}{2}\right) \text{ from (6 and 12)}$$

$$\therefore C E = k \sin \frac{\alpha}{2}\left(1 + \frac{\lambda}{2}\right)$$

and

$$k = \frac{C E}{\sin \frac{\alpha}{2}\left(1 + \frac{\lambda}{2}\right)} \quad . \quad . \quad . \quad . \quad (18).$$

Consequently we have means at hand of determining the constant of a ballistic galvanometer by using a condenser.

The method of connecting the condenser, ballistic galvanometer, and battery for the determination of k will be understood from Figs. 8A and 8B, in which K is a special form of key, designed so that the condenser may be very quickly charged and discharged. It is a matter of

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importance when using condensers that no possibility of loss of charge by leakage should be permitted in the interval between charging and discharging, hence the necessity for a special, highly insulated key, such as is shown in Fig. 7.

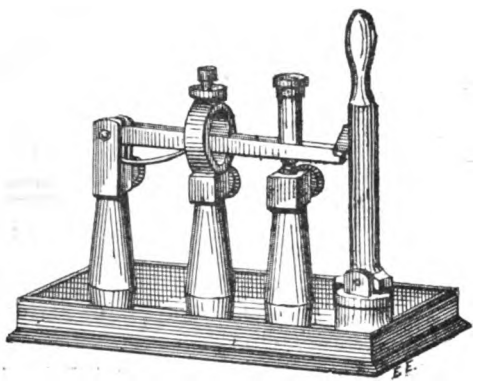

FIG. 7.

From Figs. 7 and 8B it will be observed that the key possesses three terminal, *a*, *b*, and *c*, and a lever arm, L. The terminal, *b*, of this arm is connected with one pole of the condenser, the other pole of which is connected with the ballistic galvanometer and the standard Clark cell, S.C.

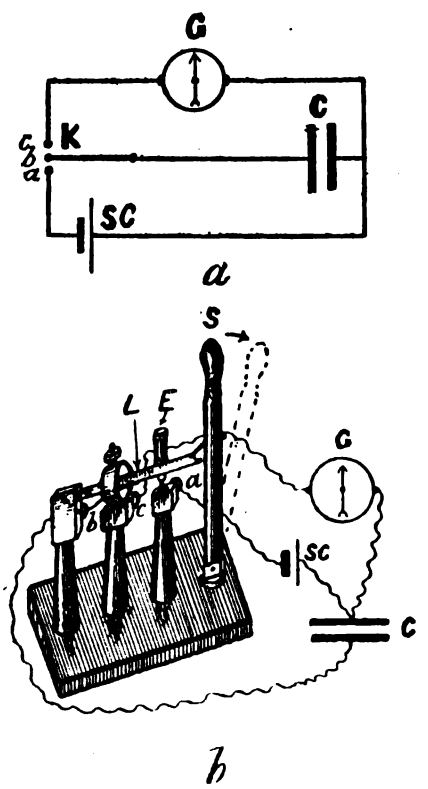

FIG. 8.

When the lever arm is depressed by means of the switch-arm, S, so that L is horizontal, contact is made with *a*, and the condenser is charged by the standard Clark cell, S.C. The free end of the lever arm, it will be noticed, has two recesses, and when the catch on the switch-arm, S, is in the upper recess (as shown) the condenser is in circuit with the battery and is being charged. By slightly moving the switch-arm in the direction of the arrow, the catch rests in the lower recess, and the lever arm, L, makes no contact with *a* or *c*—that is, the condenser is charged, but is insulated both from the galvanometer and battery. On moving the switch-arm into the position shown by the dotted lines, the lever arm is raised by means of a spring and makes contact with the terminal, *c*, putting the galvanometer in circuit with the condenser, which is immediately discharged. In practice the lever-arm is put into charging position by pressing down the insulating cap, E, and replacing the switch-arm vertically. It is released by knocking back S, the two operations being performed very quickly.

Example (IV.).—The following gives the result of an actual test. A $\frac{1}{3}$-microfarad condenser was charged by means of two standard Clark cells connected in series. The first throw of the ballistic galvanometer needle was 95 divisions to the right when the condenser was discharged through the galvanometer. The divisions on the scale were in millimetres and the needle was 914·4mm. from the scale. The temperature was 17deg. C. The value of λ, the logarithmic decrement, was found to be 0·009037286. Determine the constant of the galvanometer.

Note.—The practical determination of the logarithmic decrement will be explained presently.

$$\text{Since } Q = C \times E = k \cdot \sin\frac{\alpha}{2}\left(1+\frac{\lambda}{2}\right),$$

$$\therefore k = \frac{C \times E}{\sin\frac{\alpha}{2}\left(1+\frac{\lambda}{2}\right)}$$

$$= \frac{\left(\frac{1}{3}\times\frac{1}{10^6}\right)\times 2 \times 1{\cdot}432}{\sin\frac{\alpha}{2}(1+{\cdot}004518643)}.$$

Note.— $\frac{1}{3}$ microfarad $= \frac{1}{3}\times\frac{1}{10^6}$ farad

and that the E.M.F. of a standard Clark cell at 17deg. C. = 1·432 volts and that Q in coulombs $= \left(\frac{1}{3}\times\frac{1}{10^6}\right)$ farad $\times$ (2 $\times$ 1·432) volts.

To determine $\frac{\alpha}{2}$ proceed as follows:

$$\text{Tan } 2\alpha = \frac{95}{914{\cdot}4} = 0{\cdot}103892;$$

$\therefore 2\alpha = 5^\circ\ 55'\ 54''$ (from table of natural tangents),

and $\frac{\alpha}{2} = 1^\circ\ 28'\ 58''$

$\therefore \sin\frac{\alpha}{2} = 0{\cdot}0258765$ (from table of natural sines)

$$\therefore k = \frac{\frac{1}{3}\times\frac{1}{10^6}\times 2{\cdot}864}{0{\cdot}0258765 \times 1{\cdot}004518643}$$

$$= 0{\cdot}000036727.$$

(To be continued.)

THE MECHANICAL CONSTRUCTION OF ELECTRICAL MACHINERY.

BY F. M. WEYMOUTH.

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THE DYNAMO

(Continued from page 299.)

Bearings (continued).—As we pointed out, the former footstep or thrust bearings we described (Figs. 275 to 278) indicated more particularly crude notions; and the designs were not refined to the extent of their containing any provision for wear. Fig. 279 herewith illustrates a bearing for taking end thrust in one direction, in this particular instance that due to a worm on the same shaft. This is a design by Messrs. P. R. Jackson and Co., Manchester; and we reproduce the drawing from the patent specification (1,137, '96). A special feature thus here present is that this bearing is provided with means of adjustment to compensate for wear resulting from the end thrust.

It will be observed that the end of the spindle, *a*, is rounded to a hemisphere. On this there fits a hard-steel cap, *c c*, in which an annular groove is turned to form a ball race as shown for the balls, *r r*; and a circular hard-steel plate, *d d*, has a corresponding ball race. This latter plate beds centrally against the convex inner surface of the outer cap or cover, *e e*; and, not being too tight a fit within the end of the bearing, *f f*, it is free to some extent to rock in any direction on this convex surface. It will thus be perceived that all end pressure from the shaft

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will be evenly distributed round the ring of balls. On the back of the cover, *e e*, a hexagon head, *g g*, is formed, which by means of a spanner enables the screwed cover, *e e*, to be rotated, and thus afford adjustment of the pressure on the end of the shaft: or if there is a similar bearing at the other end of this shaft also, it is obvious that the longitudinal position of the shaft itself may likewise be thereby adjusted. Though no other method is shown in the drawing, we find it intimated in the specification that the cover, *e e*, may be adjustably secured to the bearing in any suitable manner; which may include presumably some method of locking it so that it should not rotate from any set position under the influence of vibration.

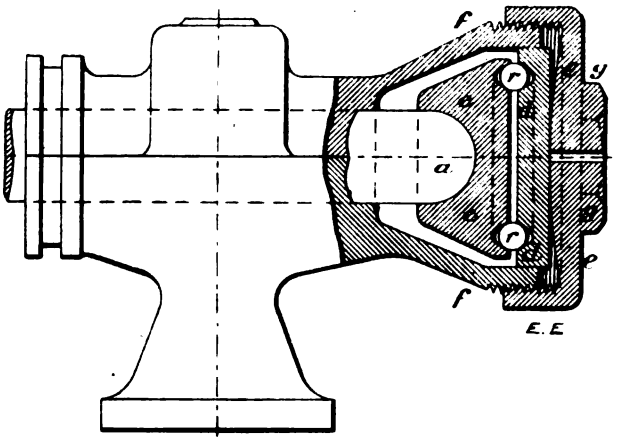

FIG. 279.

Two further designs for thrust bearings, adopted perhaps more especially for small motors, are added in Figs. 280 and 281; of which the latter is also fitted with end adjustment. These are intended for working in any position, even if the bearing is inverted so that the lubricator is below instead of above, and have a resemblance to bearings that have been used with success on the armature spindles of electric drilling machines, wherewith the end thrust was principally or only that due to gravity when the spindle was otherwise than horizontal, by Messrs. The Thames Ironworks and Shipbuilding Company, Limited, Blackwall.

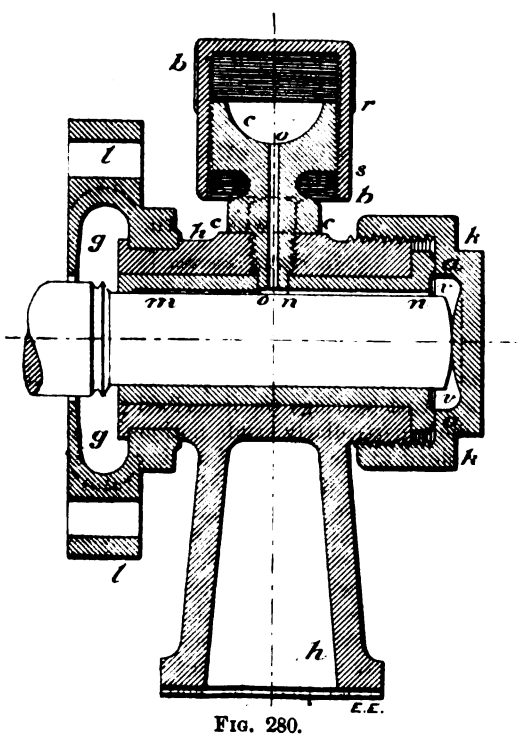

FIG. 280.

To give our attention to the former first, however, Fig. 280, we note here also a screwed cap, *a a*, on the end, having a convex inner surface, very similar, in fact, to that shown in Fig. 279. This cap is of cast steel, and so also the shaft: and the latter does not therefore require to be fitted with a hard-steel plug, as was shown in Fig. 276. The end of the shaft being rounded, it will impinge on the inner convex surface of the cap, *a a*, and thus will rotate with the least possible amount of resistance as regards friction due to end thrust. This bearing is intended to be lubricated with vaseline, or other such solid or semi-solid lubricant; and a well-known form of lubricator for this purpose is depicted. As will be seen, this consists of a stalk, *c c*, having a hexagon section in the middle, as shown, which permits it to be screwed tight into a tapped hole in the top of the bearing. The upper part of this stalk forms a cup having its outer surface screwed; and over this is fitted a cap, *b b*, with its interior threaded as shown. This cap, *b b*, is filled with vaseline; and thus on being screwed down, it forces the vaseline through a small hole, *o o*, in the centre of the stalk, and thence along the groove, *n n*, to the interior of the steel cap at *v v*. It will now be noted that this latter cap bears hard against an annular ridge on the bush, also indicated by the letters *a a*, thus forming an oil-tight joint. The vaseline in the space *v v* has thus no means of exit except along the journal where it is required.

Experience teaches the necessity of adding also a small groove toward *m* as shown. For a workman, on first starting the machine, is apt sometimes not to screw the upper cap, *b b*, down sufficiently far; and thus, from lack of lubricant, without the groove toward *m*, the end of the journal toward *m* will run dry, and thus give trouble and heat and seize.

Though this method of lubricating is often very convenient and handy, its satisfactoriness depends much on good design and workmanship. It is obvious that if the cup, *c c*, were made very shallow in respect of the dimension from *r* to *s*, and the threads coarse, and the cap, *b b*, a loose fit, the vaseline under any pressure would escape past the threads. In the illustration, therefore, we find the head of the stalk, *c c*, shown deep from *r* to *s*, and the threads are fine. The workmanship also must be good, so that the cap is a tight fit on the stalk, yet such that it can be turned by the hand without unreasonable effort. With these precautions, therefore, leakage may be reduced to a minimum, if not altogether stopped: though it is, of course, also necessary to thoroughly cleanse the threads and inside of the cap before putting into use, not merely to ensure easy working, but as well to prevent the presence of such grit in the lubricant. To increase the grip for the hand, the outside of the cap may be milled near the top as indicated.

The vaseline, or other so-called solid lubricant such as may be used, exuding from the further end of the bearing, will be caught in the hood, *g g*, formed in the brush rocker. This latter is made in two halves bolted together, to enable it to be put in place. As the lubricant, being thick, cannot flow away, the rocker must be removed at intervals for the purpose of cleaning out the hood. This latter may therefore be made with a capacity somewhat greater than that of the cap, *b b*, and thus it will be sufficient to clear it each time the cap is replenished. The main casting, *h h*, especially if small, will preferably be of gunmetal. The recesses, *k k*, in the cap, *a a*, indicate two flats to receive a spanner for tightening, similar to the case of the cap, *a a*, in Fig. 281.

This last-named illustration may now receive our attention. It will be observed to differ principally in two respects from the foregoing. Thus the cap, *a a*, is fitted with two flat-ended steel clamping screws, *b b*, so that by tightening these the cap may be securely held in any position to which it may be turned. With this method the oil-tight joint between the cap and the bush that existed in Fig. 280 is sacrificed. On the other hand, an effect of tightening the screws, *b b*, is to force the threads of the cap, *a a*, hard against the threads on the bearing, and thus make the joint between nearly or quite oil-tight: though this point may be assured by putting a little white lead on the threads before setting.

A trouble with these bearings is the possibility of their heating, due not only to inattention to the lubrication, but also to conduction along the shaft of heat from the armature or commutator. The result is the melting of the lubricant, which thus virtually becomes oil. Hence a screwed cap as at *b b* Fig. 280, though tight enough for vaseline, would not retain oil, as any fluid would escape between the threads which are not here so tight as to prevent such leakage. We thus find that in order to meet

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this difficulty a piston lubricator is employed in the design shown Fig. 281. This piston is constituted principally of a circular pad, *w*, of soft oiled leather held between two brass plates, *u* and *v*, and made a tight fit in the cylinder, *c c*, which latter is bored smooth inside. The piston is secured to the short rod, *d*, by a screw to enable an easy renewal of the leather when worn: or otherwise, the lower end of the rod, *d*, may be extended and turned small, and the piston being slipped on, the small end may be riveted over. A steel pin penetrating the plate, *u*, and the end of the rod, *d*, and two more through the plate, *u*, and the pad, *w*, as shown, will prevent loosening of the parts by any unfortuitous turning of the rod, *d*, as might otherwise be the case. It will thus be seen that any lubricant below the piston can be forced into the bearing by pressing down the rod, *d*, and the piston: while further, should the lubricant be liquid, either originally or by melting, the tight fit of the leather piston will prevent its escape. In practice sometimes an adjustable spring is fitted behind or above the piston, so as to maintain a slight constant pressure on the lubricant.

To facilitate the withdrawal of the piston for replenishment of lubricant, the plate, *v*, must be of small diameter, so that the edge of the leather may drop and admit air, which can otherwise only enter past the journal. The lubricant exuding from the commutator end may either be flung off without being caught, or else a split hood may be

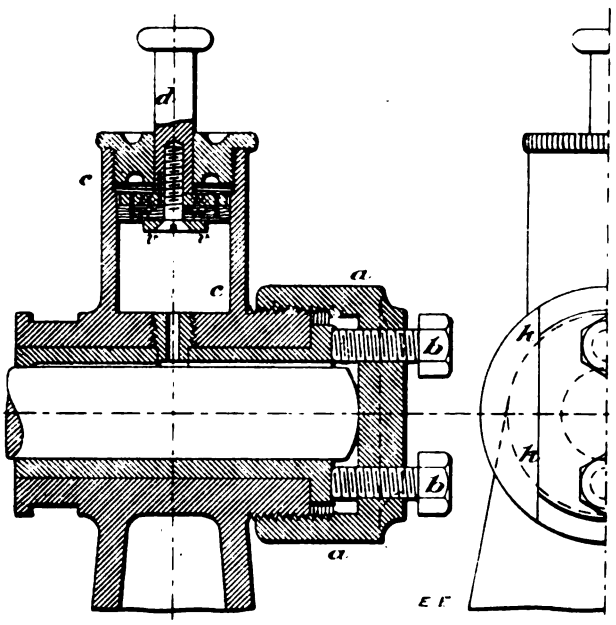

FIG. 281.

attached similar to that shown in Fig. 280, but without the projections, *l l*, which are there supplied for holding the spindles for the brushes.

It will thus be perceived that a shaft may be fitted with a thrust bearing having a cap such as that shown at *a a*, Fig. 280, at one end, and, in order to adjust the longitudinal steadiment of the shaft, one like that shown in Fig. 281 at the other end: or a bearing as in Fig 281 may be put at each end so as to permit adjustment of the position of the shaft; while the form of lubricator would be optional according to circumstances.

The above three bearings, it will be noticed, were for end thrust in one direction only. We now, however, come to two designs of bearing to take end thrust in either direction, the whole of such duty thus falling on one bearing here, which was divided between two bearings, one at each end of the shaft, in the foregoing cases. Of those now before us, Fig. 282 illustrates a bearing fitted with ordinary gunmetal brasses with annular recesses bored within them to receive five collars on the shaft, as shown. As there is additional liability to heat due to the end pressure of the collars, beside the vertical pressure of the shaft, efficient lubrication becomes doubly important. We thus find two lubricators here shown, and a deep oil-way, *e e*, is cut along the upper brass, so that the collars are each of them immersed in oil at the top. For the sake of coolness, as well as lubrication, an oil-pump may be used for maintaining a continuous and copious supply of cold fresh oil: and this draining below, may then, if at all heated, be cooled before again passing the pump.

Fig. 283 depicts a white metal thrust bearing. There is, of course, less liability of a white metal bearing becoming heated, as compared with gunmetal brasses, due to the lesser friction. Thus, according to experience, and knowledge of the end thrust, the syphon wick method of lubrication may be adopted instead of the foregoing. Further, whereas

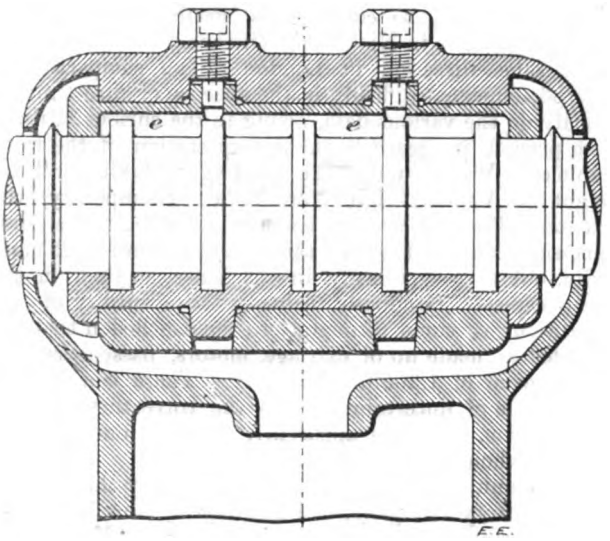

FIG. 282.

some makers let the oil drop on to the collars, as shown in Fig. 282, we now find it supplied between the collars. The immediate point however, attained in both cases illustrated, is that of affording not only a sufficient, but also an equable lubrication along the whole length of the bearing. In Fig. 283 oil-ways, *o o*, are shown from collar to collar; and these may also be extended down the sides of the annular recesses in which the collars work. It is to be noted that the centrifugal force will tend to make the oil fly to the periphery of the collars.

The ends of the bearing at *r r* will be observed to be bored so as just to clear the shaft; and thus the latter does not rub the cast iron. On the other hand, this clearance is small, so that in case the white metal should

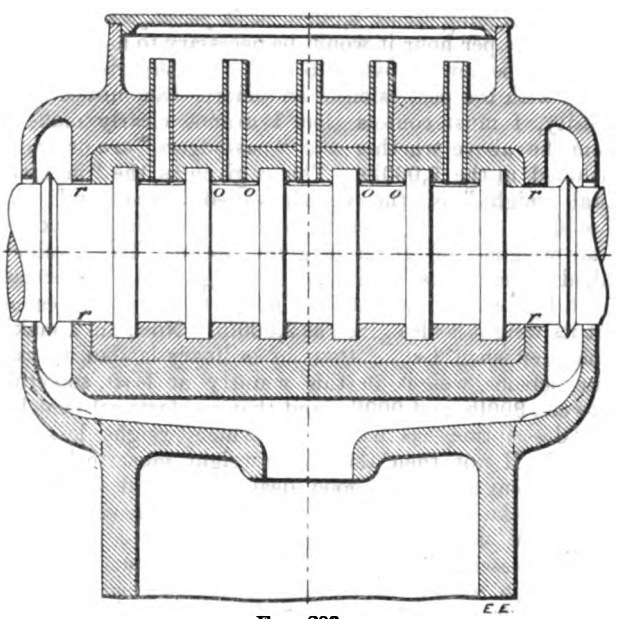

FIG. 283.

get over-heated and run, the shaft would be caught by these lips, *r r*; and thus the disaster of a great drop averted. The extent to which such an accident would affect the end thrust would, of course, depend on the arrangement of the rest of the machinery. As already pointed out in connection with Figs. 240 and 244, it is optional to run the white metal in on a mandril with a diameter smaller than the journal, and subsequently bore

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the white metal and the recesses for the collars; or else the metal may be run in with the shaft in place. In the case of the gunmetal brasses, boring is, of course, without option.

(*To be continued.*)

ELECTRIC MOTOR-CABS IN NEW YORK.

BY DESMOND G. FITZ-GERALD.

It is interesting to compare the results of the trials of automatic vehicles in New York with what has been done in the same direction in London. The comparison is rendered somewhat difficult, in the absence of direct means of verifying the various data, owing to the curious latitude which prevails in regard to the interpretation of the word "vehicle." When, under the heading "Maximum Total Weight of Vehicle," our New York contemporary, the *Electrical World*, places "landaus 2,500lb.," the first impression conveyed is that these carriages are built more solidly, not to say clumsily, in the American than in the British capital. Gradually realising the absurdity of this supposition, we come ultimately to the conclusion that the "vehicle" is made up of carriage, motors, passengers, and perhaps even of 1,200lb. of battery. There is a troublesome degree of uncertainty as to the correctness of this interpretation, but it is apparently the only one that will cover the whole of the facts.

The accumulators used are manufactured by the Electric Storage Battery Company, of Philadelphia, New York, and Boston. Some of the batteries consist of "Manchester type" plates, by which is probably meant Planté plates of the Tudor form; but in most cases "Chloride" plates are used. The complete battery equipment for a "single" hansom cab weighs about 900lb., which must be a minimum, since we are elsewhere informed that "hansoms" weighing 3,000lb. carry a maximum weight of 1,200lb. of battery. The proportionate weights of battery, I should say, would be unprofitably low, in the absence of extended facilities for recharging, concomitant with the use of a "rapid-charge" accumulator. The former battery has a normal discharge rate of about 21 amperes, and is stated to maintain 80 volts, even at abnormally high rates of discharge. Three plates only are contained in each cell, an arrangement which is said to greatly facilitate renewals.

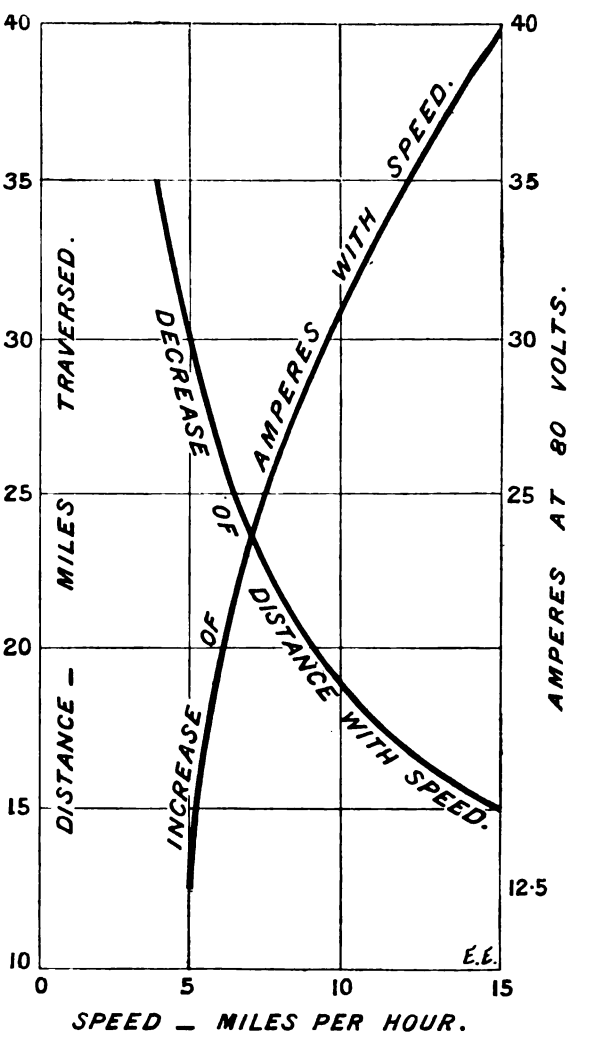
In another portion of the report on the electric motor-cab service in New York City we are told that "to propel a vehicle weighing about 2,000lb. *with passengers* at a speed of 10 miles per hour it would be necessary to have a battery output of somewhat over 1·5 h.p." At the risk of being taxed with the possession of an abnormal amount of mental density, I must confess that I cannot clearly make out from the above whether the "passengers" are or are not included in the 2,000lb. This is given as the "maximum total weight" of the vehicle called a "surrey," which should be much lighter than a landau, the "maximum total weight" of which is given above. The "vehicle" called a victoria is, as I have been given to understand, much lighter than an ordinary landau to carry four persons, but its weight is also given as 2,000lb. Now, am I making a blunder when I state that an ordinary landau, to carry four persons, weighs, in this country at least, something between 800lb. and 900lb., and that an electrical vehicle of this description has been built which weighs less than 600lb.? If not, then the above weight must include, not only passengers, but a good deal more besides. It must mean, I take it, the whole traction weight, or what is designated "W" in traction formulæ.

The "essential"—query minimum—output of 1·5 h.p. per 2,000lb. would, we are told, be far exceeded ordinarily, and would approach nearer 3 h.p. This is for traction over the streets of New York. "It has therefore been found," says the report, "that about 900lb. of battery are needed to give a travelling capacity of about 30 miles (at 10 miles an hour), or about 1,350lb. with a vehicle weighing complete about 3,000lb." The word "therefore" here means that 900lb. of battery is required to give 3 h.p. effective; this being dependent upon voltage and rate of discharge. It happens also that the capacity of the battery is such that 100lb. gives one horse-power hour, and that 900 horse-power hours are equivalent to 26·8 ton-miles under the given conditions of traction. Did I not fear to be hypercritical I should say that there is a slight *non sequitur* in the sentence above quoted.

The following are amongst the most satisfactory of the data given in the report: "It has been found that 800lb. of battery, including retaining trays, jars (*sic*), acids, etc., as arranged and used for these vehicles, will drive a ton weight 35 miles in four hours over ordinary city streets where grades are not excessive. Put in another way, it may be said that 100lb. of battery will deliver one horse-power hour, and two horse-power hours will drive a ton at the rate of a little over eight miles an hour. These are actual results, and not calculations."

The trays, each containing 11 cells, are of sheet iron, lead-coated and painted all over with acid-proof paint

According to my calculations, from the practical data, any weight of the battery in question will theoretically convey itself, under the given conditions of traction, over a distance of 98 miles. It is more than probable that the peroxide plates require renewal within a period measured by months, and that, to obtain the given results, they are considerably overworked; but the above figure compares favourably with that applicable to the traction battery in use for automotric cabs in this country—viz., 83 miles. I think it can be shown that it would be an improvement to increase the weight of cells to one-half of the total traction weight.



The following are the essential practical data at which I have arrived from the consideration of the New York trials of electric motor-cabs:

1 h.p. effective is obtained from 300lb. of battery.
1 h.p.-hour „ „ 100lb. „
1 ton-mile (·3 h.p.-hour) is obtained from 30lb. to 33·3lb. of battery.

One very instructive result is obtained from these trials. It is usual in traction formulæ to consider the expenditure of energy, *cæteris paribus*, as proportionate to the distance,

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L, traversed, and to measure this simply by the product of speed × time, whatever may be, within the limits of practice, the separate values of the factors of the product. We know that this is not exactly accurate; but, if *speed* be augmented, *time* is in most cases proportionately decreased, or nearly so, and the value of L remains sensibly constant. But in the case of automotric electric traction, if we increase S, the value of *t* may be much more than proportionately reduced, and L may therefore become very considerably diminished. This occurs whenever the battery is overworked—*i.e.*, when the plates become "polarised" by the effect of discharge. Of course the explanation is that when S is increased current is augmented, and the available energy may be greatly diminished by reason of a too rapid discharge.

The diagram applies to the case of a traction weight of 2,000lb., and a battery, of the kind above referred to, weighing 900lb. The voltage is supposed to remain constant at 80; the amperes corresponding to different speeds are roughly indicated by a curve for which no degree of accuracy is claimed, but which seems to show that the amperes under the constant voltage vary in a ratio not very different to that of the speeds. The second curve shows that when the speed is increased from four or five to about eight miles an hour, the distance traversed is diminished from 30 or 35 to 20 or 24 miles; and that when the speed is increased to 15 miles an hour, the distanced traversed is only 15 miles. This diagram will no doubt be improved as to accuracy when further data are obtainable, but, in its present form, it may be suggestive if not useful.

SOME TESTS ON THE VARIATION OF THE CONSTANTS OF ELECTRICITY SUPPLY METERS, WITH TEMPERATURE AND WITH CURRENT.*

BY G. W. DONALD RICKS.

The general object of the tests to be described in this paper was to afford a means of studying the behaviour of direct-current electricity supply meters with regard to variations in the accuracy of their indications under varying conditions of temperature, current, and potential difference.

Some of the more important meters were put through a series of tests, which aimed at ascertaining:

1. How the accuracy of the meter depended upon the current at various constant temperatures, all other conditions being maintained constant.

2. How its accuracy depended on the potential difference at constant current and temperature.

The first of these tests was carried out at three different temperatures—namely, about 2deg. C., 18deg. C., and 40deg. C., which may be fairly taken as the extreme and mean ordinary working temperatures. From the results of this test the effect of change of temperature at constant potential difference and current was ascertained.

The second test is, of course, only applicable to energy meters. It was made at the maximum current and at atmospheric temperature, the pressure being varied from about 10 per cent. below to 10 per cent. above the normal value.

The above tests were carried out at the City and Guilds Central Technical College upon each of the following meters, obtained direct from the makers, and not opened or in any way altered before testing:

Name of meter.	Maker's number.	Normal pressure.	Maximum current.	Declared constant.
Elihu Thomson	80,711	100	10	1·0
Schuckert	10,717	110	15	0·5
Ferranti	17,876	—	25	1·0
Perry	401	—	20	2·0
Chamberlain and Hookham	6,973	—	25	1·0

These, it will be seen, fairly represent the principal types of direct-current meters now in general use in this country.

* Paper presented by Prof. W. E. Ayrton to the British Association meeting at Toronto.

Apparatus and Method of Testing.

In carrying out these tests it was necessary to have some means of controlling the temperature of the air surrounding the meter, and for this purpose a thermal case of the following construction was employed. The inner tank, T_1 (Fig. 1), is of copper, 14in. square by 20in. deep, and is fixed within another similar tank, T_2, by means of wooden distance pieces, W W, leaving a space of 2½in. between the two tanks at the sides and bottom; the top, however, was covered by a mahogany lid, L, provided with a large window of ¼in. plate glass. The whole was then placed in a wooden case 28in. square and 32in. high, the intervening space being filled up with sawdust to retard as much as possible interchange of heat and consequent change of temperature. For the same reason the top was covered with cotton wool, except for a small portion of the window through which observations were made.

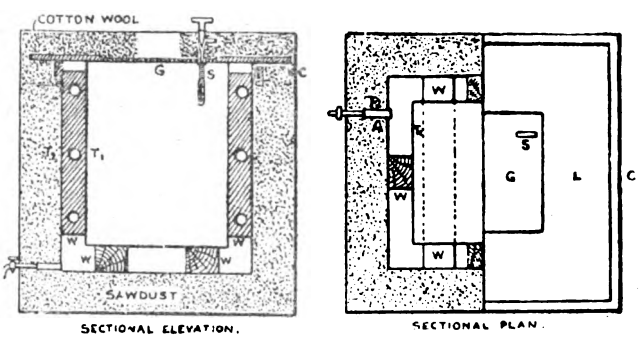

FIG. 1.

For the higher temperature tests the space between the copper tanks was filled with water at a temperature rather above 40deg. C., and this was maintained constant by passing steam into the water, thus supplying heat in place of that lost by radiation, etc. The rate at which this steam was passed in was governed by a Reichert's automatic thermostat, S, which regulated the supply of gas in the steam generator. Using this apparatus no difficulty was experienced in keeping the temperature of the air in the inner tank constant to within ½deg. C.

The low temperature, on the other hand, was obtained by substituting for the hot water a freezing mixture of salt and ice, and it was found that in this case no regulation was necessary, because after the freezing mixture had been in for several hours a steady condition was reached, after which the air in the inner tank showed no appreciable rise of temperature for two or three hours.

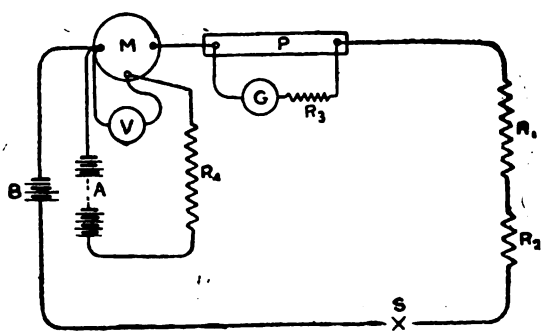

FIG. 2.

The intermediate temperature taken was that of the atmosphere at the time of testing, and after closing up the thermal case no greater variation occurred than in the other cases.

The rest of the apparatus and its arrangement is shown in Fig. 2, where M is the meter under test, B a battery of accumulator cells, R_1 a variable carbon resistance, and R_2 a variable mercury resistance for close regulation of the larger currents used. Currents down to 10 amperes were measured by means of a Kelvin balance previously standardised by the copper deposit method. It was not suitable, however, for currents below 10 amperes, and for such currents it was therefore replaced by the arrangement shown in Fig. 2, and consisting of a sensitive

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d'Arsonval galvanometer, G, connected in series with a variable resistance, R_3, to the ends of a platinoid strip, P. This arrangement, after being carefully calibrated, constitutes a very sensitive ammeter possessing the very desirable property that its sensibility can be adjusted according to the magnitude of the current to be measured. It was calibrated relatively by the potentiometer method, and absolutely by comparison with the Kelvin balance In the case of ampere-hour meters this completes the arrangement, but for energy meters it is necessary also to energise the shunt windings by keeping their terminals at the proper potential difference. This was effected by means of the battery of small accumulator cells, A, with a regulating resistance, R_4, in circuit. This potential difference was measured on an Ayrton and Mather dead-beat astatic station voltmeter. In the second set of tests, however, in which it is required to determine the effect of varying the potential difference, a reflecting voltmeter of the d'Arsonval type was employed.

The accuracy of supply meters is most conveniently studied by experimentally ascertaining to what extent the constant or multiplier differs from its declared value under different conditions. By plotting the result as a curve of variation one obtains a clear indication of the behaviour of the meter as regards the accuracy of its readings. The multiplier referred to is the number by which the amount indicated by the meter must be multiplied to give the true value in watt-hours or ampere-hours as the case may be. Hence the constant or multiplier may be defined as the ratio of the true value to the indicated value. To obtain the actual value of this constant experimentally, much time and labour can be saved by observing the revolutions of the armature instead of taking the dial readings in the ordinary way, for since they are connected simply by multiplying mechanism, their motions are proportional. All that is necessary is to determine once for all the number of revolutions of the armature which correspond to the registration of one unit on the dial.

Let a = number of revolutions of the armature per unit registered on dial.
K = constant of multiplier.
A = current in amperes.
V = potential difference in volts.
T = time in hours during which A might flow.
N = number of units registered in time T.
w = speed of armature in revolutions per second.

Then $$a = \frac{3{,}600\,w\,T}{N} \text{ and } N = \frac{3{,}600\,w\,T}{a}.$$

In the case of watt-hour meters:

By definition,

$$K = \frac{\text{true watt-hours}}{\text{registered watt-hours}} = \frac{A\,V\,T}{N},$$

substituting for N

$$K = \frac{A\,V\,T}{3{,}600\,w\,T} = \frac{a}{3{,}600}\,\frac{A\,V}{w},$$

and $$w = \frac{a}{3{,}600\,K}\,A\,V.$$

If K' = the declared value of K,

w' = speed of armature when the meter is registering accurately,

$$w' = \frac{a}{3{,}600\,K^1}\,A\,V$$

$$\frac{K}{K'} = \frac{\frac{a\,A\,V}{3{,}600\,w}}{\frac{a\,A\,V}{3{,}600\,w'}} = \frac{w'}{w}$$

$$K = K^1\frac{w'}{w}.$$

The constant a having been first carefully determined, values of w' for different currents are calculated and tabulated or plotted for use.

Exactly the same method is applicable to ampere-hour meters, the only difference being that the quantity V does not occur.

In testing, therefore, there are in general three quantities to be measured—viz., current, potential difference, and speed—the constant a being of course determined once for all for each meter.

The current and potential difference were measured and regulated as already described, the speed of the armature was observed by noting, by means of a stop-watch, the time taken for a convenient number of counted revolutions. The interval of time measured was never taken less than five minutes, so that the percentage error in w would be very small. In all cases the meter was allowed to run for a minute or two after each change of speed before any observation was taken, and the determinations of k for each point were repeated until concordant results were obtained.

Elihu Thomson Meter.

This meter may be regarded as a form of electrodynamometer so arranged that, instead of merely indicating power, it integrates it with regard to the time, and so measures the amount of energy that has passed. The general principle of all such meters is that a small fraction of the power to be integrated is employed to produce motion in an armature. If the velocity of the armature can be made exactly proportional to the whole power, then the number of revolutions of the armature in any time is a correct measure of the total energy that has passed.

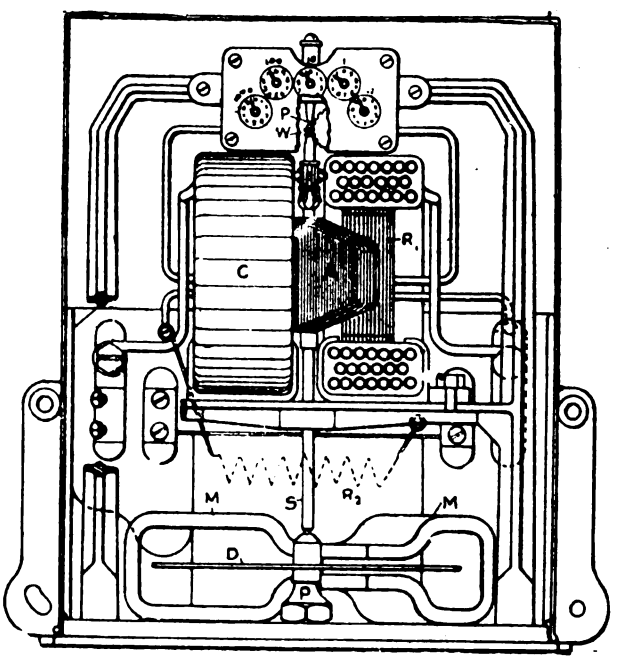

FIG. 3.

In Fig. 3, CC are two coils of thick conductor which carry the main current. The field thus produced is proportional in strength to the current, and in it is placed the armature, A, which is drum-wound, without any iron in its core; its windings form part of the high-resistance pressure circuit. Since there is no iron in the magnetic circuit, the driving torque thus produced is proportional to the product of current and pressure, and if the retarding torque could be made strictly proportional to the speed this would be sufficient; but solid friction at the bearings introduces a disturbing effect which is overcome, first by making the bearing friction as small as possible, and also by compensating what remains by means of a permanent driving torque, in addition to that already mentioned. Solid friction may be considered as being very nearly constant throughout the range of speed employed. So the extra driving torque must be independent of the speed. It is produced by placing two fixed coils, R_1 R_1, of fine wire in the pressure circuit, and by connecting this circuit to the lamp side of the series coils, so that both the shunt and main currents pass round these windings (Fig. 4). The pressure circuit then consists of these two fixed coils, the armature, and an added non-inductive resistance, R_2, which brings the total to above 3,000 ohms. As the meter is designed for use on either direct or alternating current circuits, it is important that the self-induction of the

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pressure circuit should be comparatively small, consequently the non-inductive part, R_2, forms the greater part of the whole resistance. Connection is made with the armature windings by means of a small silver commutator, E, at the top, and two lightly-pressing spring brushes, B B, with silver contact-pieces. Fixed to the spindle at its lower end there is a large copper disc, D, rotating in a non-uniform but constant magnetic field, supplied by two or three permanent magnets, M M. The reaction between the Foucault currents induced in the disc and the magnetic field producing them, gives the required retarding torque proportional in magnitude to the velocity. The counting mechanism gears into a worm on the spindle at its upper end; the dials are usually direct reading in kilowatt-hours, but in some sizes multiplication by a simple constant is necessary. In this meter solid friction is reduced to a minimum by having a delicate jewelled bearing, P, at the lower end of the spindle. It is provided with a spring arrangement to prevent injury from vibration, and it can be lowered out of contact when the meter is being moved. Very light pressure of the brushes is sufficient to give good electrical contact, and the upper bearing is, of course, unimportant, being little more than a guide. What solid friction remains is in great part neutralised by the permanent torque already referred to.

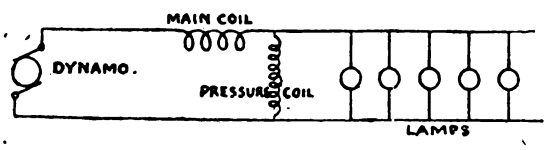


FIG. 4.

The law of this meter is comparatively simple, and may be expressed as follows:

Let A = main current.
V = potential difference.
w = speed of the armature.
a = a constant depending on windings, etc., of series coils.
b = " " " " armature.
c = " " " " coils R_1 R_1.
p = " " " solid bearing friction.
f = " " " brake field.

Then Driving torque $= a\,A\,b\,V + c\,V\,b\,V$.

Retarding torque $= f^2\,w + r$.

For steady motion

$$a\,b\,A\,V + b\,c\,V^2 = f^2\,w + r.$$

Now if bearing friction is exactly compensated by the permanent torque

$$b\,c\,V^2 = r,$$

and

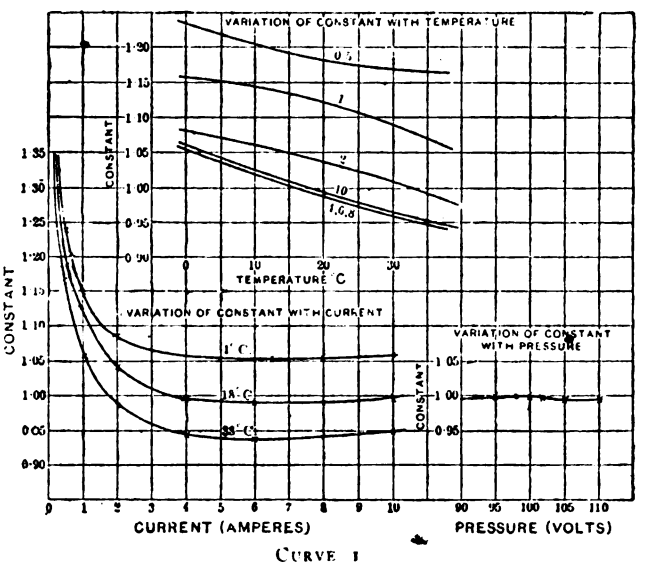
$$A\,V = \frac{f^2}{a\,b}\,w.$$

The results of the tests on this meter are given in Table 1 and shown graphically in Curve 1. The starting current, below which of course the constant is infinite, is about 0·14 ampere, or 1·4 per cent. of the maximum. The constant then falls very rapidly as the current increases; not, however, reaching its normal value till the current has risen to about 40 per cent. of its maximum value, after which it remains remarkably constant till within 10 per cent. of the maximum, when it begins to rise slightly. This high value of the constant at small current is, of course, due to the uncompensated part of the solid friction. There are several reasons why it is desirable to not quite compensate for all the solid friction. Not only would it increase the amount of continuously absorbed energy, but the meter would be liable to start without any series current, should the pressure increase slightly. Another consideration is that it is very desirable to keep the self-induction of the pressure circuit as low as possible, in order to lessen the difference which it causes between the direct-current and alternate-current readings.

The effect of temperature change is also shown in Curve 1. Except for low currents, where the value of the constant is not so well defined, these curves are practically straight lines. The constant decreases proportionately to the rise of temperature, and the temperature coefficient of the meter is therefore negative. Its maximum value is about – 0·32 per cent. per degree C.; but for currents between 4 and 10 amperes its mean value is – 0·29 per cent. per degree C. This coefficient, it will be noted, is not very much less than that of copper, and it may therefore be surmised that the coefficient of the pressure coil is very much less than that of the copper disc.

The tests made with varying pressures show that the accuracy of the meter's indications is quite independent of the pressure when varied within 10 per cent. of the normal value.

This meter possesses some very useful advantages compared with meters generally. It is comparatively simple



CURVE 1

in construction and is equally applicable without any modification to either alternating or direct current circuits. As already pointed out, its constant is remarkably accurat for currents above 40 per cent. of the maximum; for low currents, however, the error is considerable. The power absorbed is also fairly large; the pressure circuit takes 3·2 watts, and the series coils at full load 9·6 watts, so that at full load the wasted power is 1·28 per cent. of the maximum power, and at no load about 0·32 per cent.

Symbols Used in the Tables.

w = speed of armature in revolutions per second.
K = constant (determined experimentally).
K^1 = declared constant.
A = current in amperes.
V = potential difference in volts.
a = number of revolutions of the armature per uni registered on the dials.

TABLE 1.—Elihu Thomson Meter.

Maximum current, 10 amperes. Pressure, 100 volts. $a = 2$. $K^1 = 1$, Current varied.

Current A.	At - 1deg. C.		At 18deg. C.		At 38deg. C.	
	w	K	w	K	w	K
0·5	0·0225	1·236	0·0234	1·186	0·0237	1 17
1	0 0483	1·150	0 0492	1·129	0·0526	1 055
2	0·1028	1·081	0 1070	1·040	0·1132	0·983
4	0·2106	1 056	0·2241	0 993	0·235	0 945
6	0·3160	1·055	0·3360	0·994	0·354	0 942
8	0·422	1·056	0 448	0·991	0·471	0·945
10	0·523	1 061	0 556	1·000	0·585	0 951

TABLE 1A.—Pressure varied. Current = 10 amperes.

V.	w.	K.
90	0·501	0·999
95	0·528	1·000
98	0·546	0·999
100	0 556	1·000
102	0 567	1·000
105	0·586	0·997
110	0·612	0 999

(To be continued.)

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A METHOD OF DETERMINING MAGNETIC HYSTERESIS LOSS IN STRAIGHT IRON STRIPS.*

BY J. A. FLEMING, M.A., D.SC., F.R.S., PROFESSOR OF ELECTRICAL ENGINEERING IN UNIVERSITY COLLEGE, LONDON.

The exact determination of the magnetic hysteresis loss in sheet iron as used for alternating-current transformer construction has become of commercial importance of late years. Owing to the obvious necessity for reducing the core loss in transformers to the lowest attainable limit, it is now the custom to carefully test the iron to be used and to express the determined hysteresis loss in the iron sheet, in watts per pound per 100 frequency, at a maximum induction during the cycle of 2,500 C.G.S. units. Two processes are in ordinary use for effecting this measurement. The most accurate but most tedious is by the employment of a ballistic galvanometer and the graphical delineation of a number of (B, H) cycles. This method has the advantage that it can be conducted with either small or large samples of iron, but the reduction of the observations to give the required hysteresis loss is very tedious; and including the construction of the necessary ring-coil, the actual observations, and the reductions, a single determination of the hysteresis value of an iron can hardly be carried out, even by a couple of industrious workers, in less than a day.

The method employed by Prof. Ewing and Mr. F. Holden of rotating a laminated specimen of the iron in a magnetic field, or rotating a field round the specimen and comparing the torque produced on the field magnet or on the specimen with that produced by a similar sample of iron of known hysteretic value or else measuring it by a calibrated torsion spring, is very much more rapid. This last method is, however, open to the great objection that if used merely to compare a sample of iron with a standard sample, the user of the instrument is at the mercy of his instrument-maker. He receives with it one or more samples of iron which he is told have certain hysteretic values, but he cannot check the truth of the statement. Moreover, if he happens mechanically to injure the standard samples, he may seriously change their hysteresis constant. The writer therefore sought for a method which should combine the advantages of both the above processes whilst eliminating their disadvantages, and which should be an absolute method, like the ballistic method, but at the same time a rapid method like the rotating-field method.

The following paper contains a description of a process which is based upon the use of the bifilar reflecting wattmeter and operates upon samples of iron, large or small, in the form of straight strips which are simply slipped into a long magnetising coil. All the actual practical work and numerous calculations involved in putting this process to test have been conducted under the author's direction by Mr. A. R. Peart and Mr. W. M. Park, working in the electrical laboratory of University College, London; and to these gentlemen belongs the full credit for all this portion of the research, as well as for the labour required in much tedious numerical and graphical work.

The method is based upon an interesting discovery with regard to the distribution of the induction in a bundle of straight iron strips or iron or steel wires, when placed in a uniform magnetic field.

If a long, straight, magnetising coil is prepared by winding insulated wire upon a paper or vulcanised fibre tube, and if the length of the solenoid is, say, 10 times its mean diameter, then for a distance equal to at least three-quarters of the total length of the coil we have a practically uniform magnetic field in the interior of the bobbin, when a constant current is sent through the wire. If into this uniform magnetic field a bar of iron or straight bundle of iron strips or iron wire is introduced, the length of the iron being not greater than the uniform portion of the interior field of the coil when the iron is not there, this iron has magnetic induction created in it which varies in density from point to point in the bar, but is symmetrical in value about the central point of the bar.

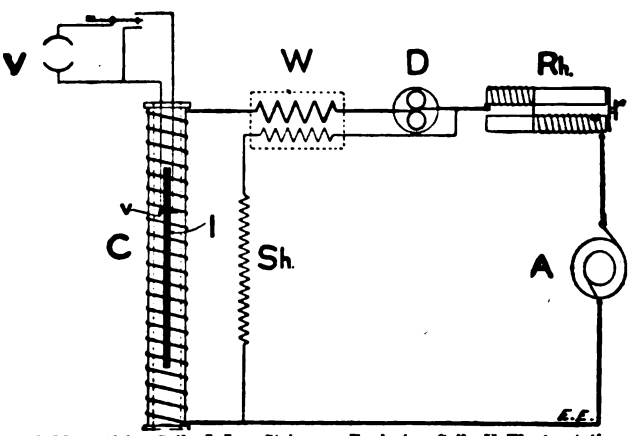
The induction density, B, is greatest in the centre of the bar, but falls off towards each end. If the magnetising coil is traversed by an alternating current, and if the iron is laminated, the maximum value of the induction density in the bar can be easily determined at any point in its length by placing upon the bar a flat bobbin of fine insulated wire, which is connected with an electrostatic voltmeter capable of reading from 1 to 20 volts (see diagram). The first portion of this investigation was concerned with the study of the mode in which this induction density varies from point to point in the length of a bundle of iron strips or iron wire or steel rods of various lengths and diameters, thus placed in the centre of a low magnetising solenoid.

A magnetising coil was prepared, wound on a paper tube, 5·7cm. in internal diameter and 99cm. long. On this tube was wound, in three layers, a coil of 1,235 turns of cotton-covered copper wire, ·064in. diameter or of No. 16 size S.W.G. The resistance of this coil was 1·069 ohms at 15deg. C.

The number of turns per centimetre length of this coil was 12·47. Hence, since the interior central field is $4\pi/10$ times the ampere-turns per unit of length of the coil, we have thus the value of the field, H, in the central regions of the interior of this bobbin, given by the equation

$$H = 15{\cdot}66\,A,$$

where A is the ampere current through the coil.



C, Magnetising Coil; I, Iron Strips; v, Exploring Coil; V, Electrostatic Voltmeter; W, Wattmeter; D, Dynamometer; Rh, Rheostat; A, Alternator.

The secondary or exploring coil consisted of a flat bobbin wound up of silk-covered copper wire ·0024in. in diameter and having 2,000 turns; the thickness or length of the bobbin being 0·7cm. and the external diameter about 4·5cm.

The exploring coil was wound on a circular ebonite former having a rectangular hole in it so as to closely fit the bundle of iron strips to be used, but at the same time it could be slid along the bundle.

The voltmeter used with it was one of Prof. Ayrton's low-reading electrostatic instruments of the idiostatic type and read from 1 to 25 volts, the reading being taken by a mirror and scale. The voltmeter was calibrated when required by means of standard cells or a potentiometer.

The first experiments were conducted with strips of transformer iron, kindly furnished to us by Messrs. Sankey. This sheet iron was ·0121in. or ·0307cm. in thickness, and the strips were each 1in. or 2·54cm. wide. The strips used were of various lengths; 60cm., 30cm., 15cm., down to 5cm. A bundle, I (see diagram), of a certain number of strips was made, and the secondary coil, *v*, slipped on to it. The magnetising coil, C, was then traversed by an alternating current having a frequency of 80~, and the R.M.S. (root mean square) value of the current was read by a dynamometer, D, or Kelvin balance.

The electrostatic voltmeter, V, being connected to the ends of the secondary coil gave the R.M.S. value of the induced E.M.F. set up in the exploring coil. The form of the curve of the primary current was very nearly a true sine curve, and the variation of induction density in the iron at any point closely followed the same law.

In any case, if f is the form-factor* of the secondary

* Paper read before the Physical Society on June 11, 1897.

* See "The Alternate-Current Transformer," Fleming, vol. i., new ed., p. 583, for a reference to this term.

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voltage curve, which in these experiments was 1·13, and if

N = the number of windings in the secondary coil;

S = the total cross-section of the iron;

B = the maximum value of the induction density in the iron in C.G.S. units at that point in its length at which the secondary coil is placed; and

n = the frequency of the induction cycle; then, if e_2 is the R.M.S. value of the secondary E.M.F. in volts as measured by the voltmeter, we have always

$$10^8 e_2 = 4f\,N\,S\,B\,n.$$

Hence the maximum value of the induction density, B, can be calculated from the known value of all the other quantities. In this manner a large number of measurements of the value of the induction density, B, were made at different points in the lengths of various bundles of iron strips of different lengths and total cross-sections.

These values were then laid down in a series of induction density curves so drawn that the ordinates represented the maximum value of the induction density in the bar at different transverse sections along the half-length of the bar, taken as corresponding abscissæ.

(To be continued.)

ON A NEW METHOD OF MEASURING HYSTERESIS IN IRON.*

BY J. L. W. GILL, B.A.SC.

When a specimen of iron is passed to and fro through a magnetic field without any motion of rotation, the direction of the field being reversed each time the specimen passes out of the field, the iron passes through a complete magnetic cycle for each cycle of motion, and a definite amount of energy is lost, due to hysteresis in the iron. Since energy is supplied only in the form of mechanical work upon the specimen, the hysteresis loss is, by the law of the conservation of energy, numerically equal to the resultant mechanical work expended.

The instrument described below is based upon the above principle, and its function is to measure the work so expended. The magnetic field is obtained by the use of a solenoid wound on a brass tube. This solenoid is arranged vertically and has a vertical motion, the ends of the solenoid being fitted with collars, which slide on two rigid vertical rods. An arm is fastened rigidly to the solenoid, and extends out on one side. To this arm is fastened a cord, which passes over a grooved pulley vertically above. A balance-weight is attached to the other end of the cord. By rotating the grooved pulley the solenoid may be moved up and down, and will remain in any desired position. The specimen to be tested is placed in a stirrup, which is sufficiently small to pass through the solenoid, and is suspended by a helical spring, the point of suspension being vertically above the centre of the solenoid. Another helical spring extends from the bottom of the stirrup to a point vertically below. This serves to keep the stirrup steady. The stirrup is suspended, so that when the solenoid is in its lowest position the specimen is out of the magnetic field, being above the solenoid. As the solenoid is moved up the stirrup and specimen pass through it, and when the solenoid is in its highest position the specimen is practically out of the field. If the solenoid be moved once up and down, the field being reversed when the specimen is out of it, the specimen passes through a complete magnetic cycle, provided the specimen has been once through the field and is initially in that particular cyclic state.

As the solenoid is moved up, the specimen is attracted down, the force of attraction increasing until it reaches a maximum when about one-half of the specimen is inside the solenoid. The attraction then decreases and becomes zero when the specimen is in the centre of the solenoid. Up to this point work is being done by the magnetic force. As the solenoid is moved up to its highest position the specimen is attracted upward, and the work is done against the magnetic force; the attracting force becomes a maximum when the specimen is about one-half out of the solenoid on the lower side, and becomes zero when the solenoid is its highest position. The maximum force in the second half of the motion is greater than the maximum force in the first half. The work done in the second half of the motion is also greater than that done in the first half, the difference being the work expended in taking the specimen through half a cycle. When the field is reversed and the solenoid moved down, the action is similar to that which takes place when the solenoid is moved up, and the resultant work done will be the same, provided the specimen is homogeneous.

The resultant work done on the specimen may be determined by observing the attracting force when the solenoid is in different positions, and then drawing a distance-force curve. The integral of this curve gives the resultant work done on the specimen. The force at different points can be determined by calibrating the springs which support the stirrup, and then observing the extension of these springs. The author has determined the hysteresis loss in different specimens at different inductions by this method, the extension of the springs being observed with the aid of a microscope.

To make this method practical, a simple integrating apparatus is attached to the instrument above described, by which the work done is integrated automatically. A glass disc is connected rigidly to the pulley which moves the solenoid, so that when the pulley rotates, the glass disc rotates in its own plane, which is vertical, the axis of rotation passing through its centre. The motion of the glass disc is therefore proportional to the motion of the solenoid. An arm is fastened to the stirrup which supports the specimen, and extends up to the glass disc. This arm supports a graduated steel disc, which is free to rotate in its own plane about a vertical axis through its centre. This steel disc presses lightly on the glass disc, the point of contact being at the centre of the glass disc. When the solenoid is moved up, the specimen is attracted down, taking the stirrup with it. This causes the steel disc to recede from the centre of the glass disc. A motion of rotation is then communicated to it by the glass disc, the speed of rotation depending on its distance from the centre; since its distance from the centre at any instant is proportional to the attracting force, and the motion of the glass disc is proportional to the motion of the solenoid, the speed of rotation of the disc is proportional to the work being done at that instant. The total amount of rotation is therefore proportional to the total work done. Consequently all that is necessary to test a specimen with this instrument is to place the specimen in the stirrup, move the solenoid up and down to get the specimen in a cyclic state, then take it through a cycle, and observe the amount of rotation communicated to the steel disc. This is a direct measure of the work expended.

The constant of the instrument is determined by placing a known weight in the stirrup and observing the amount of rotation communicated to the disc when the solenoid is moved through a known distance.

The specimen may be taken through a number of cycles and the readings allowed to accumulate. The average of a number of cycles is thus obtained.

* Paper read at the British Association meeting at Toronto.

City and Guilds of London Institute.—The programme of technological examinations for session 1897-8 has been issued by Messrs. Whittaker and Co. at the exceedingly low price of 10d. The volume contains the usual information, lists of council, executive committee, and examiners, together with regulations, syllabuses of the various examinations, and a set of the examination papers given at the recent examinations. There is little to criticise in a work of this kind unless we attempt the task of discussing each syllabus or each examination paper, but this is out of the question. We should, however, like to suggest that the examiners propose questions more in accord with the syllabus rather than, as in the preliminary of electric light and power, to set seven questions out of eighteen upon subjects referred to in one paragraph only of the syllabus.

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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A POINT IN THE REPAYMENT OF LOANS.

The question of the best method for the repayment of loans is as yet unsolved, but there is one point about it which we have never yet heard discussed. When we consider that the National Debt is being gradually extinguished by a twofold process—first, by means of a definite sum annually set apart for that purpose each year, and, secondly, by the amount of the ascertained surplus of income over expenditure—we may ask if a similar plan might not be followed with local debts. As at present managed, loans are repaid by periodical instalments, and surpluses are used in aid of the general rate. We suggest that under some circumstances it might be better to use the accrued surplus for the reduction of the debt rather than pass it to the general rate. There may be strong reasons for not doing this, but the nation in its collective wisdom sees fit to decrease its debt rather than to decrease its taxing powers. There is no doubt but that the credit of a community, just the same as the credit of an individual, is in inverse ratio to its indebtedness. The tendency of present-day legislation is to throw greater and greater burdens upon the rates, and this tendency is almost as nothing compared with that of people advocating all manner of changes, whose formula for everything is that the State, or the local authority, should do this, that, and the other. The carrying out of any of these suggested changes means the expenditure of money obtained from the rates. The ratepayer, so far as the hobbyist is concerned, is an animal to be bled unmercifully, hence those who occupy positions of responsibility should endeavour to keep the local indebtedness within moderate limits.

It seems, then, to us that continuity in the rating should be aimed at rather than fluctuating levies. From our point of view the desire of any local authority to obtain a profit upon its undertakings in order to relieve the rates is a mistaken policy, and impolitic policy, and an absolutely unfair policy. Let us put the matter in the most sentimental manner, and assume that the credit of a town is pledged to obtain a loan for electric lighting. The loan, interest, and working expenses are paid out of the income received from consumers. There seems to be no valid reason why the consumers should, in addition to this, pay a smaller or a larger amount in profits to go to the reduction of the general rate. From this point of view we should contend that the ascertained profit at the end of each year ought to be used to repay capital so long as any remained unpaid, but we should also contend that the price charged to the consumer should be the lowest possible consistent with making the balance on the right side. It is impossible to estimate so closely that the balances are exact, and no one would trouble about a few pounds or a few hundreds of pounds being used for general expenses. It is only when the balance runs to a considerable amount, and when the aim of some authorities seems to be to get as big a profit out of the consumers as possible, that we have any objection to make.

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SIGNS OF THE TIMES.

When "Old Moore" takes to prophesying, it may be considered certain that the question, if it relates to political matters, is one that has entered the bounds of practical politics. Readers of the 1898 almanack will find this prophet foretelling the era of "penny postage." Most people who read the daily papers and can think for themselves are in as good a position as the compiler of "Old Moore's Almanack" to say what subjects are looming in the immediate future for solution. One of these is undoubtedly that of "telephonic communication." The action of the Post Office in regard to postal service and telegraphy has had a persistent critic in the person of Mr. Henniker Heaton, M.P., and we feel assured that if any member of Parliament had interested himself in telephony as Mr. Heaton has in the other branches we should long ago have commenced "reformation." The evil, however, is so crying that the Associated Chambers of Commerce have taken up the question, and at the recent meeting unanimously carried a resolution asking the executive council "to call the attention of the Postmaster-General to the irregularities and delays on the trunk-line telephone service throughout the country with a view to remedial measures." In the discussion which took place upon the resolution it was agreed that the Post Office ought to have full and undivided control of the telephone service, and that dual control was necessarily inefficient. It is pretty certain that the agitation in favour of Post Office control will continue to increase, and in the end will prevail. From the very first the Post Office authorities took a wrong view of the matter, and having once taken that wrong view, have not had the courage to acknowledge it. Their style of reasoning is very clear. In the earliest days of the discoveries of Bell and Hughes they doubted the practical value of the discoveries, refused or neglected to test that value, allowed independent capitalists to test and prove it; and then the authorities did worse, they took fright, brought a legal action, got a verdict that telephony was but a phase of telegraphy, and hampered progress. And that is just what they have been doing ever since—marking time, and hampering progress. The inevitable must come, and the bill of costs will be proportionately heavy with the delay in presentation. It is only natural that the authorities, fearing the effect of the competition of telephony upon telegraphy, should have pursued their hampering policy. Their true course was, after the doubts as to its practical value were shown to be unfounded, to have taken over the whole telephone service and developed it as rapidly as possible. The sooner that can be done now, the less the cost to the nation. Meanwhile, there is no reason why the trunk-line service should not be made effective.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

MOTORCAR EXPLOSION.

SIR,—Referring to the accounts which have been published concerning an accident to a motorcar in Ludgate-circus last week, whereby the oil-engine exploded, will you kindly make it known that it was not one of our carriages, as some of the reports might lead people to suppose. Our carriages are electrical, and an explosion such as occurred with the oil-engine is quite impossible with an electric motor.—Yours, etc.,

WALTER C. BERSEY, Manager.

London Electrical Cab Company, Lambeth, S.E.,
September 9, 1897.

ELECTRICAL CABS.

SIR,—It may interest your readers to have a few particulars of the working of the electrical cabs since the inauguration on August 19 last. I may say that so far everything has been most successful, and the fact that the Scotland-yard authorities, after having refused licenses to several other kinds of motor carriages, have, after a severe test, duly licensed the cabs, is in itself a proof of their efficiency. A part of the Scotland-yard test is to run each cab up and down the Savoy hill in the Strand, this hill being the steepest gradient in London.

At different times, and on several occasions, journeys have been made to and from Hampton Court, Kempton Park, Lewisham, Sandown Park, Norwood, Croydon, Crystal Palace, Crouch End, etc., and the steep hills to be met with on some of the roads running to these various places, such as Highgate-hill, Sydenham-hill, and Richmond-hill, have given no trouble whatever. Further, 12 of the cabs have been plying for hire in and around the City and the West-end of London, and the takings of cabmen—amounting as they do to about 150 per cent. more than the takings of an ordinary hansom—show very well the public favour with which the cabs have been received.

With regard to the "opposition" of the London Cab Trade Council, which numbers some 50 or 60 members, we have to place side by side the fact that the great Cab-drivers' Union of London, numbering some 10,000 members, are distinctly in favour of the new cab. Thanking you in advance for the courtesy which admits this letter to your valuable columns—Yours, etc., WALTER C. BERSEY.

Lambeth, S.E., September 11.

TUDOR ACCUMULATORS.

SIR,—I trust you will allow me to correct one or two points in the interesting article on the "Improved Tudor Accumulator," which appeared in last week's number of your journal.

In the first place, with reference to covering the positive plates with a thin coating of peroxide, the patent to which you refer—viz., that of Messrs. Fitz-Gerald and Hough—is two years later than that of Mr. Tudor (No. 11,543 of 1887), to whom priority in this invention is accordingly due. A large number of these batteries were working before 1889, and one at Dolhain, Belgium, manufactured with plates made by this method, which was put in in 1888, is still working at the present time.

The form of plate shown in the sketch is not quite that of the latest type, of which the ridges are much less pointed, the sides being very nearly parallel. These ridges are vertical, and are intersected at intervals of 15mm. by horizontal ribs, which strengthen the plates, and at the same time distribute the current evenly.

The last point to which I would draw your attention is that the capacity for discharge in half an hour is 35 per cent. of that in 10 hours instead of 30 per cent., as stated in the article.

I trust you will kindly make these corrections, which do not at all detract from the value of the article itself.—Yours, etc., A. B. PESCATORE

Manchester, September 14, 1897.

NEW YORK CONDUIT TRAMWAYS.

The horse trams have been used in New York for many years because the city authorities, like the London County Council, object to the overhead construction. After

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extended trials with different cars the company have decided to put down a conduit system over four of their principal lines. The *Electrical World* gives many details of the construction of these conduits, from which description we take the following particulars. The aggregate length of single track now being laid down is 45 miles, and three lines will be equipped this year as soon as some legal obstructions have been removed. The construction of the tracks is most massive, as the following weights per yard

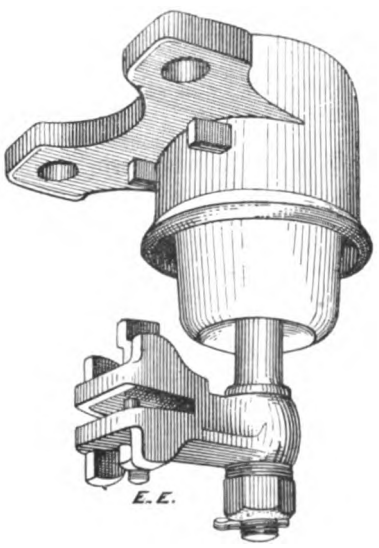

FIG. 1.

will show: tram rails 107lb., slot rails 58lb., conductor 21lb., and conduit plates 16lb. These give a total weight of steel per yard of 400lb. The cast-iron yokes are spaced 5ft. between centres. Every third yoke is a hand-hole yoke and weighs 600lb. The intermediate standard yokes weigh 410lb. each, making a total weight per yard of 500lb. of metal.

The rails are fastened together by heavy 12-hole fish-plates. The bolts are 1⅛in. in diameter, there being two rows of them, one over the other, six bolts in a row. The conduit is not as deep as the cable conduits, and does not, therefore, necessitate the removal of underground piping.

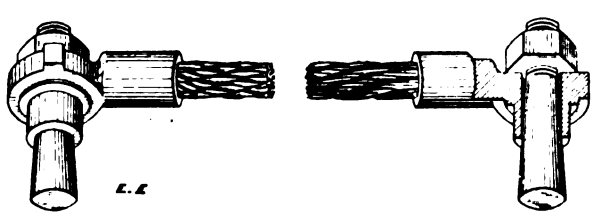

FIG 2.

The total depth of excavation is only about 30in. The conduit shell is made of concrete, 4in. in thickness, carefully made with Portland cement. On each of the yokes is cast a set of lugs, which serve to hold in place wooden boards forming a temporary retaining wall for the outside of the tube of concrete forming the conduit. The oval interior surface is formed by sheets of steel plate bent to fit the yokes and sustained in place by sectional wooden shapes, which are removed after the work is completed.

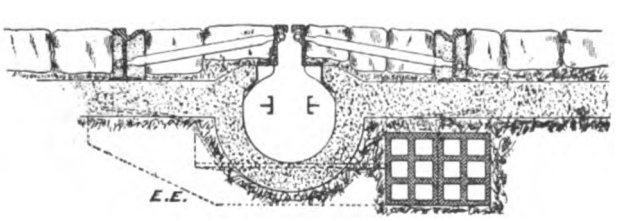

FIG. 3.

Current is supplied to the system by two T-shaped conductor rails, one serving as supply and the other as return conductor. The system, therefore, has not necessarily an earth return. These conductor rails are supported by porcelain insulators (Fig. 1) at every 15ft., where hand-holes occur. These insulators are cemented in a cast-iron shell, which is bolted to the lower flange of the slot rails. A pin cemented into the insulator carries the conducting rail.

The problem of bonding is much simplified by the use of a return rail in the conduit. The conducting rails are not jarred by the pounding of wheels, and are not buried in material soaked with corrosive liquids. The bond to be used (Fig. 2) is provided with a cast copper stud, which is turned down to fit in a hole in the web of the rail. The

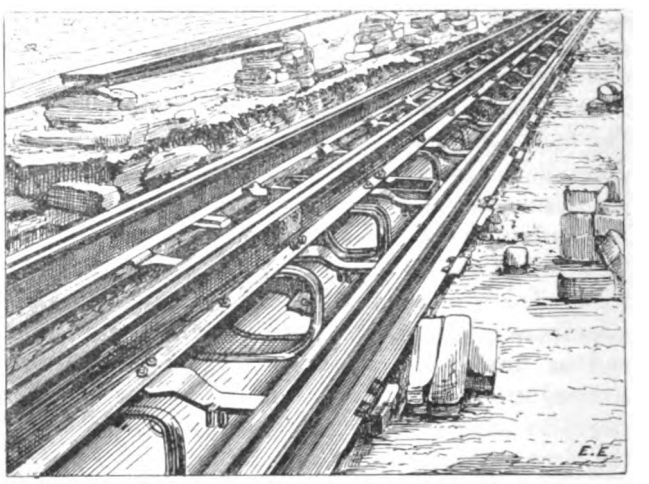

FIG. 4.

stud is then expanded by a taper pin passed through it and pulled up by a nut.

Current will be supplied for the lower part of the island from the Twenty-Fifth-street power station. This station at present drives the Lexington-avenue cable line, but it will be increased by the addition of four 800-kw. General Electric generators, direct connected to horizontal Corliss engines made by the Pennsylvania Ironworks. Three similar units will be added to the present equipment at One Hundred and Forty-sixth-street, for driving the upper part of the system. Ground has been bought for a large station at Ninety-Sixth-street and East River, which will eventually supply current to the whole system on the multiphase distribution system.

Fig. 3 shows a cross-section of this track, showing the position of the conductor rails, while Fig. 4 is a view of the ironwork of the conduit ready for the concrete to be put in. We understand that where this line crosses cable tracks the arrangements for the crossing are yet to be decided on. In one place the cars will run over 1,500ft. of cable line, and in this case the conduits will be placed side by side in the middle of the track.

ON SOME NEW FORMS OF GAS BATTERIES AND A NEW CARBON-CONSUMING BATTERY.*

BY WILLARD E. CASE.

In 1839 Grove announced his discovery of the gas battery, considering it the most simple arrangement to produce electricity. He never considered it a practical way to generate electrical energy. Grove used platinum sponge or platinum black as the absorbent to facilitate the combination of the gases. The following experimental determinations by the author will show, as far as they extend, that platinum or its compounds are not necessary to produce the combination of the gases in the production of electrical energy, so doing away with one of the most expensive drawbacks to the gas battery. The experiments also prove that carbon is oxidised to CO_2 at normal temperature without the application of heat, with the production of electrical energy.

In these experiments it will be noted that platinum is not essential to the reactions. Both electrodes in each case can be carbon tubes or plates. The physical condition of the carbon in its many forms plays a most important part.

* Paper read at the British Association Meeting at Toronto.

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The Chlorine-Carbon Cell.—A porous carbon-tube electrode, into which chlorine gas was passed, opposed to a carbon rod, which had been heated red hot, was placed in hydrochloric acid of specific gravity 1·10. An E.M.F. of from 0·50 to 0·54 volt was obtained, depending on the condition of the carbons.

The carbon electrodes, after being heated, were again assembled and placed in distilled water. With no gas passing through, they gave an E.M.F. of 0. When the chlorine gas was passed into the carbon tube, at slightly above atmospheric pressure, the E.M.F. gradually increased to 0·44 volt at the end of 26 hours. On short-circuit 0·04 ampere was obtained, but it dropped rapidly to 0·02. The internal resistance was very high. The electrodes were taken out and the solution analysed It was found to contain hydrochloric acid and carbon dioxide. The same experiment was repeated in a dark case, to see if the action took place in the absence of light. The chlorine gas was made in the dark and passed through the electrode. The E.M.F. gradually increased, as in the first case, showing that the action took place in the dark.

A carbon electrode, through which chlorine was passed, and a negative platinum electrode opposed to it, in dilute hydrochloric acid, gave 0·4 volt, but the E.M.F. did not hold up through the voltmeter circuit. Both electrodes were covered with gas after short-circuiting, and the E.M.F. dropped to 0·24 volt. On shaking, the voltage jumped to 0·4.

A negative carbon electrode was substituted for the negative platinum. It had been heated red hot and was very porous, the surface soft and rough. The E.M.F. reached 0·58 volt, and gave on short-circuit 1 24 amperes, but dropped slowly to 0·3. The negative carbon electrode was oxidised.

A platinum electrode in a paper envelope, opposed to powdered carbon in the bottom of a glass jar in hydrochloric acid, chlorine being passed into the solution near the platinum. An E.M.F. of 0·60 volt, and on short-circuit 0·9 ampere, were obtained. The current remained fairly steady. The surface of each electrode was about 45 square inches.

A cell made up as above, but with graphite instead of carbon, gave 0·5 volt, but dropped rapidly on short-circuit, the graphite not oxidising fast enough to give a steady current. A dense carbon rod opposed to powdered carbon gave 0·4 volt, and on short-circuit 0·2 ampere. The rod was encased in filter paper to protect it from floating particles of powdered carbon, and the chlorine passed into the solution near it.

Two small glass beakers connected by an inverted U-tube, and containing hydrochloric acid, with a carbon rod in one and platinum plate in the other. When chlorine was passed into the vessel with the platinum, an E.M.F. of 0·48 volt was obtained. When chlorine was passed into the beaker containing the carbon rod an E.M.F. of 0·14 was obtained, but it dropped almost immediately to zero. When chlorine was passed into both beakers, no E.M.F. was obtained.

The chemical reaction of the chlorine-carbon cell was as follows: $H_2O + Cl_2 = 2HCl + O$, the oxygen of the decomposed water attacking the carbon, and hydrochloric acid and carbon dioxide being formed.

Carbon Monoxide-Chlorine Cell.—Cell made as follows: A glass tube, 2·25in. bore and 6in. long, corked at each end, with a porous tube, 1in. outside diameter, passing through the glass tube and corks, and corked at each end, carbon rods and gas inlet and outlet tubes let into each chamber, which were filled with dry animal charcoal previously treated with hydrochloric acid. The porous tube was saturated with concentrated hydrochloric acid. Chlorine gas was passed through the outer tube. An E.M.F. of 0·18 volt was obtained. Then carbon monoxide gas was passed through the inner tube, and the voltage increased to 0·33 volt. A slight increase of the pressure of the gases increased the voltage. The glass tube became hot. This reaction would produce carbon oxychloride.

Marsh Gas-Chlorine Cell.—Two carbon-tube electrodes, ¾in. in diameter and 4in. long, opposed to one another in a solution of hydrochloric acid, with chlorine passed into one and marsh gas into the other, gave an E.M F. of between 0·6 and 0·7 volt, varying with the condition of the carbon. A current of 0·7 ampere was obtained on short-circuit, but the cell rapidly polarised. Afterwards, fresh carbon electrodes, with the gases passing through them, were placed in distilled water, and the E.M.F. gradually increased from zero to 0·14 in 12 hours. On testing the solution, hydrochloric acid and carbon dioxide were found to be present. The chemical reaction of this cell is as follows:

$$CH_4 + 4Cl_2 + 2H_2O = CO_2 + 8HCl.$$

The calculated E.M.F. of this cell is 0·65 volt.

In making these determinations of E.M.F. and current, a Weston direct-reading voltmeter and milammeter were used. Resistance of voltmeter, 352 ohms, reading from 0·01 to 3 volts. The ammeter read from 0·01 to 2·00 amperes. In all the experiments, the gases used were but slightly above atmospheric pressure. Owing to limited time the author is not able to furnish further data. Experiments to determine the many interesting questions involved are being conducted.

Mr. C. E. Timmerman, of Cornell University, who has assisted me, has taken great care, with the limited time at our disposal, to verify these results.

ON CHARGING OPEN-HEARTH FURNACES BY MACHINERY.*

BY JEREMIAH HEAD, M.I.C.E.

The gradual development during the last 25 years of the open-hearth process for the manufacture of steel, and the severe competition which has since arisen between different districts and countries, has compelled more and more attention to be paid to all expedients which promise to save labour, time, and other elements of cost.

Materials Charged.—Confining our attention for the moment to the acid process, which is that by which open-hearth steel is at present usually made in this country, we find that for every ton of steel produced in the shape of ingots, the following quantities of materials are introduced into the furnace:

	Cwts.	Percentage of charge.
Hematite pig iron	16	66·7
Wrought scrap	4	16·7
Ore (containing 50 per cent. Fe)	4	16·6
Total	24	100 0

The 20cwt. of pig iron and scrap lose by oxidation about 10 per cent., or 2cwt. But the 4cwt. of ore, containing as it does 2cwt. of metallic iron, just replaces this loss, as it becomes reduced by the action of the metalloids associated with the pig.

Acid and Basic.—The ratio of iron-containing materials charged to the steel produced does not seem to differ materially, even though the relative proportions of pig, scrap, and ore may vary considerably. The following table gives the average practice over the year 1896 at a works in America where there are several 15-ton furnaces, with both acid and basic linings. Basic additions and ferro-manganese are in no case included:

	Acid furnaces		Basic furnaces	
	Weight charged per ton of ingots.	Per cent. of charge.	Weight charged per ton of ingots.	Per cent. of charge.
	Cwts.		Cwts.	
Pig iron	6	27	11¾	51
Scrap	15¼	67	10½	45
Ore	1¼	6	1	4
Total	22¾	100	23¼	100

For the purposes of this paper I will assume that 24cwt. of material must be introduced into the furnace, whether acid or basic, for every ton of ingots produced.

Capacity of Furnaces.—The capacity of modern open-hearth furnaces varies considerably. The tendency hitherto has been towards continual increase. Typical steelworks in the North of England have 30-ton, 40-ton, and 50-ton furnaces. Forty-ton furnaces may be taken as a fair average for a modern plant. Such furnaces, when in full working order, make nine heats per week of 141 hours—that is, from, say, 6 p.m. on Sunday night to, say, 3 p.m. on

* Paper read before the Iron and Steel Institute.

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the Saturday following. This gives $\frac{141}{9} = 15\frac{2}{3}$ hours for each heat, including fettling and charging. The full weekly produce of such a furnace would be $40 \times 9 = 360$ tons of ingots. But furnaces cannot be relied on to work fully or continuously. There are various contingencies but too well known to managers which prevent this. The actual production of an open-hearth plant varies from seven-eighths to three-quarters of its nominal capacity, and, indeed, is sometimes even less than that. Or, put in another way, from one-eighth to one-fourth of the furnaces comprised in any steel-melting plant are on the average always standing for repairs. A 40-ton furnace in fair working order requires every $15\frac{2}{3}$ hours 40 tons × 1·2 tons or (24cwt.) = 48 tons of materials to be charged into it, and this occupies under present circumstances (in addition to an hour for fettling) about $3\frac{1}{2}$ hours, which is equivalent to $\frac{48}{3{\cdot}5} = 13{\cdot}7$ tons per hour.* To perform this, among other duties, three men are employed (on each shift), called the first, second, and third hands, and these three men employ a fourth to aid them in dealing with a furnace of the size mentioned. The total number of men employed on both shifts is thus eight per furnace.

Picked Men Required.—It is clear, therefore, that each of these four men handles on the average $\frac{13{\cdot}7}{4} = 3{\cdot}4$ tons per hour for $3\frac{1}{2}$ hours, or about 12 tons in all, each charging shift he is at work, which is alternately four or five times per week. To some furnaces light swing cranes are attached, but these are only or mainly used for heavy castings, cobbles, and so forth. The pig, scrap, and ore has to be charged by hand, and that in face of a furnace radiating a considerable amount of heat. It is evident that to fulfil these requirements great physical and constitutional strength is necessary in all the men, besides technical skill, which, however, is exercised mainly by the first hand. They must therefore be picked men, and must be paid accordingly.

Cost for Labour.—In this country the labour needed for open-hearth steel-melting is paid by a tonnage rate on the ingots produced. The present rate is 1s. 10½d. per ton net. In a 40-ton furnace this amounts to—

£0	1	10½ × 40 tons =	£3	15	0	per full heat.
3	15	0 × 9 heats =	33	15	0	per full week.
33	15	0 =	4	4	4½	the average earned per man per full week.
8 men.						

The average earnings per man taken over the whole year are, however, less than this by one-eighth to one-quarter, as before explained. These labour costs, which apply to the charging platform only, do not seem unreasonable under the conditions I have described.

Saving of Time and Labour.—It is to reduce the time required to charge a furnace, and to prevent the necessity of so much and such costly hand-labour, that charging machinery has been devised and brought to great perfection during the last few years in the United States. To this machinery I now propose to invite your attention.

Original Charging Machine.—The first charging machine for open-hearth furnaces ever made was designed and erected just 10 years ago at the works of the Otis Steel Company of Cleveland, Ohio, by Mr. S. T. Wellman, then superintendent of the works, and is still in operation there. It consists of a main carriage on four wheels, travelling longitudinally on overhead girders along and above the charging platform. On the carriage, and moving transversely to it, is a truck called the charger truck, having four wheels above and four below the cross girders of the main carriage. To the truck is attached an inverted hydraulic cylinder with piston and rod, to the cross-head of which a horizontal platform is fixed. The cross-head is guided by wheels travelling on strong guides depending from the carriage. As the piston is raised or lowered, so is the platform. The machineman or operator sits at the back end of the platform facing the furnace with his handles conveniently placed in front of him. The cross-head has in it a large horizontal hole at right angles to the furnace front, and through this passes a strong horizontal bar called the charging bar, which can be rotated or twisted by another inverted hydraulic cylinder on the platform acting on a rack and spur-wheel. The longitudinal motion of the main carriage is effected by a fixed steam-winch at the end of the charging platform. The charger truck, carrying with it the operator's platform and charging bar, is moved towards or from the furnace door by two horizontal cylinders fixed to the main carriage. The materials are brought up to the charging

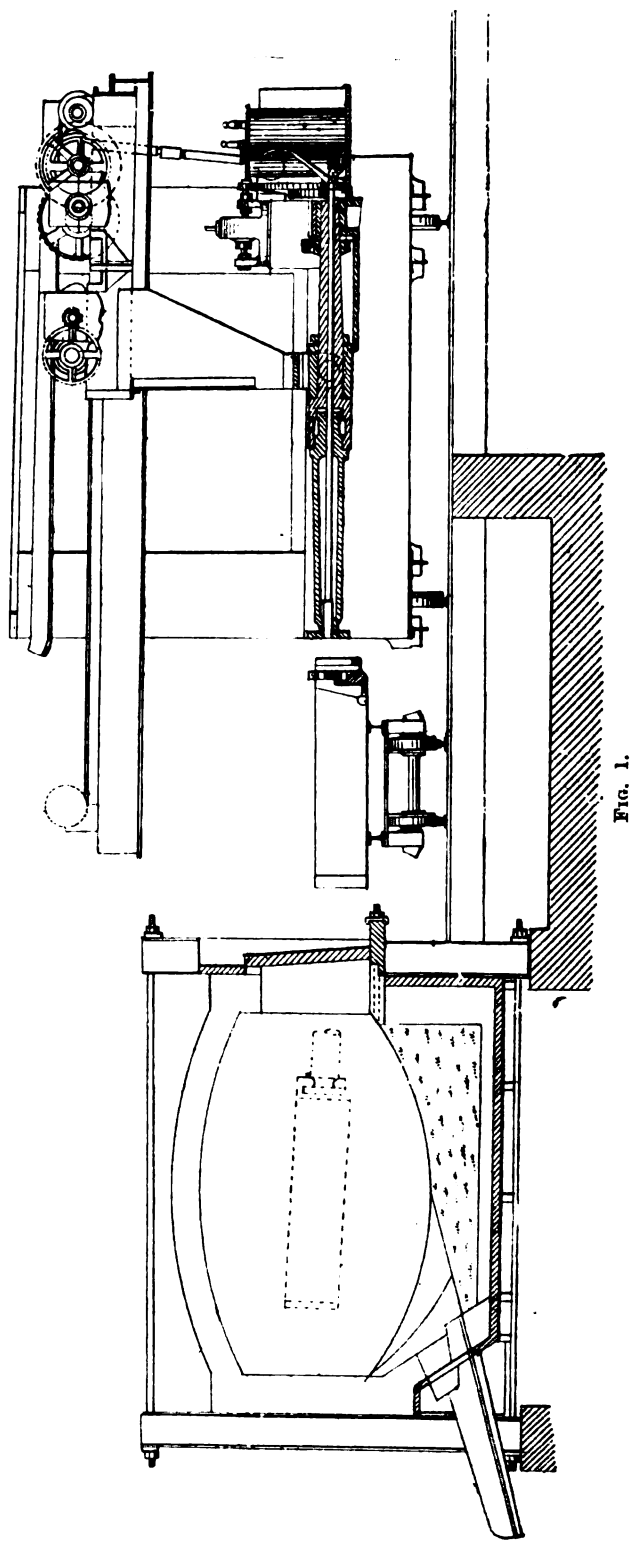

FIG. 1.

platform on bogies, called charging bogies, running on a subsidiary 2ft. gauge railway, which connects it with the stock heaps and with the full-gauge input sidings, and constitutes a complete system, with miniature locomotives, turntables, hydraulic lifts, and so forth. Placed upon and across each charging bogie are three or more charging boxes (or scoops), into which is loaded, at the stock heaps or input sidings, the pig iron (each pig being broken in two pieces), the scrap, and the ore. Each box contains approximately a ton of material. The ends of the boxes, which, on arriving at the charging

* A 40-ton furnace can be charged by hand in $3\frac{1}{2}$ hours only by having two doors on the tapping side as well as three on the platform side. This is now customary in the North of England.

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platform, are next to the machine, are steel casings formed into sockets. The end of the charging bar, which is made to fit, is brought over and dropped successively into these, and (in the original machine) temporarily secured by a wedge-shaped key driven in by a boy. The operator is then able, by means of the lifting, cross-traversing, and twisting cylinders, to introduce the box and its charge into the furnace, empty and withdraw it, and return it to the bogie; and the boy having knocked out the key, he repeats the process with the next one.

used near hot furnaces, is difficult and costly to maintain. It is further evident to the eye of a mechanic that the original charging machine is deficient in strength and rigidity, and is suitable only for very light loads.

The Thurlow Machine.—For the reasons given, machinery for charging open-hearth furnaces attained but limited success, until at length electricity became available as a motive power. In May, 1894, Mr. Wellman constructed at Thurlow, Pennsylvania, a charging machine in which all the movements were electrical, except locking the

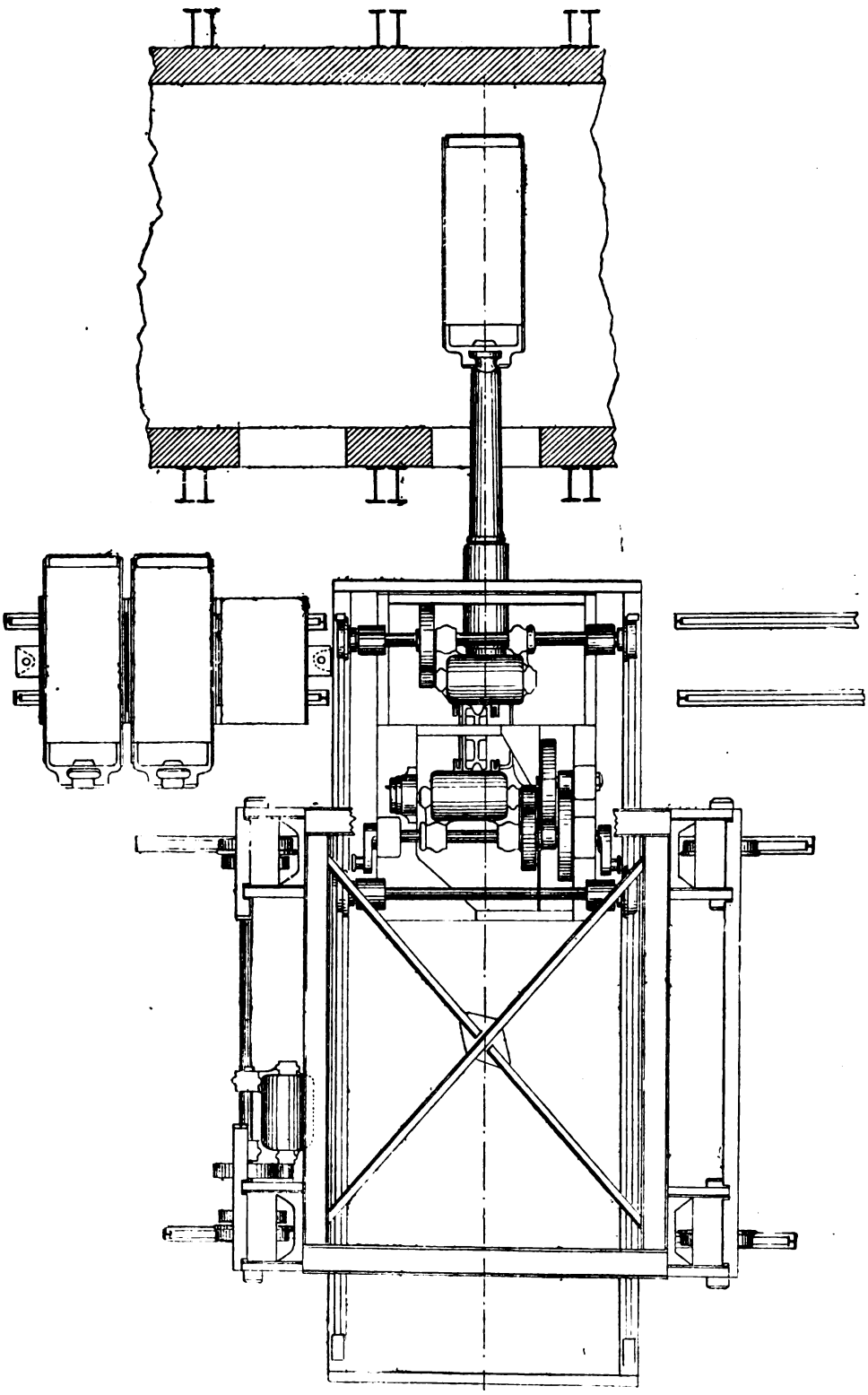

FIG. 2.

Defects of Original Machine.—Although this machine has worked fairly well from the first, and has effected a considerable saving compared with charging by hand, it is evidently far from perfect. The hydraulic movements are too slow, and there is loss of power when they take place with less than maximum resistance. The boy needed to fix the boxes, and the isolated steam-winch, with its attendant, ought clearly to be dispensed with. The constant supply of high-pressure water to a machine travelling longitudinally over a considerable distance is attended with difficulty, and indiarubber pressure pipe, if

charging bar to the boxes. This apparatus travelled longitudinally on rails at the floor-level. The floor of the main carriage was divided into three oblong sections, the two outer ones being fixed, and the centre one sliding towards and from the furnace. This section carried the charging bar, the motor and gear for sliding it, the motor and gear for twisting it, and the hand-gear for locking it to the charging boxes. The motors and gear for giving longitudinal movement to the main carriage and for raising or lowering the front end of the sliding section were placed on the left side fixed section, whilst the operator with the

rheostats and current controllers sat on the right side fixed section.

Defects of the Thurlow Machine.—The apparatus was perfectly successful so far as its performance was concerned, but it had certain obvious defects. For instance, the main frame covered a floor width of 19ft. instead of 14ft., which alone is necessary in the latest design. The weight of the operator and his platform with the controlling gear were not utilised to counterbalance the charging box and its load. The operator was not immediately behind and opposite to the charging door, and therefore could not always see what he was doing. And lastly, the main carriage and its fittings were not massive enough to form a sufficient base for carrying heavy loads in the boxes when the charging bar was at its farthest forward position.

The Newest Type of Electric Machine.—These defects have now all been remedied. Figs. 1 and 2 represent a machine of the newest type, which has just been made by Mr. Wellman for the Otis Steel Company, so that that company now possesses the most recent as well as the oldest and two intermediate examples of charging machines. Fig. 1 shows a cross-section of a furnace, the charging bogie with a charging box upon it, and the charging machine itself. Fig. 2 shows the same in plan. It will be seen that the apparatus has much in common with those which preceded it. It is, however, more substantial, whilst at the same time it is simpler and more compact. The main carriage is 5ft. narrower from back to front than in the case of the Thurlow machine, which is a great advantage in that less floor room needs to be kept clear. Stability is maintained by extending it 3ft. longitudinally, an addition which interferes with nothing. At the four corners of the main carriage box columns are erected, which are surmounted by a framework consisting in the main of a pair of channel section beams fixed transversely to the columns and projecting forward beyond the main carriage, almost as far as the furnace front. The channel beams carry rails, on which runs on four wheels the charger truck. Above the wheels on either side are steel angles which serve the purpose of guard-rails in case the truck should tip up behind. Downward from the charger truck projects a strong bracket, ending in double-eye bearings, which carry a trunnion sleeve. Into this sleeve is threaded and secured with a back collar the charging bar. On the after end of the latter is carried the operator's platform, the tail end of which is connected by two rods with the pins of two cranks, keyed symmetrically to a shaft running across the charger truck frame at its rear end. A motor carried on the truck is connected by gear with this shaft. By switching on the current the operator can rotate the crankshaft in either direction, and so move the charging bar up or down like a heavy gun in its trunnion bearings. As the motion is of the "all-round" type, no harm can come from over-running. On the charger truck is also mounted a motor and gear for moving it and the charging bar, and all connected therewith towards or from the furnace by operating on the front axle and wheels.

(To be continued.)

ELECTRIC LIGHTING AT ROCHDALE.

The following is Mr. E. M. Lacey's report on the electric lighting of Rochdale, which has recently been under the consideration of the Corporation, and which was adopted. The report is dated August 14, 1897, and is addressed to Mr. T. B. Ball, the manager of the Corporation gasworks:

Sir,—On June 10 last you kindly wrote me that the Corporation of Rochdale had approved the recommendation of the Gas and Electric Light Committee that I should be appointed consulting electrical engineer to report on and design the proposed electricity supply works for Rochdale, subject to satisfactory terms being arranged, and on the 24th of that month you further wrote me to the following effect: "Adverting to your letter of the 11th inst., I am pleased to be able to say that the committee have agreed to the terms of remuneration as set out in your letter, and they desire me to say that they wish you to proceed with the necessary preliminaries at once."

Having satisfied myself that, for the proper consideration of the conditions associated with the investigation, an inspection of the town would be necessary, I arranged to visit Rochdale on July 19 last, when you kindly furnished me with certain local information and details as to the proposed sites and lighting area, and conducted me through those localities most suitable for the introduction of an electric supply. You also introduced me to Mr. Brookman, the sanitary engineer, who accompanied me over the destructor works, and supplied me with very full and detailed information with regard to the practicability of utilising the spare refuse for steam-raising purposes in connection with the proposed electricity works.

I have since thoroughly considered the whole subject, and now beg to submit the following report thereon. For the more ready elucidation of my following observations I have thought it necessary to show on an accompanying plan the streets in which an immediate demand for electricity may be expected. I have not shown the extent of the area over which the distributing mains can be laid, but it may be taken that the whole of the area within the borough boundaries can be dealt with from the proposed electricity works, should the Council adopt my following recommendations. In order to place the matter before you in the clearest possible manner I have considered it advisable to divide my report under three headings: (1) the area to be lighted, and the most suitable system; (2) the capital outlay necessary; (3) the desirability of combining the electricity works with your sanitary manure works.

The Area and Most Suitable System.—I have been carefully over those portions of the town where a demand for a supply of current for lighting purposes is probable, and I find that in the event of electricity works being established there would be an immediate demand for current in the following localities: Dane-street, the Esplanade, Town Hall-square, Yorkshire-street from Town Hall-square to corner of John-street, Cheetham-street, St. Mary's-gate to Blackwater-street, Lord-street, South-parade, Oldham-road to Livsey-street, Drake-street, Manchester-road from Dane-street to Merefield-street, and Tweedale-street. I estimate that, with current sold at the rate of 6d. per Board of Trade unit, the demand in these streets and their immediate vicinity should, during the first three years' working, amount to the equivalent of 10,000 lamps connected, and that the number of lamps connected at the end of three years will amount to at least 15,000. This number is based upon the maximum charge above referred to, but any reduced charge would undoubtedly be followed by a considerably increased demand. Such a reduction, or what would have the same effect—viz., some system of rebate to profitable consumers—could in all probability be made with advantage within three years, owing to the decreased works cost per unit as the output increases. I would suggest the installation of about 16 or 20 arc lamps in the Esplanade, Town Hall-square, and some of the principal streets. These spaces are most suitable for lighting by means of arc lamps, and a trial would enable you in the future to form your own judgment as to whether it would be expedient to extend a system of arc lighting to the other principal streets and open spaces of the town. I do not anticipate that there will be any considerable demand for power purposes during the first year, and in my estimates given below I have not taken into account any current supplied for power during the first two years. The demand for power is naturally slow, as the cost of replacing existing steam or gas plants is considerable, and confidence must be established in the economy and efficiency of electrical driving before any large demand is likely to arise. However, should a large demand for power arise, no additional extension to the capacity of the generating plant would be entailed, as such a demand would be almost entirely during periods of minimum lighting load. Any extra current supplied for power purposes would therefore increase the revenue obtained from the works without incurring any extra capital expenditure, and the capital and other charges remaining fixed, the total cost of the annual production per unit would be decreased.

Electric Traction.—The economy and other advantages of electric traction are now so fully recognised by both municipal authorities and tramway companies that I need not enter into details of the subject in this report. A number of tramway companies have recently adopted electric traction, the current being generated at their own power-houses; but, on the other hand, several municipal authorities have also recently entered into arrangements to supply the tramway companies serving their districts with electricity for traction purposes, and a profitable arrangement for such supply to the Rochdale Tramway Company may at any time be made. There is also a very general tendency to municipalise tramways, and it is possible that your Corporation may, on the termination of the company's lease, decide to take this course. It is of great advantage for electric lighting works to also supply current for traction purposes, since a considerable portion of the generating plant can be utilised at periods of light load, when it would be otherwise standing idle, thereby reducing the costs of production per unit, and increasing the general efficiency of the works. For the same reason it is obvious that current for traction purposes can be produced by the Corporation at a lower cost than by a tramway company with a separate power station. Further, if your tramways are municipalised, the Corporation would not wish to be

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compelled to purchase a separate power-house, which, for the reasons given above, would be practically useless to them. It is, therefore, clearly against the interests of a municipal authority owning electricity supply works to allow a tramway company to erect an independent power-house, and to prevent such an eventuality it is advisable to design the plant so that it will be available for both lighting and traction purposes, because, provided the municipal authority is willing and prepared to supply current for traction purposes, any tramway company working within the range of its provisional order would have great difficulty in obtaining powers to erect a separate generating station and carry independent mains for current supply.

Systems of Supply.—In arriving at a decision as to the most suitable system to be adopted, it must be borne in mind that any particular system, if adopted in an unsuitable locality, may constitute a very considerable annual loss of revenue, and may in addition involve a large and unnecessary expenditure of capital. The following systems of supply are all working in certain towns in this country with great success, but, on the other hand, nearly all these systems are also working in other towns in a more or less uneconomical manner: (1) high-tension alternating supply with house transformers; (2) low-tension direct, two or three wire network (original systems); (3) high-tension direct, with sub-stations and low-tension network; (4) high-tension alternating with circuit transformers and low-tension network; (5) low-tension direct, five-wire network; (6) low-tension direct, three-wire network, combined with high-tension alternating for outlying districts; (7) low-tension direct with two or three wire network, at 400 or 440 volts.

Any one of the above systems may be the most suitable for a particular area of supply, and in selecting and designing a system, the conditions of the localities, the nature of the demand, and the area of supply, have principally to be considered. It is self-evident that the points which constitute the most satisfactory system for any particular area are as follows: (1) Low capital expenditure compared with capacity of supply. (2) Immunity from breakdown or failure and low annual expenditure on repairs. (3) Economy in the production of current and in its transmission to the consumers' premises. (4) The arrangement of the system of distribution in such a manner that extensions, both within the area and to outlying districts, may be carried out on the most economical lines.

In the case of your town it is necessary to take the following further points into consideration: (5) To provide efficient plant to meet the immediate demand, and at the same time to so design the station that additional plant may be added as required, without interference with the original installation or the system of supply. Such plant to be so designed that it may at a later date be equally workable and efficient with the greatly increased output from the station, which will undoubtedly arise in the course of six or seven years. It is a matter of no credit to the designers of one or two of the stations in this country that the plant originally put down to meet the small demand, has been thrown on one side as inefficient or unsuitable for working in conjunction with the newer plant arranged to meet extensions. (6) To design such a system that the public lighting of the streets may be carried on, so far as possible, in conjunction with the general supply system to private consumers, and in as economical a manner as possible, since the public lighting will doubtless be greatly increased in the course of time and may become of considerable extent. (7) To so design the plant as to allow of the supply of current at a subsequent date to either the existing or any new tramway systems, if possible without alteration of the generating machinery, provided that such arrangement can be made without increasing the initial cost or impairing the efficiency and economy of the plant for lighting purposes. By following these lines a very great advantage may be subsequently gained, since, should power be supplied to the tramways in the future, an exceedingly small expenditure of capital would be entailed, and the cost of the production of additional current for power purposes would thereby be reduced to a minimum.

You will understand from the above particulars that the selection of a system and the arrangement and design of the plant is of the utmost importance, and that the choice is not between only two systems, as is generally understood, but between many. I have been thoroughly into the requirements of the town, and taking all the above points into consideration advise that the system which will give the best results, both from an engineering and commercial point of view, is a system of direct-current three-wire supply, with a difference of potential of 440 volts between the outer cables throughout the whole area, and a 220-volt service to customers.

The above system can be successfully applied to your town, and will conform with the requirements enumerated above, as follows: (1, 2, and 3) The generating station, if properly designed, will allow of a low capital expenditure, and the plant can be such as to secure immunity from failure. The pressure of supply is sufficiently low to minimise trouble in both generating machinery and distribution. Further, the use of accumulators for storage purposes provides a most valuable safeguard, which is practically unattainable with alternating-current plant. The system of distribution will be such as to give the least possible transmission loss of any system in your particular case, and both the first cost and cost of future extensions will be exceptionally low, if sufficient care be given to the initial arrangement. The annual works costs for current production will be kept at a minimum, as the ease of regulation and the absence of transformers, or of any complicated apparatus for maintaining the required pressure, will enable the system to be worked with the least possible amount of skilled labour, and at the same time avoid the many attendant losses between the generation and the consumption of current. (4) If situated on the site in Dane-street, or at some equally suitable point, the whole of the generating machinery can be centralised, and without the aid of any auxiliary apparatus your distribution system could be extended over the whole of the area within the borough boundaries. Should extensions be required beyond this area, as they undoubtedly may be at some future date, these can be executed without incurring any very serious transmission loss. (5) The plant can be so designed and arranged, if sufficient care be taken, as to comply in every way with the requirements under this heading. (6) I propose to so arrange the street-lighting that in the event of its extension over a large area it shall still be most efficiently worked by the same generating plant as is used for the supply to private consumers without increasing the cost to any considerable extent, thereby limiting the capital expenditure to the one type of generating machinery only, and obtaining the consequent advantages of the interchangeability of plant for all purposes. (7) The generating plant would be, with some slight additions, equally suitable for the generation of current for electric traction purposes. I am at the present time preparing designs for such an arrangement of generating machinery for two other towns in this country, and am also engaged in modifying another plant to comply with this requirement. Such arrangement necessitates only a very slight increase in the cost of the machinery, and obviates the necessity of any intermediate and complicated gear, the latter of which not only involves a considerably increased capital outlay, but also introduces into the system those chances of failure which are a danger attendant on the use of all such intricate apparatus. The site in Dane-street opposite the gasworks is (taking into consideration only the requirements of the proposed electricity works) eminently suitable. This site is of sufficient size to meet all present and future requirements for some years.

Capital Outlay.—In order to provide for the adequate supply of current for the number of lamps connected during the second year, as estimated above (10,000), generating plant would be required of a capacity of 150 kw., but it would also be necessary with a first installation of plant to provide a duplicate generating set as a stand-by. For any extensions no further stand-by plant will be required, and it can, therefore, be seen that the cost of extensions will not be in the same proportion as the initial cost of the installation. To provide steam for the above generating machinery boilers of a sufficient size are required, together with a spare boiler. The remarks applied to the duplicate generating machinery also apply to the boiler extensions. With this plant a balancing apparatus for the centre main and accumulators for storage purposes are required, together with a main switchboard for the efficient regulation of the current supply. The above, together with the requisite steam, exhaust, water, and electrical connections, overhead travelling crane and engine-room accessories, are all that are necessary, but I have also included the cost of condensing plant, as the saving effected by this will at present more than pay the interest and sinking fund on the increased capital expenditure, and, with the future increased output, will effect a very considerable economy.

The estimates given below do not include the capital expended for purchase of a site, but do include the annual rental of such site. This figure, however, should be checked by yourself. The buildings would comprise engine and boiler house, chimney shaft, accumulator-room, test-room, stores, and offices, and these would be so designed as to facilitate extensions at the least possible cost. The cost of suitable buildings and chimney shaft need not exceed £5,500, and this, again, is a matter which you of course can deal with yourself. I have considered it best to include such a sum for distributing mains as shall be not only sufficient to meet the immediate demand, but shall include everything possible to deal with all future reasonable extensions. I estimate the cost of the works described above, including the buildings, chimney, steam dynamos (each having an output of 150 kw.), engine-room accessories, balancing apparatus, regulating gear, switchboard, instruments, connections, accumulators and connections, two Lancashire boilers (8ft. by 30ft., together with condensing apparatus, feed pumps, steam and exhaust pipes), feeder and distributing mains, junction boxes, and all necessary street works, meter and service connections to consumers, contingencies, legal expenses, fees, superintendence, will give a total cost of £22,000. The above estimate is not an imaginary figure, and I am perfectly confident of my ability to carry out the works without exceeding the total named,

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although this will be seen to compare exceedingly favourably if examined side by side with the expenditure on other electricity works in your part of the country. The works can be so designed that the additional cost of plant and mains for a further 6,000 lamps would not exceed £7,000, or a total of, say, £29,000 for 16,000 lamps connected. Further extensions could be carried out on a slightly advanced ratio of cost.

Cost of Working.—Taking it that during the first two or three years as many as 12,500 lamps are connected to the mains, the cost of production and receipts for one year would be approximately as follows: With 12,000 lamps connected—average price obtained, say, 5d. per unit; estimated units sold for all purposes, 185,000.

Estimated receipts from sale of current	£3,854
Estimated meter rents and other charges	150
Total receipts	£4,004
Estimated works costs—coal	£260
Water and engine-room stores	120
Carbons, lamps, etc.	90
Repairs and maintenance	120
Station wages	380
Management expenses	600
Rent, rates, taxes, insurance, etc.	230
Interest and sinking fund on £22,000 at, say, 6 per cent.	1,320
Total costs, including capital charges	£3,120

or a profit on the year's working of £884.

The above figures on revenue and works costs are not theoretical calculations, but are based directly on the revenues obtained and the actual costs at electricity works with which I have been connected.

Combination of Electric Light Works with Sanitary Manure Works.—The combination of electricity works with towns' refuse destructors has been strongly advocated and widely discussed, and although the advocates of such combination have far exceeded in their statement any possible economies which could be, or have ever yet been, obtained in practice, I am still of opinion that destructors can be so designed as to give better results in steam raising than has been obtained up to the present in any electric light works. In your town the circumstances are somewhat peculiar. Your destructors are already in existence and the heat generated is already made use of to a considerable extent in drying the excreta and in providing steam for the electric lighting plant and the auxiliary machinery in connection with the works. I have considered this matter of such importance that I have not only gone very carefully into the figures kindly supplied me by Mr. Brookman, but I have also paid a second visit to the sanitary works, to specially ascertain fully the conditions under which they work. I find that the work already being carried out by the town refuse amounts to the evaporation of about 70,000lb. of water per day, in addition to the steam supplied from the destructor boilers, which is utilised for the urine-raising pump, grinding machine, mortar mills, engines on excreta cylinders, electric lighting plant and auxiliary machinery. That a large amount of useful work can be obtained from ordinary house refuse is clearly shown by the very excellent results already obtained by Mr. Bookman, but in my opinion there is not a sufficient further margin of steam power obtainable to show any material gain if the electricity works are situated at the sanitary works. I estimate the value, for electric lighting purposes, under the conditions at Rochdale, of the steam power obtainable from the destructor boilers to be about £45 per annum during, say, the third year, and increasing during a subsequent year possibly to as much as £75. To balance the saving effected by this we must take into consideration (1) the outlay required for the steam connections and gear necessary in the adaptation of the two systems of steam raising; (2) the somewhat increased cost of the mains and feeders owing to the position of the works being not quite so central; (3) the facilities on the Dane-street site of obtaining waste coke, breeze, etc., which can be used to effect a valuable saving in the fuel costs; and, lastly (4), the better centralisation of the works for administrative purposes, since these can at any rate during the early years of supply be managed with much greater economy if combined with the gas department.

In conclusion, I would add that the prospects of making an electricity supply undertaking a financial success in Rochdale are such as to fully warrant the Corporation in taking steps to obtain a provisional order and exercising their powers under it.

LIVERPOOL ELECTRIC LIGHTING.

The following is an abstract of Mr. Bromley Holmes's report on the extensions of generating stations and plant that will be necessary to meet the demand for electrical energy in Liverpool in 1898. He states that the equivalent number of 16-c.p. lamps connected to the supply mains at various dates has been as follows: July 1, 1894, 27,580; July 1, 1895, 33,732; July 1, 1896, 41,515; July 1, 1897, 57,336. In arriving at the above figures, each arc lamp is considered to be equal to nine incandescent lamps, and the electrical energy supplied for motors is expressed in the number of incandescent lamps that it would be capable of supplying. The increase in the number of lamps during the first year the supply has been in the hands of the Corporation has been nearly 16,000 lamps, as against an increase of 8,000 lamps for the previous year. The equivalent number of lamps for the supply of which applications have been received up to August 1 exceeds 63,000. Of this number about 7,500 lamps represent the supply of electrical energy to the Corporation for public buildings and street-lighting. In addition to the demand for electrical energy for lighting, the favourable rates offered for power purposes are developing a demand for hoists and for motors for use in printing and other trades, and experience in other places indicates that a very material increase may be anticipated in this branch of the business.

In dealing with the extensions necessary to meet the demand for the coming year, it is desirable to consider what the demands for electrical energy may ultimately amount to, so that any arrangements now adopted may form part of the larger undertaking that may be necessary to meet developments in the more distant future. The area of supply comprised in the Liverpool Electric Lighting Order of 1896 includes the whole of the extended city, a district about 7½ miles long and five miles wide. It is not unreasonable to assume that this area may ultimately require the equivalent of 250,000 to 300,000 16-c.p. incandescent lamps, or, say, 25,000 h.p. for lighting, and, say, 5,900 h.p. for motors and other purposes. In addition to this the tramways may ultimately require at least 10,000 h.p. Although the plant required for lighting will always largely exceed that required for tramways, the advantages of a plan that provides for a supply of electrical energy for all purposes from the same stations are so obvious that the electrical engineer feels that the committee will desire to consider the subject in its broadest aspect, and to invite the co-operation of the Tramways Committee, and he submits a complete scheme for their consideration. For this purpose he assumes that the power required at a not very distant period for the generation of electrical energy may be estimated as follows: for lighting, 25,000 h.p.; for motors, 5,000 h.p.; for tramways, 10,000 h.p.—total, 40,000 h.p.

The main points that require to be decided are: the number, size, and location of the generating station; the system of generation and distribution; the type and size of plant to be adopted as the unit. When a generating station reaches a certain size, little, if any, economy in working can be attained by increasing its size. For example, two stations of 10,000 h.p. each can be worked with practically the same economy as one station of 20,000 h.p., and by sub-division the risks of stoppage by fire, explosion, and any other accident are minimised. Whatever system of distribution is adopted, a station is most advantageously situated when placed in the centre of the area to be supplied. In stations supplying energy for lighting only, the average working hours at heavy load do not exceed two hours per day, and consequently the charges for interest and depreciation on the capital value of the plant form a much larger proportion of the cost of production than the coal bill. For this reason such stations should have plant of the simplest description, and be located, as nearly as circumstances admit, in the centre of the area to be supplied. On the other hand, a station supplying energy for tramways will carry a large load throughout a working day of 16 to 18 hours, and in this case interest and depreciation are of less relative importance than the cost of fuel. Power stations, therefore, should be located so as to secure the cheaper delivery of fuel by railway or canal, and the additional cost of condensing plant may be wisely incurred.

It is often assumed that the cost of electrical energy depends mainly on the size of the generating station. This is not the case beyond a certain limit, but the main factor is the number of hours the plant can be run daily at a reasonably good load. The Paradise-street and Oldham-place stations are very favourably located for the supply of energy for lighting in the most important portion of the city, and when completed will be capable of supplying about 10,000 h.p. for this purpose, with due regard to economy of working.

Electrical energy can be generated and distributed either in the form of direct current or of alternating current, and either at high voltage or low voltage, the latter not exceeding 500 volts. As regards the cost of production in the generating station, there is no difference between the two systems, except that the greater ease with which machinery can be worked in parallel on the direct-current system somewhat lessens the cost of attendance. The alternating current is not suitable for directly supplying tramways or motors, or for arc lamps or for charging accumulators, but has great advantages when energy has to be distributed over very long distances at pressures of more than 3,000 volts. In every system of electrical distribution it is necessary to have a low-pressure network of distributing mains to which the con-

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sumers' service lines are connected, and so convey the electrical energy from the generating station to this network of feeding mains. When a district is sparsely populated, or in cases where it is impracticable to find a suitable site for the station within the area of supply, the cost of low-pressure feeding mains may become commercially prohibitory, and it is then necessary to use a high-pressure system of distribution with transforming stations, in which the high-pressure current can be transformed into the lower pressure necessary for the distributing network. Any transformation of energy from one pressure to another entails a loss in the process and a certain amount of complication, and is consequently to be avoided as far as possible. For the work to be dealt with in Liverpool the alternating-current system is for the most part unsuitable, and high-pressure and transforming apparatus unnecessary.

The pressure required for tramways is about 500 volts, and, as the bulk of the Liverpool tramways are situated within a circle of only two miles radius, the direct supply of energy to them at the above pressure presents no difficulty. As regards lighting and motors, the supply is now given in all but the centre portion of the city at a pressure of 220 volts, and as the supply mains are arranged on the three-wire system, the pressure at the distributing points will ultimately be 440 volts.

The economical limit for distribution for lighting purposes at this pressure does not exceed two miles from the generating station, and consequently for some of the most distant portions of the area of supply the energy will have to be transmitted at higher pressure (say, 1,000 to 3,000 volts), and reduced at transformer stations to the pressure of supply. The areas to be dealt with in this exceptional manner will, however, be but a very small portion of the total area. Plant of similar design can be used both for lighting and for the tramways, which would reduce the amount of spare plant which would be required.

COMPANIES' MEETINGS AND REPORTS.

SEASHORE ELECTRIC RAILWAY COMPANY.

A general meeting of shareholders in the Brighton and Rottingdean Seashore Electric Tramroad Company was held at the offices, Madeira road, last week. Mr. E O. Bleackley (chairman of directors) presided.

The following was the report of the directors: Your directors, in submitting their annual report (the presenting of which has been delayed till the reopening of the line), are pleased to announce that the repairs necessitated by the disastrous gale of December last have now been completed. The car has been reconstructed in an improved manner, and equipped in a most sumptuous way. The line was reopened on Tuesday, July 20, and is being well patronised by the public, and the passengers are so satisfied with the excursion that many go day after day. After a long and trying period the directors now trust that the shareholders are within measurable distance of a substantial return for their investments. The debenture interest for the year 1896 has now been paid. Mr. Volk has foregone his claim to an amount of £149. 9s. 11d. due up to June 30 1896, and has also given his services and foregone all commission from June 30 last up till the date of reopening the line, a period of over 12 months, representing a saving to the Company in all of about £629. The directors regret to announce that the Company's secretary, Mr. F. J. Cully, died in May last. Mr. Magnus Volk has agreed to act as secretary *pro tem.* Mr. E. O. Bleackley, chairman, retires by rotation, and, being eligible, offers himself for re-election. The retiring auditor is Mr. James T. Haslam, who, being eligible, offers himself for re-election.

The **Chairman**, in moving the adoption of the report and balance-sheet, said that, after having passed through very troubled waters, they now found themselves once more equipped, and the car steadily at work. They would understand something of the worries and anxieties of the past nine months when within a week of their successful opening a great part of the undertaking was destroyed. In reconstructing the car many improvements had been introduced, from which they hoped to derive considerable benefit; the protective work at Greenway's was well in hand, and would be available during the forthcoming autumn and winter. Although they did not anticipate any repetition of last winter's disaster, the car and jetties had been insured, so that any future loss would not fall on the Company. Since the line had been reopened it had been well patronised by the public, so much so that except on two or three boisterous days scarcely a day had passed without the booking having to be suspended, the full complement of tickets having been sold. Owing to a miscalculation of the contractors for the engine, they had not been able to run the car so fast as they expected, though still at a very satisfactory speed, and the makers of the engine had promised to give more power, but during the present busy season, as no alterations could be carried out without suspending the traffic, little could be done in that direction. One thing was fairly certain, that the public appreciated "a sea voyage on wheels," and were quite ready to respond to all the reasonable accommodation that could offer them.

In answer to questions, the **Chairman** said he expected there would soon be another car constructed; it was only a matter of funds, and they had now learned how to build them much cheaper.

The report and balance-sheet were unanimously adopted.

BRUSH ELECTRICAL ENGINEERING COMPANY, LIMITED.

Directors: J. B. Braithwaite, jun., Esq. (of Messrs. Foster and Braithwaite), chairman; Arthur Ayres, Esq., M.I.C.E.; John S. Raworth, Esq., M.I.C.E.; Aymor H. Sanderson, Esq.; Colonel Frederick George Steuart; B. H. Van Tromp, Esq.; Edward Woods, Esq. (past-president Institution of Civil Engineers. General manager: R Percy Sellon, M.I.E.E.

Eighth annual report to be presented to the shareholders at the general meeting of the Company to be held at Cannon-street Hotel, London, E.C., to-day (Friday, September 17, 1897), at 12 noon:

The profit and loss account for the year ended June 30, 1897, shows an available gross profit of £43,761. 6s. 3d. After deducting maintenance, general charges, and interest on debenture stock there remains a balance of net profit of £18,962. 4s. 5d. The directors recommend that this sum be applied as follows:

Balance of dividend due to preference shareholders for year ended June 30, 1895	£2,141	3	8
Dividend at 4 per cent. per annum on preference shares for year 1896-7	7,200	0	0
Bonus payable to employés under profit-sharing scheme	1,609	2	4
Reserve fund	5,000	0	0
Balance carried forward	3,011	18	5
	£18,962	4	5

The results of the year's working show a decided improvement over those of the previous year. Further administrative economies have been and are being effected, of which the accounts for the past year have not derived the full benefit. The directors are glad to report that the condition of the industry generally is steadily improving. Formal sanction to the reduction of the ordinary share capital authorised by the shareholders last November having been obtained, the balance sheet is drawn in accordance with the reduced valuation of assets approved by the Court. Of the £76,770 4½ per cent. redeemable second debenture stock, the directors have decided to pay off £26,770. This amount has been drawn in accordance with the provisions of the trust deed, and will be redeemed on October 1 next. There will then be a sum of £50,000 second debenture stock outstanding. Capital expenditure to the extent of £11,348. 5s. 8d. has been incurred during the year on extensions of buildings and plant at Loughborough, and further additions are now in progress. The directors consider this capital outlay justified by the large volume of orders now in hand and the improving prospects of the Company's trade. The Company's works have been employed during the past year in the manufacture of electric lighting and traction plant, consisting of steam-engines, alternating and direct current dynamos, and accessories; also of locomotives, cars, and other rolling-stock. In the field of electric traction the Company has secured important contracts, which are now in progress. The result of the year's operations enables a further distribution to be made to the employés under the Company's profit-sharing scheme, the scope of which was extended in 1893 to include the Company's workmen. Since then the sum of £4,753. 6s. has been distributed among participants in cash or invested in the provident fund on their behalf. In the opinion of the Board the scheme continues to work well in the interests both of shareholders and participants. During the year Mr. J. S. Raworth has resigned his position on the executive staff as joint manager and chief engineer, and has been elected to a seat on the Board. Mr. R. Percy Sellon has been appointed general manager. Mr. A. H. Sanderson and Colonel F. G. Steuart are the directors who retire by rotation, and, being eligible, offer themselves for re-election. The auditors, Messrs. Cooper Bros. and Co., also retire and offer themselves for re-election.

PROFIT AND LOSS ACCOUNT, YEAR ENDED JUNE 30, 1897.

Dr.	£	s.	d.
General charges—viz., directors' fees	1,000	0	0
Auditors' fee	105	0	0
Salaries	6,100	2	11
Law charges	192	16	1
Insurance	600	0	1
Postage, stationery, and printing	1,012	19	9
Rent, rates, and taxes	1,227	0	0
Advertising and London office expenses	1,732	9	1
	11,970	7	11
Further cost of removal to Loughborough	58	5	3
Cost of head office removal	518	19	5
Maintenance of buildings and plant	2,449	16	9
Maintenance of patents	166	14	9
Interest on first debenture stock to June 30, 1897	5,625	0	0
Interest on second debenture stock to June 30, 1897	3,454	13	0
Income tax	458	17	5
Bad debts	96	7	4
Balance, profit carried to balance-sheet	18,962	4	5
	£43,761	6	3

Cr.	£	s.	d.
Balance brought forward from last account	3,795	2	4
Gross profit on trading	32,655	9	10
Profit realised on securities sold, interest account, and dividends on securities held	7,224	0	1
Transfer fees	86	14	0
	£43,761	6	3

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Dr. BALANCE-SHEET, JUNE 30, 1897.	£	s.	d.
Authorised capital—150,000 6 per cent. preference shares of £2 each	300,000	0	0
180,000 ordinary shares of £2 each (altered from 150,000 ordinary shares of £3 each, £450,000, by special resolution confirmed by the shareholders Nov. 2, 1896, and by order of the Court dated Aug. 7, 1897)	360,000	0	0
	660,000	0	0
Capital issued—90,000 6 per cent. preference shares of £2 each	180,000	0	0
90,000 ordinary shares of £3 each, £270,000; less reduction of £1 per share, confirmed by order of the Court dated Aug. 7, 1897, £90,000	180,000	0	0
	360,000	0	0
4½ per cent. perpetual first debenture stock, secured by debentures charged on the undertaking	125,000	0	0
4½ per cent. redeemable second debenture stock, part of £105,000 secured by debentures charged on the undertaking, £76 770; less cash in hands of trustees, £18 799. 15s. 5d.	57,970	4	7
Sundry creditors — head office, £35,020. 3s. 2d.; Australian branch at April 30, 1897, £513. 11s. 2d.	£35,533 14 4		
Bills payable — head office, £4,876. 14s. 5d.; Australian branch at April 30, 1897, £242. 3s. 1d.	5,118 17 6		
	40,652	11	10
Balance of profit and loss account	18,962	4	5
	£602,585	0	10

NOTE.—Liability on shares in other companies, £3,700.

Cr.	£	s.	d.
Property—Freehold and leasehold factories at Loughborough, Lambeth, and Southwark, including plant and machinery, as per valuation of Messrs. Fuller, Horsey, Sons, and Cassell	88,847	0	0
Additions during the year, including £525 valuers' charges for making above valuation	11,348	5	8
	100,195	5	8
Patents and goodwill	181,397	8	9
Goods in hand, in process of manufacture, work in progress and materials in London, at Loughborough, and other places	£92,318 14 9		
Australian branch at April 30, 1897	11,136 0 6		
	103,454	15	3
Sundry debtors—head office, including £45,194. 4s. instalments on contracts at interest	136,608 9 7		
Australian branch at April 30, 1897	4,389 18 4		
Ditto, balance of items in transit and invoices rendered, less cash received from April 30 to June 30, 1897	2,282 15 3		
	143,281 3 2		
Bills receivable, head office	1,039 6 8		
	144,320	9	10
Cash at bankers, on current and depoeit accounts, and in hand—head office	9,838 2 9		
Australian branch at April 30, 1897	601 12 0		
	10,439	14	9
Shares and debentures held at or below cost price	62,777	6	7
	£602,585	0	10

NATIONAL ELECTRIC SUPPLY COMPANY.

The following is the amended report of the directors for the year ending December 31, 1896, to be submitted to the general meeting of shareholders, to be held at the offices of the Company, at Preston, on Monday, September 13, 1897. The general balance-sheet at December 31, 1896, varied to show the effect of the reduction of capital sanctioned by the Court, is also appended:

The directors, in submitting their amended report for the year 1896, with accounts as certified by the Company's auditors, are pleased to state that the business shows a steady increase, and that the position of the Company has been considerably strengthened during the past year. Since the ordinary general meeting, held February 10 last, extraordinary general meetings have been held, and steps taken (in accordance with the special resolutions passed) to reduce the issued capital of the Company, by reducing the nominal amount of the issued shares from £5 to £3. 12s. 6d. per share. This reduction was sanctioned by the Court on August 9, 1897. The total amount of capital reduced is £15,056. 5s., and the items written off amount to £15,055. 18s. 1d., as under:

Formation expenses	£1,285	13	6
Preliminary expenses	7,729	11	10½
Adverse balance of revenue account	1,000	0	0
Experimental plant account	5,040	12	8½

The expenditure on capital account during the year 1896 was £3,640. The mains, during 1896, have been extended in Bow-lane, Ribblesdale-place, Upper Walker-street, Meadow-street, Glover-street, and Garstang-road. A new feeder main has also been laid from the works, to meet the increasing demand in Winckley-square and the neighbourhood. Thirty new arc lamps for public street-lighting have been erected, and the necessary connections made to the mains. The required capital has been raised by the issue of second debentures, 4½ per cent. per annum. The gross profit for the year 1896 is £4,025. 7s. 5d., an increase of £1,623. 14s. 4d. over the year before. After paying debenture and bank interest, the directors recommend that the balance should be appropriated as follows:

Interest on debentures and bank interest	£1,115	17	0
Depreciation on machinery, etc., and to provide for bad and doubtful debts	909	13	11
Reduction of preliminary expenses	174	17	11
Payment of a dividend, at the rate of 2s. 6d. per share per annum, on the ordinary shares of the Company for the year ending December 31, 1896	1,324	18	7
Balance to be carried forward	500	0	0
	£4,025	7	5

The plant and machinery have been maintained in a high state of efficiency, out of revenue, and are capable of furnishing a much large output than has yet been required.

GENERAL BALANCE-SHEET.	£	s.	d.
Capital account—amount received	63,678	15	0
Sundry tradesmen and others due on construction of plant and machinery, fuel, stores, etc., to Dec. 31, 1896	1,386	11	6
Sundry creditors on open accounts	90	0	7
Amount due to bank	2,336	2	0
Depreciation fund	1,318	11	8
Interest on debentures	386	2	0
Rents, rates, etc., accrued	8	6	8
Net revenue account	1,824	18	7
	71,029	8	0
	£	s.	d.
Capital account—amount expended for works	65,640	1	2
General stores on hand Dec. 31, 1896	2,534	6	4
Sundry debtors for current supplied to Dec. 31, 1896 (less allowance for discounts), £2,765. 14s. 7d.; less reserve for bad and doubtful debts, £20	2,745	14	7
Rents, rates, etc., unexpired	74	13	5
Other debtors	24	12	6
Cash in hand	10	0	0
	£71,029	8	0

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Lisbon.—Tenders will close on 23rd inst. for the supply of cables for lifts, for the Portuguese Railway. For particulars apply to 28, Rue de Châteaudun, Paris.

Switzerland.—Tenders are invited at Lausanne for a concession for erection and lease of electric works. Applications to be made to the Municipality before September 25.

Crossgates.—Tenders are required for fixing electric bells in eight houses at Crossgates. Application for particulars should be made to Messrs. Stevenson and Murgatroyd, builders, Crossgates.

Ploesti (Roumania).—Tenders are invited for lease of lighting the town by electricity for one or three years. Deposit, £120. Particulars may be obtained on application to the Municipal Authorities at Ploesti.

Paris.—The Managers of the Mont-de-Pieté invite tenders for an electric, acoustic, and telephonic installation. Tenders close September 25, at 1.30 p.m. For full particulars application is to be made to the Tribunal of Commerce, Paris.

Jassy (Roumania).—Contracts will close on September 18 at 4 p.m. for the electric lighting of the town of Jassy. Specifications, plans, and all particulars may be obtained at Paris, 80, rue de Varenne, at the Bureau des renseignements commerciaux.

Sydney (New South Wales).—Tenders are required by October 18, at noon, at the General Post Office, for supplies to the Telegraph, Telephone, and Post Office Departments, including iron, copper, and insulated wire, insulators, nails, screws, nuts, bolts, electric batteries with all accessories and chemicals, diaphragms, arc lamps, incandescent lights, 11,000ft. carbon for arc lamps, and various other appliances.

Leeds.—Tenders are invited by the Guardians for the electric lighting of the Board-room, East-parade, Leeds. Plans may be seen and specifications obtained by application at the offices of Mr. T. Butler Wilson, F.R.I.B.A., architect, 12, East-parade, Leeds. Sealed tenders to be delivered to Mr. James H. Ford, clerk, Poor-Law Offices, East-parade, Leeds, endorsed "Electric Lighting of Board-room," before 12 noon on 25th inst.

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Norway.—Her Majesty's Secretary of State for Foreign Affairs has received information from her Majesty's Consul-General at Christiania that tenders are invited by the Norwegian State Railway Administration for the supply of telegraph and telephone materials. Tenders will be received by the Administration up to 7 p.m. on September 22, 1897, and should be marked "Telegraf og Telefonmaterial," and addressed Tyrelsen's Expeditionskontor, Statsbanerne Christiania. Further particulars may be obtained on application at the Commercial Department of the Foreign Office between the hours of 11 and 6.

Russia.—Two concessions for the erection and lease of street railways are open for tender. These tramways may be worked either by electricity or any other means. Tenders for the works at Penza will close September 30. Particulars are to be obtained at the offices of the Municipal Administration. The second lot of contracts is for a similar undertaking in the town of Kontais, in the Caucasus. The municipal authorities will furnish applicants with particulars as to this work. For the benefit of intending contractors, we observe that they will save themselves time, and probably disappointment, if they will write their letters in French.

Halifax.—Tenders are invited for the supply and erection of a tramway switchboard. Specifications may be obtained on application to Mr. T. P. Wilmshurst, borough electrical engineer, Foundry-street, Halifax, on payment of £1. 1s, which will be returned on receipt of a bona fide tender. Tenders will only be considered from firms having experience in electric tramway switchboard. Tenders, endorsed "Electric Tramway Switchboard," must be sent to the town clerk, Mr. Keighley Walton, before 10 a.m. on 20th inst. The person whose tender is accepted will be required to observe the fair contracts clauses adopted by the Corporation.

Ludlow.—The Corporation offers a prize of £20 for the best and most economical scheme of electric lighting for the borough. The scheme must deal exhaustively with the whole matter, and give definite information of the cost of steam and water power for the purpose of comparison with the total cost of the undertaking and working expenses. Schemes to be delivered at the offices of Mr. John Herbert Williams, town clerk, Ludlow, marked "Scheme for Electric Lighting," before 4 p m. on October 1. Should the Corporation employ the engineer whose scheme is awarded the prize to carry the work out, then the £20 will merge in the commission to which he would then be entitled to.

Whittingham.—Tenders are invited by the Lancashire Asylums Board for electric lighting and plant required at the new hospital and reception wards at the County Asylum, Whittingham. Plans and specification may be seen, and further information obtained, at the offices of Messrs. Simpson and Duckworth, architects, Richmond-chambers, Blackburn, and also at the offices of the consulting engineers, Messrs. Fawcus and Clirehugh, Temple-chambers, Brazennose-street, Manchester, on and after 28th inst. General conditions, specification, and form of tender on deposit of £5. 5s., returned on receipt of bona fide tender. Tenders to Mr. J. P. Muspratt, County Offices, Preston, not later than first post on September 20.

Llandudno.—The Urban District Council invite tenders for the following work in connection with their electric lighting and dust destructor station: (Section A) water-tube boilers; (B) condensing plant, steam plant, etc.; (C) steam engines and dynamos; (D) switchboard; (E) battery; (F) travelling crane; (G) underground mains, arc lamps, posts, etc. Copies of the specification, with form of tender and general conditions, can be obtained at the office of Mr. A. H. Preece, A.M.I.C.E., 39, Victoria street, Westminster. Applications for any or all of the above must be accompanied by a cheque for £5. 5s., which will be refunded on receipt of a bona fide tender. Sealed tenders, marked "Electric Lighting Tender for Section —," must be delivered at the office of Mr. A. Conolly, clerk, Council Offices, Llandudno, by 10 a.m. on 22nd inst.

Plymouth.—The Corporation are prepared to receive tenders for engineering works in connection with the tramways of the borough, full particulars of which appear in our advertising columns. The contracts are divided into two—viz. (Contract No. 10) overhead trolley line, posts, brackets, etc.; (Contract No. 11) tramcars, trucks, motors, trolley arms, etc. Contractors may tender for either of the contracts, but not for a part of any contract. Copies of the conditions, specifications, and forms of tender, bound up together, may be obtained on deposit of £2. 2s., for each copy, which will be returned on receipt of a bona fide tender upon the prescribed form and within the stated time. A copy of the drawing of posts will be sent to those wishing to tender for Contract No. 10. Sealed tenders, endorsed "Engineering Contract No. —," must be delivered to Mr. J. H. Ellis, town clerk, Plymouth, not later than October 2. The acceptance of any tender will be subject to the contractor paying the standard rate of wages obtaining in the district where the work may be carried on.

Hull.—The Corporation are advertising for tenders for the electrical equipment of their tramways, to the extent of about nine miles double track and half mile single track. It will be open to contractors to submit tenders for various systems, and the contract, which will not be divided, will include engines and generators, switchboards, feeders, poles, brackets, trolley wire, rail bonding, and all accessories, also the first instalment of cars (15 motorcars and five trailers). It is expected that the specification, lithographed plans of the routes, and other particulars will be ready for issue early in September, and copies, when ready, may be obtained from Mr. A. E. White, city engineer, Town Hall, Hull, by persons proposing to tender, upon payment of a deposit of £10, which will be refunded upon receipt of a bona fide tender and return of the papers and plans supplied. Cheques to be made payable to Mr. Thos. G. Milner, city treasurer. Tenders, endorsed "Tender for Tramway Equipment," are to be addressed to the Chairman of the Works Committee, and delivered at the Town Clerk's Office, Hull, before noon on November 5.

Barking Town.—The Barking Town Urban District Council are prepared to receive tenders for the supply and erection of the following plant: Section A.—Generating plant, boilers and fittings, economiser, feed pump, injector, etc.; steam dynamos, condensers, oil filter, fittings, etc.; steam, exhaust, feed, blow-off, and sundry pipes; valves, water-tank, etc. Section B.—Storage batteries. Section C.—Switchboard and all connections. Section D.—Overhead travelling crane. Section E.—Conduits and mains for private supply. Section F.—Mains for public lighting, and adaptation of existing lamps. Section G.—Arc lamps and posts. Tenderers are at liberty to tender for any section or sections, or for the whole of the sections, but not for part of a section. Successful tenderers will be required to enter into a contract to pay the trades union rate of wages and to observe the trades union hours of labour. The ground plan of plant, diagram of switchboard, plan of streets, etc., and specifications, with forms of tender, may be obtained at the offices of Mr. W. C. C. Hawtayne, the consulting engineer to the Urban District Council, Mansion House-chambers, 20, Bucklersbury, E.C., on payment of £2. 2s., which sum will be returned on receipt of a bona fide tender. Tenders, sealed and marked "Tender for Electric Lighting," addressed to the Chairman of the Urban District Council, Council Offices, Barking, must be sent in by noon on September 21.

Madras.—Tenders are invited for the utilisation of water flowing from the Periyár Lake for purposes other than irrigation and not incompatible with the use of the water for drinking. The irrigating season extends over nine to ten months, during which time the discharge is likely to be from 1,100 to about 500 cubic feet a second, according to the demands for irrigation and the available quantity in the lake. Subject to the risk of interruption by accident or drought, supply can be given throughout the irrigation season. No supply can be guaranteed at other times, but, so long as water is available, the Government will be prepared to issue it in such daily quantities as may seem to it advisable with reference to the time which is likely to elapse before the supply is replenished by the setting in of the rains. The fall from the tunnel to the foot of the hills is approximately 900ft., and the distance measured along the course of the stream about 6,800ft. One cubic foot per second falling 900ft. is estimated to produce over 60 effective horse-power. Intending lessees should state the quantity of water required in cubic feet per second and the annual rent offered for each cubic foot per second. No rent will be charged for the first year from the date of the concession; for the second year the charge will be one-fifth, and an additional charge of one fifth will be made every year until the full rent is reached. The whole or part of the concession may be surrendered on a year's notice being given. Lessees will construct at their own expense, on plans to be approved by Government, all the weirs and other works required to divert the water from the river below the tunnel. For further information, application may be made to the Chief Engineer for Irrigation, Madras, by whom tenders will be received up to October 31, 1897.

Port Elizabeth (Cape Colony).—The Town Council of Port Elizabeth (Cape Colony) invite tenders for lighting the streets and municipal buildings of Port Elizabeth by electricity, in consideration of the grant of a concession for the exclusive right of supplying electric current through the streets and roads of the town, to private houses, stores, etc., for terms of 5, 15, 20, 25, or 30 years respectively. There are approximately about 54 miles of streets in the town, as follows: main thoroughfare, 5 miles 1,196 yards; principal streets, 16 miles 1,433 yards; minor streets, 32 miles. The streets of the town are at present lighted by 380 gas lamps of reputed 16-c p. The municipal buildings consist of town hall, municipal offices, morning market, feather market, wool market, and museum. The main streets are to be lighted by arc lamps, and the side streets and municipal buildings by incandescent lamps. Tenderers must state at what sum per annum they are prepared to adequately light the streets and municipal buildings for the various periods mentioned above, if they are granted a concession for any one of the periods referred to. The concession will provide, inter alia, that the particular system and plant to be adopted by the concessionaires shall be subject to the approval of Council; the charge for supplying current to private houses shall not exceed 1s. 9d. per London Board of Trade unit; and that the Council will have the option of taking over the whole undertaking, etc., at a valuation to be made in case of difference by two arbitrators or their umpire at the end of the period of the concession at the then value of the plant and mains. Tenders, endorsed "Port Elizabeth Electric Lighting," should be delivered to the agents of the Municipality, Messrs. Davis and Soper, 54, St. Mary-axe, London, E.C. (from whom further information may be obtained), on or before September 21.

RESULTS OF TENDERS.

Leeds.—The Corporation have accepted the tender of Mr. T. Harding Churton for the electric lighting installation at Kirkgate Market.

London, E.—The Electrical Power Storage Company, Limited, Millwall, E., have received the following tenders for extension to boiler-house, boiler-setting, etc.: F. Thorne, £646; Jones and Groves, £615; W. Mills, £568; Windsor and Co., £523.

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BUSINESS NOTES.

Dudley.—The Royal assent has been given to the Dudley electric lighting order.

Montrose.—The Town Council have decided to apply for a provisional electric lighting order.

Colne.—The Town Council are applying to the Board of Trade for an electric lighting provisional order.

Appointments Vacant.—As seen by our advertisement columns, there are several vacant positions—draughtsmen, etc.

Tunbridge Wells.—A deputation from the Corporation of Gloucester inspected the local electric light works last week.

Keswick.—The Urban District Council are advertising for offers for either the lease or purchase of their electric light provisional order.

Chichester.—The Chichester City Council have decided to take the necessary steps to procure an electric lighting provisional order.

Dundee.—The Town Council are still deliberating upon the question of motive power for the tramways proposed to be purchased by the Municipality.

Cheltenham.—The Electric Lighting Committee have acquired offices near that of their electrician. Several additions to the electric lighting system are in the course of preparation.

Manchester.—The city fund in aid of the rates have profited by a sum of £10,000, which represents the earnings of the last financial year of the municipal electric lighting undertaking.

Montgomery.—The Town Council decided at their meeting on the 7th inst. to apply to the Light Railway Commissioners for an order authorising a light railway from the town to the railway station.

Electric Construction Company, Limited.—The works of this Company at Bushbury, near Wolverhampton, are about to be extended. This will increase the number of employés from about 750 hands to 1,000.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended September 12 amounted to £1,451, as compared with £1,262 in the corresponding week of the previous year, being an increase of £189.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended September 10 were £2,495. 15s. 9d., compared with £2,388. 8s. 1d. for the corresponding period of last year, being an increase of £107. 7s. 8d.

Stockton.—The Middlesbrough, Thornaby, and Stockton Electric Tramways are inviting tenders for the erection of power-house, buildings, etc. Specifications may be seen at the offices of the engineer, Mr. J. Clifton Robinson, Bridge-road, Stockton-on-Tees.

Colwyn Bay.—We are informed that the electric lighting of Colwyn Bay promenade is only a temporary installation until the end of the season, consisting of six arc lamps, the power for running dynamo being derived from the Council's steam-roller, which, so far, runs it satisfactorily.

Change of Address.—The offices of the British Electric Traction Company, Limited, will be on and after the 20th inst. at Donnington House, Norfolk-street, Strand, W.C.—The offices of the *Electrical Review* and the "Universal Electrical Directory" have been removed to 4, Ludgate-hill, E.C.

Dundee Institute of Architecture, Science, and Art.—The excursion for 1897 to Edinburgh (M'Ewan Hall, Blackford Observatory, Craigmillar Castle, etc.), by kind permission of Prof. Copeland, George Somerville, Esq., Captain R. G. Gilmour, and others, will be held on Saturday, September 18.

Switzerland.—The electric line of Gorpnergrat, which is to be constructed in the Zermatt district, will be six miles long, with a gradient of 10deg., and will land the passenger at the foot of the glacier at an altitude of 3.291 yards, the highest point yet attained by any European line. The journey will take 1½ hours.

Berwick.—The National Telephone Company has now commenced operations in connection with their trunk-line system for Berwick. Alterations are being carried out at the Hide Hill office, and communication will shortly be established by telephone between Berwick and every city and town in the kingdom.

City and South London Railway.—The returns for the week ended September 12 were £879, compared with £835 for the corresponding period of last year, being an increase of £44. The total receipts for the half-year 1897 amounted to £9,906, compared with £10,016 for the corresponding period last year, being a decrease of £110.

Huddersfield.—Messrs. Read, Holliday, and Sons have taken over the business of Mr. A. B. Brook, electrical engineer, Brighouse. Mr. Brook remains in the electrical department of that firm, and the Brighouse branch will be carried on under his management until the extensions at the Huddersfield works are completed.

South Staffordshire Tramways Company.—The traffic returns for the week ending September 10 were £632. 17s. 7d., as compared with £668. 18s. 4d. in the corresponding week of the previous year. The aggregate receipts so far this year were £22,799. 5s. 9d., as compared with £22,269. 9s. 7d. in the [corresponding period in 1896.

Smethwick.—A meeting of the District Council was held on 14th inst. Two electric light companies notified their intention of applying to Parliament for provisional orders to supply the district with electricity. The clerk was instructed to take steps to obtain the necessary provisional order, and to oppose the applications of the private companies.

San Bernhard.—The engineers sent to report upon the feasibility of an electric railway up the San Bernhard (Fell's system) have finished their investigations, and, it is said, are perfectly convinced that the project can be carried out. A London syndicate announces that it expects soon to receive the necessary concession from the Italian Government.

Darwen.—The minutes of the Electric Light Committee recommending the Town Council to adopt a scheme of electric lighting and to appoint an electrical engineer at a salary of £200 per year have been adopted. It was pointed out that the time would soon arrive when the electric light works would be utilised to the transmission of power for the trams and motors.

Hunsworth.—The Hunsworth District Council met on the 14th inst. A representative from the National Telephone Company attended the meeting and asked for permission to erect poles along the Bradford and Dewsbury road, on the causeway side. The application was refused, strong feeling being evinced against allowing the road to be disfigured for the benefit of a private company.

St. Clement Danes.—The Rev. Septimus Pennington, the vicar, at a parish meeting held 15th inst., stated that the stands erected round the fabric on the occasion of the Jubilee realised £5,750, and legally he was entitled to the whole of this sum. He had decided, however, to give the amount for the purposes of the complete restoration of the church. The alterations include the introduction of an electric light installation.

Shrewsbury.—At the last monthly meeting of the Town Council the Finance and General Purposes Committee reported that they had considered the report of Messrs. Kincaid, Waller, and Manville, the electrical engineers employed to report upon the Shropshire Electric Light and Power Company's works, and recommended the Council to purchase the same, and to obtain the necessary power by provisional order. The clerk was instructed to enter into the necessary negotiations.

Morley.—At a meeting of the Electric Light Committee the following resolution was passed: "That the plan of extension drawn out for the Local Government Board by Mr. Hammond be approved, and that in view of the fact that the contracts for paving had been let in the Bruncliffe-road, St. Andrew's-avenue, and Park-street districts, the mains be laid in those streets in accordance with the plans presented by Mr. Hammond, at an estimated cost of £1,500."

D.S.D. Tramways Company, Dublin.—The traffic receipts for the week ending September 10 were £586. 16s., as compared with £799. 7s. 9d. in the corresponding week in the previous year, being a decrease of £212. 11s. 11d. The number of passengers carried was 88,777 in 1897 and 103,145 in 1896. The aggregate returns up to date are £8 416. 3s., as compared with £9,306. 8s. 3d., being a decrease of £890. 5s. 3d. The mileage open is the same as last year—viz., eight miles.

Blackpool.—By invitation of the North Pier Steamship Company a number of members of the Blackpool Corporation visited Douglas last week, for the purpose of inspecting the electric tramways in operation. The party travelled by the ss. "Greyhound" to Douglas. By the invitation of Mr. A. Bruce, J.P., and the directors of the Isle of Man Tramways and Electric Power Company, the members of the Corporation proceeded to Laxey by the Douglas electric tramway, thence to ascend Snaefell.

Carnarvon.—At a meeting of the Gas Committee of the Town Council it was resolved that the town clerk be asked to advise at the next Council meeting whether the Council should go in for a provisional order or local Act, in view of the application about to be made by a company for powers to supply electricity within the borough; also that he be asked to give his opinion as to the probable cost of each. Enquiries will be made, and, if necessary, a special meeting called. The committee's recommendation was ultimately adopted.

Altrincham.—A petition has been received by the Council from the secretary of the New Mutual Telephone Company of Manchester asking for the seal of the Council to a petition to the Board of Trade for a license to incorporate a company at a much cheaper rate than the present companies. Objections were raised to the granting of monopolies, and it was said if this were granted that proper powers would be inserted to safeguard the public, if it were desirable hereafter to acquire the rights of the company. After some discussion the matter was deferred.

Barrow-in-Furness.—Application is about to be made to the Local Government Board for an expenditure of £30,000 for the purpose of an electric lighting installation. The generating station will be erected on Corporation land adjoining the Furness Railway from plans prepared by the borough engineer; Messrs. Kincaid, Waller, and Manville, of Westminster, acting as electrical engineers for the Corporation. The system adopted is a combination of the high-tension continuous-current transformer system and the low-tension continuous-current direct system.

Electric Light on Trains.—An interesting experiment is now in progress on the London and North-Western Railway. To some of the new rolling-stock small dynamos have been attached, each of which generates electricity sufficient for a whole carriage, and also to charge 16 accumulators which will provide light for five

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hours in case the train is brought to a standstill, or an accident happens to the generator. At present two sleeping-cars—one running to Scotland and the other meeting the Irish packet boat—and 12 ordinary carriages have been fitted with the new appliances.

Vienna.—A proposal is before the Municipal Council for the authorisation of a loan of three millions sterling to construct an electric tramway system throughout Vienna. The proposal makes provision for the buying and remodelling of the existing lines now worked by other methods of traction. It also includes the introduction of a Bill for that purpose into the Parliament of Nieder Oestereich during the present session. The necessary steps are to be taken to get for this loan the identical concessions which have hitherto been obtained for other loans of the city of Vienna.

Thorne.—A meeting of the Thorne Parish Council took place on 13th inst. to consider the lighting question. An opinion was expressed that they could have the town lighted with electricity before that day three months. After a lengthy discussion, the votes were put to the meeting, when three were in favour of the amendment and four for the original motion, the result being that the report of the Lighting Committee, suggesting that the offer of 29s. per burner be refused, was adopted, and that the town will be without light until some arrangement is made with the Thorne Gas Company.

Aberdeen.—The Watching and Lighting Sub-Committee of the Town Council have visited several thoroughfares in which it was considered that improved lighting was required. The sub-committee have decided to erect four electric lamps in Market-street, and further resolved to rearrange the lighting at John-street, and to substitute pillar lamps for the present wall brackets, and to recommend the erection of three large Bray lamps at different points. It is understood that the sub-committee will also recommend the introduction, by way of experiment, of 36 incandescent gas lamps in Albyn-place.

Rotherhithe.—The Vestry have resolved not to take any action on a letter received, offering to prepare a preliminary report on electric lighting for Rotherhithe, and to advise the Vestry as to the best course to pursue in order to obtain a provisional order. The County of London and Brush Provincial Electric Lighting Company, Limited, have asked for the formal consent of the Vestry to the company's application for a provisional order under the Electric Lighting Acts. The clerk was instructed to request information as to which streets the company proposed to include in the compulsory area of the provisional order.

Isle of Man Tramways.—An extraordinary general meeting of shareholders in the Isle of Man Tramways and Electric Power Company was held at Douglas on the 15th inst., when the directors were authorised to increase the existing preference share capital of the Company by the sum of £25,000, and to create and issue as separate share capital under the Act authorising construction of an electric tramway from Laxey to Ramsey 50,000 5 per cent. preference shares of £1 each, and 50,000 ordinary shares of £1 each. It was stated that the new line would act as a feeder to the existing undertaking, and promised to be a paying concern.

Ossett.—On the recommendation of the General Purposes Committee, the Mayor was, at the last monthly meeting of the Town Council, authorised to call a special meeting next month for the purpose of authorising an application to the Board of Trade for an order or license empowering the local authority to supply electricity for public or private purposes. Referring to this resolution, it was stated at the meeting that they had already had application from a company, and if they neglected to secure powers for themselves, and let the present opportunity slip, they would very likely find themselves in a similar position to that of Leeds at the present time, and be under the necessity of buying out a private company at a heavy cost.

Birkenhead.—A correspondent of the *Birkenhead and Cheshire Advertiser* advocates the establishment of a trial line of electric trams from Woodside to New Ferry.—The members of the Gas, Water, and Electrical Committee on Saturday last held their annual inspection of the estate entrusted to their care. Chief interest centred in the inspection of the electrical works in Bentinck-street, where the committee made special enquiry as to the suitability of the site with a view to the introduction of the electric tram system, and in the boring works at the Ford, Upton, where there is now a yield of about 9,000,000 gallons weekly. The water pumped here was found to be very hard, but until the machinery is completed, and the yield properly tested, it is impossible to form an estimate as to the suitability of the water for domestic use.

Elmore's Copper Company.—The accounts of this company show that after keeping the plant, machinery, and buildings in efficiency and providing for contingencies, and after paying all working expenses, except interest on the Haigh Park estate mortgage, and interest on capital borrowed under exceptional circumstances, the profit is £7,212, including £1,521 brought forward from last year. After defraying the interest, which is £779 more than last year, on borrowed capital, there remains a balance of £3,564 in hand. The directors regret that so large a deduction has to be made out of the profits for the payment of high rates of interest, but hope that this will very soon be remedied. At the meeting details of the scheme of amalgamation between this Company and Elmore's Wire Manufacturing Company, and possibly with other companies, will be submitted.

Catalogue.—We have received a catalogue of new and improved electrical instruments and apparatus specially designed for the use of technical and science schools from Mr. L. M. Waterhouse, A.I.E.E., of Birdhurst-road, Croydon. Mr. Waterhouse puts forward a strong claim to an honest endeavour to supply throughly reliable and well-made electrical instruments, and laboratory and workshop accessories, at a very moderate cost. For five years he has been the lecturer in electrical engineering at the municipal technical schools of Croydon and Brighton, and the designs that he has elaborated and improved are the result of that experience. His catalogue is well thought out and arranged, and to persons in charge of technical and science schools it will be found of very great use, as bringing before their notice the most improved and reliable apparatus.

Bedford.—The Electric Light Committee report to the Town Council as follows: "(*a*) The committee report that they have instructed the engineer (1) to proceed with the construction of an underground sub-station at the junction of Harpur-street and Midland-road in order to meet the increased demand for electric current in that locality, (2) to make the necessary arrangements for laying the electric mains and erecting the lamp standards in Bushmead-avenue so that the public lighting thereof may be completed about the end of October next; (*b*) the committee further report that the electric mains have now been laid in the following additional streets—viz: Newnham-road, Gery street, Castle-road (east of the Circle), Embankment, Bushmead-avenue, Goldington-avenue, and Shakespeare-road. The committee will be glad to receive applications for private lighting from any residents in such streets."

Telephone Extension in Ireland.—Telephone communication from Limerick to Cork and Dublin was opened to the public from September 10, the final testings, which were made at Limerick, having proved in every respect satisfactory. The service is direct to Cork and Dublin, from which latter city a three minutes' conversation may be held with a person at Limerick for the charge of 1s. 6d, the rate from Limerick to Cork being 9d. for the same time. Three minutes' conversation, *vid* Dublin, can be had by the new telephone service with London and the other centres in England and Scotland, conversation being maintained with people in London, Carlisle, and other centres with the most satisfactory results. In several instances the voices of the operators were distinctly recognised, though a distance of from 400 to 500 miles separated those conversing at the instruments. The charge to London is 7s. 6d., and proportionate rates to other centres.

Tees-side Tramways.—The present fine open weather has materially assisted in successful progress at the Stockton and Norton sections of the Middlesbrough, Thornaby, and Stockton Electric Tramways, and Mr. Clifton Robinson, the engineer, is rapidly pushing the work forward, additional paviors being taken on, so that these sections may be completed at the earliest possible moment. New gangs of workmen are being organised for an early break upon the road between Brewery Bank, Thornaby, and Newport, in order that this low-lying district may be completed before the bad weather sets in. A further indication of the spirited policy of the directors in the matter of these works is that they are inviting tenders for the erection of power-houses, jetty, etc., on the company's riverside frontage, and all the other buildings pertaining to the construction of the central power-house at Bridge-road, Stockton. The plans of the jetty have already been submitted to the Tees Conservancy Commissioners.—*Middlesbrough and Stockton Evening Telegraph.*

Warrington.—A special meeting of the Town Council was held last week "to consider the advisability of applying to the Board of Trade for a provisional order empowering the Council to supply electricity for lighting and other purposes within the district, and to pass such resolutions in connection therewith as may be thought advisable." The Mayor, in introducing the question, said that was a statutory meeting required by the Electric Lighting Acts as a preliminary to the application for a provisional order. The resolution to apply for a provisional order must be passed at a special meeting, of which one month's notice has been previously given. The Council would remember passing in the month of January last a resolution approving of the application for a provisional order empowering the Town Council to supply electricity for public and private purposes within the area of the borough, and that the town clerk be authorised to take all necessary proceedings for obtaining the said order. In answer to questions the Mayor said: "This is merely a formal matter at present. We are doing this to prevent anyone else getting a provisional order. We don't want another gas or water works in the town." The motion was then unanimously agreed to.

Glasgow.—The annual inspection of the Corporation tramway depôts by the Tramways Committee took place last week. The committee and a large number of town councillors visited first the Coplawhill depôt. In view of the equipment of the Springburn route for electric traction, the Tramways Committee have been considering the type of car which will be most serviceable for the new system of traction. The committee have had a car built in the works at Coplawhill, so as to enable them to see and judge of it by comparison with the present type of horse-car. It is a composite car, constructed to accommodate 46 passengers, with the entrance platform in the centre. The "closed" compartment is seated for 18 persons. The other compartment is open at the sides, and is fitted with cross reversible spring seats for 16 persons. Both have a high monitor roof. The cars can be turned out of the works of the department at Coplawhill. At a special meeting of the Electricity Committee of Glasgow Corporation the scheme of amalgamation of the Tramways and Electricity Committee on the ground that the tramways would shortly be worked by electric traction, proposed by the Lord Provost, was discussed and rejected by nine votes to six.

Bradford.—The salary of Mr. Samuel T. Dalton, assistant electrical engineer, has been raised from £200 to £250 per annum

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by the City Council.—The Mayor, as chairman of the Gas and Electricity Supply Committee, has read the figures for the half-year ending June 30, showing the operations of these two departments. In the electricity department the income for the half-year had been £8,726. 12s. 3d., as compared with £6,937. 4s. 6d. in the corresponding half in the previous year, or an increase of £1,789. 7s 9d. The total expenditure for the half-year, including interest and sinking fund, was £7,061. 2s. 1d., against £5,929. 8s. 1d. for the same period of the previous year. The profit for the half-year, therefore, was £1,665. 10s. 2d , as against £1,007. 16s. 4½d. The number of consumers at the present is 521. as against 391, or an increase of 33¼ per cent. on the corresponding period of last year. The total units consumed was 443,288, as against 336,281, or an increase of 31¾ per cent. The total profits since the opening of the works in September, 1889, to June 30, 1897, after paying interest and sinking fund, amounted to £13,833 18s. 7d., and the total amount written off for depreciation had been £4,622. 18s. 2d., leaving the sum of £9,211. 6s. 5d. to be appropriated as the Council directed. The trading profit—*i. e.*, before charging interest and sinking fund—was £3. 18s. 5d. per cent. on the outlay, and the net profit—namely, after charging interest and sinking fund—was £1. 6s. 5d. per cent. for the half-year.

Leamington.—The monthly meeting of the Council this week was preceded by a special meeting called to consider the proposal to apply to the Board of Trade for a provisional order for electric lighting. A resolution was carried *nem. con.* to the effect that the necessary application for the order should be made. It was said that the present electric lighting company had put down their mains without obtaining a provisional order. The General Purposes Committee reported that they had considered the report of Mr. T Newbigging, the gas expert appointed by the Corporation, which recommended the purchase of the gasworks for £123,000, but they did not recommend that the works be bought. During the debate it was stated that if the gasworks had been purchased on the terms recommended in Mr. Newbigging's report, the Corporation would have been saddled with an undertaking which would not have been profitable, and on which, before any developments were possible, a large capital outlay would have been necessary. Any considerable increase in the gas company's business was not probable. Most of the large establishments in the town were now taking electricity instead of gas, and the introduction of the penny-in-the-slot system would not be successful in a residential town like Leamington. The General Purposes Committee's report was adopted.—The following notice of motion has been tabled for the next meeting of the Town Council: "That in the event of our applying for an order to sanction the establishment of municipal electric light works, a committee be appointed to consider the whole question, including the desirability or otherwise of purchasing any portion of the existing works. The chairmen of all committees to form such body with power to call in expert advice."

Sheffield.—We are informed that the Sheffield Electric Light and Power Company, Limited, have been compelled to give notice to the public of their inability to accept any more electric light customers this year. The immediate cause of this serious step is the strike in the engineering trade. Early this year the directors had good reason to anticipate the remarkable growth that has taken place in the demand for electric lighting, and orders were given in various directions for the delivery of 2,000 h.p. of engines and dynamos to enable the company to supply the requirements of the public during the coming winter. At that time there were no indications of trouble in the labour market, and the orders were eagerly accepted, and delivery guaranteed by the end of this month, under heavy penalties in case of default. The strike has since developed, and disjointed parts of the machines are now lying about in the various workshops in an unfinished condition. No men are at work on them, and the date of completion cannot even be guessed at until the dispute between the manufacturers and the workmen is at an end. The demand upon the company for electric light has increased by 100 per cent. since this time last year, and the directors now feel compelled to refuse further orders from consumers this year, so that the severe strain which is being put on existing machinery may not jeopardise the general supply of light to the public. Steps are being taken by the company for the introduction next year of American and Continental engines and dynamos, so that the risk of dislocation of an important public supply of light from causes similar to those now existing may in future be rendered impossible.—*Sheffield Telegraph.*

Epstein Electric Accumulator Company, Limited.—Under the winding-up of this Company the statutory meetings of creditors and contributories were held at the Board of Trade offices, Lincoln's-inn, and the Chairman reported that the Company was registered on July 31, 1891, with a capital of £101,000, divided into 100,000 ordinary and 1,000 founders' shares of £1 each. The ordinary shares carried a preferential non-cumulative dividend of 15 per cent. per annum, and the holders of the founders' shares were to receive half of any profits after payment of such dividend. The Company was formed to acquire certain patents and patent rights relating to inventions and improvements for the manufacture and use of storage batteries, and to carry on the business of electrical engineers, the purchase price being fixed at £71,000. For some time Mr. Epstein acted as managing director, but latterly he was appointed consulting engineer, with a remuneration of £400 a year and £25 per annum for each 1 per cent. paid in dividend to the shareholders. The Company appeared to have been in want of funds throughout, and in March, 1893, debentures to the amount of £6,000 were issued to Woodhouse and Rawson United, Limited. In April, 1894, an arrangement was made whereby £12,000 second debentures were created, and a sum of £1,000 paid to the liquidator of Woodhouse and Rawson, Limited, the latter relieving the Company of its indebtedness to the extent of £13,000. The accounts which had been furnished showed liabilities £25,973, of which £18,826 were expected to rank, and assets (absorbed by claims of debenture-holders) £6,520. As regarded contributories, a deficiency of £90,153 was disclosed. Sir C. W. F. Crawford and Mr. Epstein, directors, expressed their conviction that the patents were still very valuable, and the proceedings resulted in the appointment of Mr. Northby, the secretary of the Company, as liquidator.

New Companies.—The Electro-Neurotone Company, Limited, has been registered with a capital of £5,000 in £1 shares. Objects: to acquire any invention relating to the production, treatment, storage, application, distribution, or use of electricity, and to carry on the business of electricians, engineers, machinists, fitters, founders, etc.—The Pimbley Economiser Company, Limited, has been registered, with a capital of £60,000 in £1 shares, to adopt and carry into effect an agreement made August 13, 1897, between Jas. Edwards, of the one part, and A. A. Gillies, as trustee for and on behalf of this company, of the other part, for the acquisition of the business carried on by Joseph Pimbley and Co., at Farnworth; to develop and extend the same, and generally to carry on in all or any of the respective branches the businesses of makers of fuel economisers, mechanical, electrical, and hydraulic engineers, boiler-makers, metal workers, machinists, fitters, millwrights, founders, tubemakers, rivet-makers, metallurgists, galvanisers, japanners, annealers, enamellers, electro-platers, packing-case makers, and all or any businesses connected directly or indirectly with the manufacture, making, and supply of fuel economisers; tobacconists and dealers in refreshments, wines and spirits, beer, porter, aerated and mineral waters, and other drinks; to acquire and turn to account any patents, patent rights, and inventions; as stock and share dealers; to construct and maintain rail and tram roads, docks, piers, wharves, warehouses, shops, stores, etc. The signatories are: J. Garside, Springfield Works, Salford; J. Urmson, Hathershaw Ironworks, Oldham; J. D. Kay, Lands End Bleach Works, Middleton; O. Thorn, Birkacre Works, Chorley, Lancs.; J. S. Neill, The Cliffs, Acton, Northwich; T. Newby, 31, Market-street, Manchester; J. Carter, Atlas Works, Stalybridge. The first directors, of whom there shall be not less than three nor more than seven, are J. S. Neill, J. W. Bentley, J. D. Kay, J. Garside, and C. G. Norris. Qualification, £250. Remuneration as fixed by the company.

Brierley Hill.—The District Council have received a communication from the Kingswinford Rural District Council as follows: "Union Offices, Wordsley, September 4, 1897.—*Re* Electric Lighting.—Dear Sir,—The committee appointed to deal with this matter are recommending the Council to appoint delegates to discuss the question with your Council with a view to ascertaining whether joint action could be arranged for providing a dust destructor in conjunction with the electric lighting plant for both our respective districts. My Council will not meet until the 13th inst., but delay will perhaps be avoided if your Council can see its way to appoint a committee to deal with the matter.—Yours respectfully, JAS. A. LYCETT." Some divergence of opinion existed as to the proper committee for dealing with the matter—the Electric Lighting or the General Purposes—but it was decided to send the letter to both these bodies for consideration. The Tramways Committee have reported that in accordance with the wish of the Council a meeting of the clerks of the various authorities concerned in the new tramways scheme had been held, when the powers and liabilities under the agreement submitted by the Tramways Committee to the Council were fully discussed and considered. The committee recommended that the following clauses be added to the draft agreement: "(1) That in the event of this Council taking over or being vested with the powers under the Electric Lighting Acts, the said tramway company shall take from the Council a portion of the electric current required by them for the working of their trams, upon terms to be mutually arranged; (2) that the said tramway company shall pave with hardwood blocks the portion of the road between their rails, and 2ft. on either side thereof, from Lever-street to the point opposite the church gates, and shall maintain and keep the same in a good state of repair; and (3) that the said tramway company shall provide a depôt in the Council's district, so that early morning trams shall leave Brierley Hill to Dudley and Stourbridge." The committee recommended that, subject to the amendments, their report of July 9 last be now adopted. This report has been adopted.

Wolverhampton.—At the meeting of the Town Council on the 13th inst., the report of the Lighting Committee, who recommended that the "maximum demand system" of charging for electric energy be adopted, and that the price be fixed at 6d. per unit on maximum demand of two hours daily and 3d. per unit for all energy consumed in excess thereof, was adopted. In the course of the report the committee stated as follows: "In view of the satisfactory balance-sheet which your committee were enabled to present to the Council on June 14 last, showing that a profit of £225. 14s. 5d. had been made on the last year's working, they have had under their consideration the question of reducing the charge for electrical energy, with a view of further increasing the demand for the electric light, and making the undertaking a larger commercial success." The committee recommend (1) that "the maximum demand system" of charging for electric energy be adopted, and that the price be fixed at 6d. per unit on a maximum demand of two hours daily, and 3d. per unit for all energy consumed in excess thereof, and that any previous resolution of the Council

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to the contrary be varied accordingly; (2) that the committee be authorised to expend a sum of £370. 14s. 2d. in providing the necessary "demand indicators" for the adoption of this system; (3) that if necessary, application be made to the Local Government Board for their sanction to a loan of £370. 14s. 2d., and when obtained, that the Finance Committee be authorised to borrow all necessary moneys, and, if necessary, raise Wolverhampton Corporation stock for the purpose of defraying such sum, and that the corporate seal be affixed where required. The Chairman of the committee (Alderman Mander), in moving the adoption of the report, said he would just point out that the question of dealing with electricity was surrounded with a good deal of difficulty. It was very different to gas, because whilst they could store gas and use it when they thought fit without any appreciable loss, electricity, on the other hand, must, as far as possible, be produced as it was required. For instance, if a householder or a tradesman desired to have a large installation for the supply of electric power put down at his place, and only desired to use it occasionally, the committee must still be prepared for supplying the electricity whenever the consumer wished to light his lamps. The consequence was that where they had many customers of that character they would either have to make a loss on the electricity they produced, or have a large portion of their machinery standing idle at certain periods. What the committee desired was to induce a large number of people in Wolverhampton to adopt the electric light, and to use it with some degree of regularity for such number of hours each day as would enable the committee to supply the electric energy used, above a given quantity, at a lower price per unit than they did at present, and at the same time realise a profit for the Corporation.

Arbitration between Gas and Electric Light Companies.—Major-General Scott, one of the arbitrators of the Board of Trade, attended at the Northampton Town Hall last week to arbitrate in the matter of the Northampton Electric Light and Power Company, Limited, and the Northampton Gaslight and Coke Company. Mr. E. M. Browne, solicitor and secretary of the electric light company, appeared for the applicants; and Dr. Faulkner for the respondent company. The electric light company, who, it was stated, had now nearly 2¼ miles of culverts in the town, had, it was explained, uniformly made deep culverts, deep enough to permit the service pipes of the gas company to go over them. Deep culverts, however, are expensive, extremely difficult to inspect, and consequently dangerous from possible accumulations of gas, liable to accumulations of water, and from their general inaccessibility an inconvenience to the public. Mr. Browne, in the course of his opening remarks, pointed out that though the extra expense of deep culverts—£190 a mile—fell on the shareholders, ultimately it would fall on the ratepayers, who would eventually undoubtedly become the owners of the company. At the present time he had a proposal from the Corporation to purchase the company. The electric light company now asked the arbitrator to decide, in certain streets mentioned, that for the future they should be able to depress the service pipes of the gas company so that the electric light culverts could be made above them. All expenses of alterations would of necessity be paid by the electric light company. On the part of the gas company it was stated that no impediment had ever been placed in the way of the electric light company altering the gas service pipes if it could be done without detriment to the gas supply. Generally, however, the mains in Northampton were not very deep, and a depression of the service pipes would mean that the fall in their level would be from the main to the house, instead of from the house to the main. The result would inevitably be that very soon water would collect in the service pipes, and the supply of gas would be stopped. The gas company did not offer any serious objection to the alterations being made in those places where they felt it could be done safely. The difference between the parties, as disclosed in the arbitration proceedings, was chiefly as to the relative depth the gas-main must be in regard to the electric light culvert to enable the gas service pipes to the houses to go under the electric light culvert. The witnesses called for the electric light company went to show that by connecting the service pipes with the middle and not with the top of the gas-main, practically in every case where the top of the gas-main was not higher than the bottom of the culvert, the service pipes could safely be taken underneath. Mr. Eunson, the manager and engineer of the gasworks, explained that in Northampton the service pipes were connected with the top of the gas-main, that being the best and most economical method. He considered that it was not absolutely safe to have less than 6in. between the top of the gas-main and the bottom of the electric light culvert, but he would be able to manage, he thought, with a minimum of 4in. The arbitrator said that he would deliver his opinion in due course: he did not think there would be much delay.

Brighton.—The Brighton Corporation electricity undertaking continues to make remarkable progress. There have never been so many new applications for the supply of the illuminant as this year, as shown by the fact that up to the present they number 222, as compared with 204 in 1896, 132 in 1895, 128 in 1894, 122 in 1893, and 74 in 1892. This is doubtless due to the very low price at which electricity is being supplied in Brighton. It is lower this year than in any other town in the United Kingdom, the average working out at under 3½d. a unit. For reasons that are perfectly obvious, the supply in the summer is, under normal conditions, only a third of what it is in winter, and in view of the near approach of the "busy" season the manager of the electricity works (Mr. Arthur Wright) has had the necessary arrangements closely under his superintendence. In accordance with custom, the plant at the Corporation electricity station in North-road has been thoroughly overhauled, and extensive preparations—judging by the increased demand for the light—are in progress for the installation of new machinery and new boilers. The chief additions to the plant will be three very powerful water-tube boilers capable of steaming for more than 500 h.p. each, two large steam-engines of 800 h.p., and a large condensing plant for use in connection with them. Their installation has already commenced. Provided the present rate of progress does not diminish, it is computed that at the end of the year 2,000,000 units will have been sold, and probably over 1,700 ratepayers will be consumers of the light. Perhaps one of the most surprising facts connected with the development of electricity in Brighton is the exceptionally large number of private houses in which the light is used. It is claimed by those who have taken a prominent part in the development of the industry that they have brought the light not only within the reach of the poor, but that it can be had by them cheaper than gas. The number of motors electrically driven in Brighton, too, is rapidly increasing owing to the low rate at which electricity for this purpose is supplied. The striking growth of the number of electricity consumers in Brighton is attributed in no small degree to the very liberal policy the Lighting Committee has adopted of running mains in all parts of the town, whether occupied by the wealthy or the poorer classes. Some idea of the size of the undertaking may be gathered from the fact that the amount of coal required at the North-road station will reach 7,000 tons this year. The Shoreditch Vestry have carried out a scheme by which, instead of using coal to produce the steam necessary for driving electric machinery, they burn up the refuse from the ashbins; but the enormous horse-power required at the Brighton works puts the question of its utilisation there for a similar purpose entirely out of the question. At Brighton the policy has been not to make profit by supplying the light at a highly remunerative price, but to serve the ratepayers at the lowest possible cost. This, it is contended, should be the sole object of a municipality in undertaking electricity supply; and to illustrate the unfairness of the policy pursued elsewhere, it is pointed out that it benefits large numbers who have never used the light at the expense of those who have. Another result of such a policy is to limit the use of the light to the few. Brighton's policy has been entirely the reverse—to reduce the price of the light as much as possible consistent with financial safety, and not to look upon the electricity undertaking as a profit-producing department. This, it is urged, is one of the reasons why no other town can boast of such a private supply as Brighton, which numbers something like 600 private houses among its customers.

PROVISIONAL PATENTS, 1897.

SEPTEMBER 6.

20428. Improvements in cells for batteries, and connections therefor. Archibald Edward McKechnie, 9, Blandford-square, London.

20444. Improvements in and relating to telephones. Charles Junge, 75, Chancery-lane, London. (Carl Kraft, Carl Huber, and I. Josef Exner, Roumania.) (Complete specification.)

20449. Improvements in current-conducting rails for electric railway systems. Louis Edward Walkins and George Manypenny Jewett, 40, Chancery-lane, London.

20455. An electric igniter for internal-combustion engines. Peter Jensen, 77, Chancery-lane, London. (Charles White and Arthur White, United States.)

SEPTEMBER 7.

20486. Improvements in and connected with the electro-deposition of copper and other metals on rotary cathodes. William Edwin Heys, 70, Market-street, Manchester. (The Electrical Copper Company, Limited, France.) (Complete specification.)

20493. Improvements in and connected with the transmission of energy by alternating currents. Charles Schenck Bradley, 70, Market-street, Manchester. (Complete specification.)

20496. Improvements in surface-contact electric railway systems and in apparatus for use therewith. The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. (William B. Potter, United States.) (Complete specification.)

20497. Improvements in and relating to surface-contact electric railway systems. The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. (William B. Potter, United States.) (Complete specification.)

20498. Improvements in surface-contact electric railway systems. The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. (William B. Potter, United States.) (Complete specification.)

20499. Improvements in and relating to closed-conduit or surface-contact electric railways. The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. (William B. Potter, United States.) (Complete specification.)

20500. Improvements in and relating to surface-contact electric railways. The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. (Lee H. Parker, United States.) (Complete specification.)

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20501. Improvements in and relating to surface-contact or closed-conduit electric railways. The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. (William B. Potter, United States.) (Complete specification.

20502. Improvements in and connected with surface-contact railway systems and in apparatus for use therewith. The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. (William B. Potter, United States.) (Complete specification.)

20503. Imp ovements in surface-contact or closed-conduit electric railway systems. The British Thomson-Houston Company, Limited, 70 Chancery-lane, London. (William B. Potter, United States.) Complete specification.

20521. Improvements in electrical signalling apparatus and circuits. Edward Hopson Owen, Charles Nelson Williams, and Fred Hamilton Donaldson, 78, Fleet-street, London. (Complete specification.)

20583. An improvement in electric arc lamps. James Brockie, 28, Southampton-buildings, Chancery-lane, London.

20591. Improvements in electric tramway and electric transmission of pewer systems Charles William Godson Little, Herrick House, Lewisham, London.

SEPTEMBER 8.

20596. Improvements in or connected with anodes for apparatus for the electro-deposition of metals. Albert Frederick Harris, 12, Cherry-street, Birmingham.

20663. Improvements in electrically operated jigging machinery. Arthur Bergtheil, Henry Wilson-Young, and Alfred Brown, 1 Queen Victoria street, London.

20666. Improvements in dynamo-electric machines and motors. Sidney George Brown, 45, Southampton-buildings, Chancery-lane, London.

20669. Improvements in or connected with automatic brakes for electrically driven machines. Alexander Bewicke Blackburn and Wilfrid L. Spence, 47, Lincoln's-inn-fields, London.

SEPTEMBER 9.

20703. Imp-oved metallic diaphragm for electrolysis. Brodde E. F. Rhodin, 104, Gilda Brook road, Eccles, Lancs.

20732. Improvements in or relating to electric signalling apparatus for railways. George Frederick Gascoyne, 111, Hatton-garden, London.

20781. Improvements in the generation and distribution of electricity by means of alternating currents and appliances connected therewith. Llewelyn Birchall Atkinson, 1, Queen Victoria-street, London.

SEPTEMBER 10

20831. Improvements in conduits applicable for wires for conveying electricity. John James Bate, 6, Lord-street, Liverpool.

20834. Improvements in arc lamps. Joseph Devonport Finney Andrews, 45, Fulham Park-gardens, Fulham, London.

20845. Improvements in accumulators or secondary batteries and in means for transporting the same. Adolph Müller, 4, South-street, Finsbury, London.

20865. Improvements in and re'ating to primary batteries for light motive power and like purposes. Wilhelm Decker and Georg von Struwe, 18 Southampton-buildings, Chancery-lane, London. (Complete specification.)

SEPTEMBER 11.

20883. Improvements in apparatus for working electric tramways by means of underground cables. Chris Anderson, 65, Albion-street, Leeds.

20913. Machine for painting electric casing and the like. George Hawkins Cutting and George Cutting, 98, Uttoxeter New-road, Derby. (Complete specification.)

20914. Improvements in coin-freed electricity meters. Francis Charles Raphael, 1, Salisbury-court, Fleet-street, London.

20919. Improvement in electric fire alarm system. John Laurence Walker and George Brosnoham Walker, 40, Chancery-lane, London.

20923. Improvements in elect ic heaters. Edward Ethel Gold, 55, Chancery lane, London.

20943. Improvements in the construction of guards or protectors for incandescent electric lamps and other glass or breakable articles. James Dickson and Henry Ernest Brown, 8, Quality-court, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1896.

7649. Electric cables. Edmunds. (Amended.)

15856. Electric clock. Pallweber and Kolbe.

18103. Electricity and other supply meters. Gillespie and Wynne.

18537. Apparatus intended to determine the quantity of metal which a galvano-plastic bath should deposit on the object treated. Ducot.

18908. Writing desk or slab, more particularly applicable as an adjunct to telephone receivers. Lehfeldt and Stevens.

20604. Electrical resistances. Mordey.

22046. Electrical switches. Crompton and Pochin.

22194. Process for carbonisation of peat by electric heating. Jebsen. (Date applied for under International Convention March 13, 1896.)

22552. Apparatus for electrically actuating the stopping mechanism of engines, motive power, or machinery, in cases of accident or otherwise, in part applicable to other purposes. Stone.

22585. Fittings for electric light and like purposes. Byng.

22886. Closed-conduit system of electric railways. Balfour and Smith.

23084. Cell for controlling the direction of flow of electric currents, or retarding such flow, and for like purposes. Thompson. (Grätz.)

23258. Primary electric batteries. Preston and Simkin.

25010. Magnetic apparatus for effecting reciprocating motion. Hopkinson.

25290. Electric meters. De Bauw.

1897.

1087. Pipes and conduits used for electric cable mains and jointing the same. Simmons.

1572. Electrolytes for the deposition of zinc and for use in secondary batteries. Leitner.

8725. Art of, and apparatus for, generating and distributing music electrically. Sloan. (Cahill.)

12974. Electrical telegraph systems and apparatus therefor. Lake. (Burke.)

13117. Electric motors and motors for alternating, pulsating, or intermittent currents. Packard. (Date applied for under International Convention, October 26, 1896.)

13422. Coin-freed mechanism for electric lighting of vehicles. Imray. (La Société Anonyme d'Etudes et d'Exploitation de l'Accumulateur "Eclair.")

15876. Writing telegraphs. Newton. (McPherson.)

15877. Means for feeding electricity to railway and similar vehicles. Cerebotani and Moradelli.

16942. Electric furnace for the application of polyphase currents in processes of fusion or decomposition by means of the voltaic arc. Bertolus.

17092. Electro-depositing devices. Bossard.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	£	9½-9¾
Brush Company, Ordinary	£	¾-1
—— Non. Cum., 6 per cent. Pref.	£	1¼-1½
—— 4½ per cent. Debenture Stock	100	103-107
—— 4½ per cent. 2nd Debenture Stock	100	94-98
Callender's Cable Company, Debentures	100	108-113
—— Ordinary	£	6¾-7¼
Central London Railway, Ordinary	10	9¾-10⅛
——	£	5¾-6¼
Charing Cross and Strand	£	12½-13½
Chelsea Electricity Company	£	10-10⅜
—— 4½ per cent. Debentures	100	110-113
City of London, Ordinary	10	25-26
—— 6 per cent. Cumulative Pref.	10	17-18
—— 5 per cent. Debenture Stock	100	130-135
City and South London Railway, Consolidated Ordinary	100	66-68
—— 4 per cent. Debenture Stock	100	138-140
—— 5 per cent. Pref. Shares	10	15½-15¾
County of London and Brush Provincial Co., Ordinary	10	12¾-13¼
—— 6 per cent. Cum. Pref.	10	15½-15¾
—— 4½ per cent. 2nd Debenture Stock	10	15-15¼
Crompton and Co., 7 per cent. Cum. Pref. Shares	£	1½ 2
—— 5 per cent. Debentures	—	89-94
Edison and Swan United Ordinary	£	2½-2¾
—— 5 per cent. Debentures	£	4-4¼
Electric Construction, Limited	£	1¾-2
—— 7 per cent. Cumulative Pref.	£	3-3¼
Elmore's Copper Depositing	1	⅛-¼
Elmore's Wire Company	£	⅜-½
W. T. Henley's Telegraph Works, Ordinary	10	18½-19¼
—— 7 per cent. Preference	10	18-19
—— 4½ per cent. Debentures	100	109-114
House-to-House Company, Ordinary	£	9-9¼
—— 7 per cent. Preference	£	10¾-11¼
India Rubber and Gutta Percha Works	10	21-22
—— 4½ per cent. Debentures	100	105-108
Kensington and Knightsbridge Ordinary	£	13½-14¼
—— 6 per cent. Pref.	£	8½-8¾
London Electric Supply	£	1¾-2
Metropolitan Electric Supply	10	17-18
—— 4½ per cent. First Mortgage Debenture Stock	100	118-122
National Telephone, Ordinary	£	6¾-6⅞
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	15-17
—— 5 per cent. Non. Cum. Third Pref.	£	6-6¼
—— 3½ per cent. Deb. Stock	100	105-110
Notting Hill Company	10	15-16
Oriental, Limited, £1 shares	1	1¾-2
—— £5 Shares	£	8-8½
—— £4½ shares	4½	7¼-7½
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	104-106
St. James's and Pall Mall, Ordinary	£	16¾-17¼
—— 7 per cent. Pref.	£	10-11
Telegraph Construction and Maintenance	12	36-39
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	8	10¾-11¼
Westminster Electric Supply, Ordinary	£	14¾-15¼
Yorkshire House-to-House	£	8-8¼

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NOTES.

Honour for Lord Rayleigh.—The Swiss Society of Natural Science has elected Lord Rayleigh as an honorary member.

Telephones.—The Glasgow Chamber of Commerce have passed a resolution by 40 votes to 14 in favour of telephones being taken over by the Government.

The Telegraph in the Soudan.—Telegraphic communication has now been established with Abu Hamed, and the line is being rapidly pushed forward towards Berber.

A Cable Steamer Disabled.—The cable steamer "Silvertown," from London, bound for the North Atlantic, in connection with the Atlantic cables, put into Queenstown on Friday morning with her machinery disabled.

The Simplon Tunnel.—Mr. Brandt, the engineer to the projected Simplon Tunnel, proposes to make his excavations with an electric drill faced with carborundium, or black diamonds. The tunnel will be about 12½ miles long. Electricity will also be employed for the purpose of lighting the works and for the necessary haulage.

Neuchatel.—The electric works of Chaux de Fonds have an output, taking both lighting and power, of 329¾ h.p. As regards power, 240½ h.p. is taken to drive 49 motors, while lighting utilises 89½ h.p. The number of incandescent lamps is 964 and arc lamps 16, and there will shortly be installed 147 incandescent lamps and three arc lamps in addition.

Swiss Enterprise.—It appears that the canton of Vaud (Switzerland) thinks of taking into its own hands the utilisation of the motive powers of the Lac de Joux. If this is decided upon, the canton will be the only concessionaire—or grantee of rights—and will be in a position to supply electricity at a lower price than the most successful company.

The Late Galileo Ferraris.—The Municipality of Leghorn have erected a monument to the memory of Galileo Ferraris, bearing the date of his birth (October 31, 1847) and also the date of his death (February 7, 1897). The authorities at Rome also have founded a scholarship to perpetuate his memory, which will take the form of a biennial prize for inventions in the application of electricity.

The Dundee Tramways.—Very great extensions of the tramways of Dundee are in contemplation by the Town Council, and if carried out they will run into a total of over £27,000. As regards the motive power that is a subject for separate consideration, but as the committee have been instructed to obtain the advice of an electrical expert it is more than likely that electricity will be adopted.

Rapid Development in Electrical Industry.—An interesting item of news is published in the *Revue Industrielle*, showing the rapid growth of establishments for the production of electricity in Allemagne. In 1894 there were 148; on October 1, 1895, they had increased to 185, and by March 1, 1897, the number had gone up to 265. Since then 11 new works have sprung into life, bringing the actual total up to 276.

Haste to the Wedding!—Considerable interest and some diversion has lately been caused by the appearance of electric cabs at weddings. People who believe in omens and signs and wonders, and who always contemplate with fear some horrible diversion on the part of the horses attached to the bridal carriage, will for the future be able to attend weddings with a serene mind, for they have at their disposal a motive power which does not kick, is not likely to run away, and cannot blow up.

Co-operation.—The International Co-operative Congress at Delft have passed a resolution of the third section expressing the desirability that rural co-operative associations should combine all kinds of co-operative enterprise in a central organisation except credit co-operation, which, in the opinion of the section and the congress, requires separate organisation, though it can be connected with the central organisation.

Proposed University College at Swansea.—The *Athenæum* says that a proposal is being considered to establish at Swansea, as a great manufacturing centre, a branch University College in association with either Aberystwith or Cardiff, as the Newcastle College is associated with Durham. The suggestion is that scientific and technical courses might be taken at Swansea in preparation for the Welsh University degree.

Central London Railway.—The first junction of the tunnels between Holland Park and Notting Hill Gate Stations was successfully made on Saturday night. The following junctions will be made before the end of the current year—viz., Shepherd's Bush Station and Woodhouse Park (the generating station), Shepherd's Bush and Holland Park Stations, and Queen's-road and Westbourne Stations, and in February, 1898, the last junction of No. 1, 2, and 3 contracts will be made between Notting Hill Gate and Queen's-road Stations.

Cassier's Magazine.—The marine number of *Cassier's Magazine*—of which we have received a copy—is, one might say, a marvellous work, and will be of great interest especially to those who concern themselves with naval matters, as well as to engineers of all classes. There are 17 well-written articles on a number of subjects relating to ship design and construction, both as regards abstract principle and details of working. It contains an enormous number of illustrations and diagrams, and altogether forms a most valuable work of reference.

Birkbeck Institution.—This institution will commence its seventy-fifth session on Monday, the 27th inst. More than 200 evening classes meet weekly in about 70 different branches of science, in art, and in languages, mathematics, literature, commerce, law, mental science, music, technology, etc. Special classes prepare for London University and the Civil Service. The last report shows that there were 4,442 class entries in the October term, and that during the year 80 students passed some university examination, while large numbers gained successes at various public examinations.

City and Guilds Technical College.—A special course of instruction in electro-chemistry will be given during the coming session at the City and Guilds Central Technical College. The course will include practical instruction in electro-deposition, the use of the electric furnace, dynamos, transformers, and accumulators. A great part of the time of the students attending this course will be devoted to electro-chemical research and the study of electro-chemical action. The honorary secretary (Mr. John Watney) informs us that candidates for admission will be required to submit evidence of having a general knowledge of physics and chemistry, and of having been specially trained in one of these subjects.

Telegraphists' Grievances.—The Duke of Norfolk has written to Mr. A. Newton, of the Postal Telegraph Clerks' Association, in which he points out that the various assertions which that gentleman mentioned as having been made respecting the pay, conditions of service, etc., of

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telegraphists in the employment of the Department "are not in accordance with the facts," and he further hints that if the telegraphist, who is employed "during the pleasure of the Postmaster-General," does not do what is required of him, that pleasure may cease, and with it the employment. The London executive of the Postal Telegraph Clerks' Association has decided to employ the services of counsel to determine the legality of the statements contained in the letter.

The Telephone in Ireland.—The new telephone trunk line has been successfully opened between Limerick, Cork, and Dublin, giving communication with all the large towns throughout the kingdom. The new circuit consists of two hard-drawn copper wires, each weighing 400lb. per mile, and of about 7½ gauge. The resistance of the wire to the electric current is only 2½ ohms per mile, or about one-seventh that of ordinary telegraph iron wire of the same gauge employed. The Post Office engineers have had to run the wires with a "twist," like the strands of a rope, the two wires making a comple revolution every four spans. This was done with the object of shutting out the interference and inductive noises from the adjacent telegraph wires, and it is said to be completely successful.

Killed by an Electric Cab.—The first fatal accident in connection with the electric cabs occurred on Wednesday. It was due solely to childish curiosity, and had about it none of the disquieting elements to which we are becoming accustomed in relation to the other forms of motor vehicles, though the effect will probably be some alteration and additional safeguarding in the construction of the electric cabs. The vehicle in question was in Hackney, and, of course, attracted the attention of all the small boys of the neighbourhood. Several of them tried to get on at the back of the cab, and one little fellow about eight years old succeeded in doing so, but his clothing was caught, and he himself was dragged into the cog wheel and killed. He was so firmly fixed in the machinery that the wheel had to be taken off before his body could be got out.

Rontgen Rays in Medical Diagnosis.—The *Lancet* contains an article by Mr. H. Campbell Thomson, M.D., the medical registrar to the Middlesex Hospital, giving details of cases in which the X-rays had proved of great service for purposes of diagnosis. The four cases quoted were suspected of suffering from aneurisms, and the examination in each case proved the supposition to be right, distinct shadows of the aneurism being marked on the plate. The fluorescent screen was used, as it is more certain and far less tedious than photography for making examinations of the chest. Dr. Thomson concludes by remarking that when a patient complains of thoracic symptoms, and physical signs prove nothing, it is in many cases a useful corroboration to know that the Röntgen rays show nothing also, and such a result has in several cases further strengthened the diagnosis.

The Royal Photographic Society.—The forty-second annual exhibition of the Royal Photographic Society is now in course of preparation, and will open to the public on Monday, September 27. A private view will be held on Saturday, 25th inst., followed in the evening by a conversazione, at which the president (the Right Honourable the Earl of Crawford, K.T., F.R.S.) and council will receive the Fellows, members, and their friends. The judges on this occasion are: In the Art Section—F. P. Cembrano, jun., B. W. Leader, A.R.A., Sir J. D. Linton, P.R.I., G. A. Storey, A.R.A., W. L. Wyllie, A.R.A.; and in the Technical Section—Captain W. de W. Abney, C.B., D.C.L., F.R.S., Chapman Jones, F.I.C., F.C.S, and Andrew Pringle, F.R.M.S. The exhibition will be open daily from 10 to 5, and on Monday, Wednesday, and Saturday evenings (when lantern slides will be shown) from 7 to 10, and will close on November 13.

Electricity in Mines.—An extensive electric lighting plant has been laid down in the Kimberley (De Beers) mine. The first test was made a few weeks ago in the presence of Mr. G. Labram, chief engineer; Mr. J. Liddle, assistant engineer; Mr. McCracken, foreman electrician of the Kimberley mine department, and other officials, and was eminently satisfactory. The engines are of the tandem compound type, the high-pressure cylinder being 11in. diameter, the low-pressure 19in. diameter by 15in. stroke, and with 120lb. of steam, at a speed of 250 revolutions per minute, the engines are capable of developing 170 i.h.p. The engines drive two 50-kw. six-pole compound-wound dynamos, one of which generates at a pressure of 220 volts with an output of 228 amperes, the other at a pressure of 115 volts with an output of 435 amperes. The machinery was supplied by the General Electric Company of New York.

The Engineering Crisis.—It is stated that the prospect of a conference between the parties to the present engineering dispute, under the auspices of the Board of Trade, is now more hopeful, and that there are other indications of a probable settlement. Mr. Ritchie, it is said, has returned to London to assist in the negotiations, and is understood to have already arranged personal interviews with the leaders on both sides. On the other hand, a Manchester correspondent telegraphs to the newspapers that there is nothing what ever in the situation there to justify any hopes of a settlement of the engineering dispute. The employers openly declare they will allow no outside interference, and they will remain absolutely impassive until the men are forced to come to them with proposals; while the men, though willing to agree to a conference, now recognise that the struggle is one of life and death.

The Cost of Arc Lighting.—Was it not a cynical writer who said there was nothing more deceptive than figures except facts? There is no doubt about the truth of the former part of the remark, although we should cavil at being compelled to assent to the latter. We have always declared that a comparison of the cost of electric lighting, whether arc or incandescent, must necessarily be very deceptive unless the details in each case are known. Our American namesake comments upon a compilation of the figures giving the cost of arc lighting where nearly 11,000 different installations are considered with 300,000 lights, scattered over a large area. Taking the time of burning at 3,326 hours per year, and coal at 12s. 10½d. per ton, the average cost comes out at about £21. 3s. 1d. per year. It is interesting to note these things, but so many factors enter into each special case that it would be difficult to foretell the cost unless due consideration were given to those factors.

Reduction of Telephone Rates.—As we briefly announced last week, the Postmaster-General has issued notifications of reduced rates for private wires and telephone exchange wires which will come into operation on October 1. The Department reserves to itself the right to vary these new rates under special circumstances. It is also notified that telephone wires to the Central Telegraph Office can be used by the renters for communicating with Paris over the London-Paris telephone and for communicating with towns on the inland trunk-wire system, on payment of the appropriate fee for each conversation. Reduced rates for private wires have been fixed for the provinces as well as London. As examples of the new rates, it may be mentioned that the cost for a Post Office telephone exchange wire, within a radius of one mile from the exchange, will in future be for places of business £10,

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and for private houses £9 per annum, and for places within a radius of half a mile the rentals will be respectively £8 and £7.

The Wireless Telegraphy Experiments.—The experiments in wireless telegraphy at Dover seem to be meeting with success, and up to the present have proved very encouraging. In the experiment made last Friday, in which the South Foreland lighthouses were made the objective, messages transmitted from Fort Burgoyne were easily read. As the transmitter is only at one end, the ordinary means of signalling with the heliograph, etc., is adopted between the points. The accumulators used for the experiments are charged daily at the Dover electric light works. The induction coil used is a powerful one, and the messages are transmitted from a vertical wire carried up a pole. The application of the system to light-ships is to form a portion of the experiments at Dover.—Prof. Slaby, of the Berlin University, has had an opportunity of showing before the German Emperor and Empress some experiments on Signor Marconi's system, and succeeded in sending messages a distance of 2,000 yards and over without difficulty.

Engineering Education.—It must be a bold man who would suggest the formation of another society, but really the Americans do seem to have found out a path-in which there is ample scope for good work. They have organised a society for the promotion of engineering education. It may be said that all our technical societies are societies for this purpose. So they are, in a measure, but they are not directly educational. If we examine into the methods pursued in various educational establishments, we shall find that they differ greatly, and in scarcely any single instance is there a consensus of opinion as to which is the best method to pursue. We have also a number of examining bodies, but the examinations have for the most part a special object, and are not for the education of an engineer. During the past few years we have seen that great divergence of opinion exists as to the best method, for example, of teaching electricity. Surely it would be the aim of such a society as that in America to which we have referred to discuss, and in a manner to decide upon, the means whereby a boy should have inculcated the principles of a science in the best manner calculated to save time and to provide him with the necessary knowledge that he would require in engineering practice.

Opening up China.—An effort is being made by a representative body of diplomats, officials, missionaries, and merchants in China to establish at Pekin "an International Institute," with the object of communicating to China and the Chinese Western ideas of progress and science. For the management of the institute proper regulations have been framed which have received the official sanction of the Imperial Board of Foreign Affairs, while Li Hung Chang, Chang Chih Tung, and other Chinese statesmen are giving the undertaking their active individual support. So far little or no effort has been made to reach the influential classes in China. Yet it is an admitted fact that it is the mandarins who really govern the people of China, and without their assistance it is impossible to make much headway with the rank and file. The institute, as it is projected, is to consist of a large auditorium, where public lectures will be delivered, as far as possible, to the educated and official classes in Pekin. In connection with the institute there are to be small classrooms, where more technical lectures will be given. There is also to be a museum, where models of machinery and the latest Western inventions are to be on view; a library, including both foreign and Chinese books, will be built, and reception-rooms erected. By this means an almost limitless field for commerce and industries may in time be opened up, and where civilisation is there is also electricity to be found.

A Standard Arc Lamp.—It has become customary to express the lamplight at electric light stations in terms of 8-c.p. lamps; but although we all agree to speak of 8-c.p. lamps, the agreement as to the watts of such lamps is by no means unanimous. As we have mentioned several times, we prefer to have a standard of 35-watt lamps; some engineers prefer 32 watts, and others some other number. The Americans have decided as to a standard for arc lamps. They make the standard a 2,000-c.p. lamp, consuming 450 watts at terminals, or having a current of 10 amperes and 45-volt drop. We have often advocated that our Institution of Electrical Engineers should extend its functions slightly, as it might easily do without any difficulty, so as to standardise writers' and speakers' views on various questions. The way the Institution could proceed would be to insist that every author and speaker reported in its *Proceedings* should express their views in the same terms. Thus, when a speaker or writer spoke of 8-c.p. lamps, it should be understood that he was speaking of a 35-watt lamp or as an N-watt lamp, N being the number determined by the Council of the Institution. Similarly with arc lamps. This in the course of a year or two would bring all people connected with the Institution at any rate into line, and undoubtedly the influence exerted in such a manner would compel authors of text-books and writers in technical periodicals to follow in the same direction.

Electricity v. Compressed Air.—Sir Arthur B. Forwood, the chairman of the Liverpool Corporation Tramway Committee, has written to the Glasgow Corporation in response to their request for his opinion on the present position of tramway traction. While admitting that at present electric traction is the only mode which has got beyond the experimental stage, Sir Arthur evidently has his eye on the compressed-air system. The Liverpool Corporation are experimenting with the overhead trolley system on about three miles of their trams, and if the eyesight of the working citizens of Liverpool be not offended thereby, that system will probably be applied to the entire network, extending to about 100 miles. If, however, the poles and wires are found to be objectionable, it will be abandoned. The conduit systems will also go by the board on account of expense, and the compressed-air system remains. Sir Arthur Forwood says it is cheaper to instal than the overhead trolley, and fully as economical in working and maintenance. He, however, advises the rails to be bonded so as to be available for electric traction, but before installing electricity to let a trial be made on these lines with compressed-air cars. If the Glasgow Corporation do this, we hope they will publish full particulars of the cost and all working details, so that we may be able to form a true comparison. We do not at all fear the result of such a comparison so long as the two systems are placed on an equal base.

About Glasgow.—We are very glad indeed to see that the Glasgow Corporation Committee on Electricity have expressed their inability to acquiesce in the proposal by the Lord Provost for the consolidation of the tramways and electricity enterprises. In the first place, we are distinctly averse from the idea of tramways being maintained and worked by local governing authorities. The line must be drawn somewhere, and although we may be a "nation of shopkeepers," we do not want all the shops owned by the people we elect to look after our domestic comfort. For a corporation to hold the lighting and water undertakings in their hands is one thing, but if they start

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running the tramways they may as well buy up all the co-operative stores and gin palaces. Water and light are necessities, and as such ought to be freed from the insecurity and uncertainty of private enterprise, but tramways can scarcely be classed as "necessities" any more than electric cabs or motorcars. It is in the hope—vain hope, perhaps—that some day the Glasgow Corporation will see fit to de-municipalise their tramways that we are glad this undertaking will be kept apart from the somewhat allied department of electricity; and we also hope that in the future municipal authorities generally will recognise the wisdom of leasing the tramways to private enterprise, with the condition that the motive power (electricity) shall be procured from the corporation supply. We do not so much object to the combination of departments, but that is a matter that requires to be carefully considered more from its local aspect than from general principles, and we think it could best be accomplished, if desirable, by having one committee to give finality, and two sub-committees to thrash out the details and make recommendations. It is rather too hard work to impose on one committee the duty of settling such things as tram fares one minute and lighting tariffs the next.

Ourselves or Brother Jonathan.—Our contemporary the *Western Electrician* takes to heart the comments made in the technical Press in this country upon the suggestion of the Liverpool authorities to employ Mr. Pearson as their consulting engineer for traction purposes. Our contemporary, whether wilfully or otherwise, really misreads the expressions of opinion made upon this side of the water. We do not assume a knowledge and experience which are lacking; we do not claim originality in design that cannot be shown. What we and our contemporaries pointed out was that we have in England several engineers possessing knowledge, experience, and originality second to none in America or any other country, and we hold that for a town of the importance of Liverpool to employ a consultant from the other side of the Atlantic whose experience was rather Transatlantic than English, would be a step in the wrong direction and a great mistake. We have always contended that the condition of affairs in America is vastly different to the condition of affairs in England; that few of the American towns are in anything like the same position or condition as are English towns of the same size. For instance, the American towns are mostly of recent origin, and their streets are regular and wide, while, on the contrary, many of the English towns have cramped, winding streets, and excess of room is the exception and not the rule. The traffic over our streets, especially in many of the larger towns, can hardly compare with the traffic over the streets in any other country in the world, and our engineers at home thoroughly understand the difficulties they have to contend against. Their experience has been gained most largely in our own towns, and we hold that they are better able to judge what is required than an engineer, however wide his experience may be, the major part of whose experience has been gained under conditions which do not exist here.

Concession of Electricity.—The Paris *Electricien* publishes in full the text of an application for a concession for the distribution to the public of electric energy in the parishes of Puy, Brives-Charensac, Chadrac, Aiguilhe et Espaly-Saint-Marcel, lodged by M. Farigoule, a merchant of Puy, in the department of Haute-Loire. The concession proposes to utilise for the production of electricity a waterfall on the Loire at Ribeyres, near Brives-Charensac, of 200 h.p., other waterfalls on the Loire between Brives and Cussac, and steam-engines installed near the area of distribution with at least 200 h.p. Power is asked to carry the wires through any private or public property in the towns mentioned above, and also in all parishes within a radius of eight kilometres (about five miles) from the centre of the parish of Puy as may afterwards be found necessary on the application of interested parties or the concessionaire. These latter will have to receive the sanction of the Minister of Public Works. It is stipulated that the declaration of "public utility" conferred on the enterprise does not give the concessionaire in this case the right of dispossession. The concession then recites in detail all the rights and obligations of the concessionaire as to the erection and fixing of wires, the laying of conduits, etc. If a work is declared to be of "public utility," private property can be invaded to almost any extent—brackets and insulators can be erected on any building where it is convenient or necessary, poles can be erected and conduits laid on any private ground, and the holder of the concession pays no rent whatsoever for the accommodation. It must be admitted that this privilege is not abused to any great extent, presumably because it is found safer to carry the wires along the public roads as far as possible. An Englishman usually looks upon his home as his castle, and generally manages to find some way of keeping his property intact, but in France "public utility" is apt to destroy the charm of isolation. For instance, if a man obtained a concession for an electric tramway skirting the grounds of a house or château, and it were found more convenient to cut through those grounds, the owner would have to submit quietly, although very likely his property was being completely spoilt. But, after all, the submission is only natural in a country so full of liberty, equality, and brotherly affection. All cost of fixing and repairs has, of course, to be borne by the holder of the concession. The Chamber of Deputies have appointed a commission relating to the distribution of the energy at Puy, and have also referred to the investigation of that commission a Bill deposited by the Government which has for its object the establishing of general rules for the regulation of the distribution of electricity, and the facilitation of the evolution of the electrical industry.

Electric Lighting on the South Indian Railway. As we briefly stated in our last issue, the South Indian Railway Company have commenced to run a carriage between Madras and Trichinopoly lighted by electricity. From the *Indian and Eastern Engineer* we get the following particulars: The carriage is wired in two circuits, one for half lights and both together for full lights. The full lights will be used up to 10 or 11 at night, and the half lights for the rest of the night. The half-light circuit supplies a 15-c.p. lamp in the first-class bathroom; an 18-c.p. lamp in the first-class compartment; a 15-c.p. lamp in the servants' compartment; an 18-c.p. lamp in the second-class compartment; a 25-c.p. lamp in each second-class bathroom; and an 18-c.p. lamp in the second-class com partment. The other circuit, which will be turned on from dusk until 10 or 11 o'clock, supplies an 18-c.p. lamp and 25-c.p. reading-lamps in the first-class compartment; a 15-c.p. lamp in the servants' first-class compartment; and an 18-c.p. lamp in each of the second-class compartments, so that with full lights the work has 83 c.p., five in each of the three bathrooms, 26 in the first-class, 16 in each of the second-class compartments, and 10 in the servants' com partment. When the lights are all cut off, or when half the lights only are turned on, current is stored in eight E.P.S. batteries. The dynamo is shunt wound, and at a speed of 1,100 revolutions per minute produces a current of about 25 amperes at 16 volts. The dynamo is sus pended, so to speak, from one corner, so that the weight

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of the machine itself creates tension in the belt. There is a screw arrangement for taking up any slack that may arise through the stretching of the belt. One of the features of the system is the automatic switchboard, which is part and parcel of the dynamo. By means of this, connection between the dynamo and the storage batteries is not made until the dynamo is working at a sufficient speed to produce a current at least equal to that in the storage batteries, and again, when connection between the dynamo and the batteries is broken, the batteries are put in circuit with the lamps so as to keep the light in while the train is standing at stations. The lamps are Edison-Swan 16-volt B lamps, requiring 3·5 watts per candle, so that the power required for the carriage under consideration is 290·5 watts—0·38941 h.p., or a little over $\frac{1}{3}$ h.p. This experiment has been considered so successful that the agent has made up his mind to ask the board of directors to introduce Messrs. J. Stone and Co.'s system of electric lighting over the whole line.

Signor Marconi Speaks.—An interview with Signor Marconi, which has a great element of purpose about it, has been published by the *Daily Chronicle*, and may be taken as Signor Marconi's "statement of case." First he deals with the question of originality in relation to the Hertzian waves, and says that until the date of his experiment no mention was made in the scientific papers of the possibility of long-distance signals being transmitted by means of the Hertzian waves. Prof. Lodge, he says, in his work on the labours of Hertz, published in 1894, describes some experiments made with Branley's coherer, and mentions that electrical waves appeared to be "sensitive" to a distance of 40 yards. There is no mention in the book of signalling by means of Hertzian waves, and even Prof. Trowbridge says that unfortunately at the present time we cannot detect the electromagnetic waves at more than 100ft. from their source, whereas he (Signor Marconi) has sent intelligible messages for a distance of 12 miles over the open sea. He further states that the principle on which his coherer is constructed was discovered by Mr. E. Branley in 1889, and not by Prof. Lodge, but with neither of the two latter could a reliable signal be obtained any distance. He explains that the great improvement he has made to the Branley coherer takes the form of a contrivance for automatically tapping or shaking the tube in which the filings are contained. He makes the same current that passes through the coherer work an electromagnetic hammer, which automatically taps the tube while the electric waves are going through, and by keeping the filings from becoming conductive, maintains the full sensitiveness of the coherer. What he has really discovered is this, that by bringing one pole of the transmitter and one pole of the receiver in contact with the earth, and joining the other poles of the instruments to vertical conductors of suitable height, he can send a message 12 miles with an amount of battery power that would not obtain any effect at all even at 100 yards if used by the Branley, Lodge, or Righi apparatus. He ridicules the ideas that have been set afloat as to the power of his waves to blow up ironclads, regulate watches, or create motive power, but he believes in the inestimable benefits to be derived from the use of his system for communication between ships at sea, between the shore and ships, and between lightships and lighthouses and ships. It can also be employed in sending messages from one island to another where telegraphy is impossible, and as a preventative of collison and shipwreck. It has been proved that the transmission of electrical waves is not impeded by bad weather or fogs, or even solid substances, such as walls. As regards the conductors, the necessary heights which they ought to be is still a matter for future experiment. At Spezia, where the 12-mile message was sent, the conductor was 90ft. high, and the induction coil was much less powerful than the one used in England, the signals being obtained by a 6in. spark worked by a small portable battery of eight volts. Signor Marconi concludes by remarking that he did not come to the British authorities until his apparatus was completed, and he was not asking the British public for capital to enable him to work his invention.

Coal Calorimetry.—Some years ago, when paying a visit to Blackpool, we were agreeably surprised to hear that the then engineer, Mr. Hesketh, made a practice of testing the heat value of all coal sent in, and we have no doubt that the system is still continued under the able management of Mr. Quin. It ought to be one of the stock tests at all central stations to ascertain the calorimetric value of the fuel, and we are glad to see that this view is taken in a paper read before the Society for the Establishment of Science at Detroit by Mr. Charles L. Norton, who describes a modified Favre-Silberman calorimeter. The apparatus is constructed as follows: An outer water jacket of nickel-plated brass serves to protect the calorimeter proper from irregular radiation losses. The calorimeter, of thin nickel-plated brass, is cylindrical in form, being about 12cm. in diameter and 15cm. high. It has a loosely fitting cover with holes for the inlet and outlet oxygen tubes and ignition wire. The calorimeter is separated from the jacket by an air space, its position being maintained by cork spacing pieces. A rotary stirrer, driven by hand or by a small motor, is placed as near the side of the calorimeter as possible. When filled, the calorimeter holds about 1,000 grammes of water. The combustion chamber is supported on three legs in the centre of the calorimeter, and consists of a cylinder with its axis vertical. Its diameter is 5cm. and its height is 7cm. The top is a tight-screw cover, having at its centre a glass window protected by mica from the heat below. The bottom is a hemispherical shell, and is brazed on. It is penetrated by the inlet and outlet oxygen tubes, each about 5mm. in diameter. The products of combustion on leaving the combustion chamber pass into a flat box with a spiral partition, and then into a helical coil of tube about three metres in length, and finally escape at the top into the air. The outer end of the tube for supplying oxygen is above the cover of the calorimeter, from which point it passes downward through the water, penetrates the lower part of the combustion-chamber wall, turns upward and ends at the centre of the chamber. All parts of the combustion chamber and tubing are of copper nickel-plated The walls of the chamber itself are about 1mm. thick, and are gold-plated on the inside. It is to the receptacle for fuel that particular attention is called, as the successful working of the apparatus is largely due to this contrivance. A platinum crucible, with a hole in the centre of the bottom, is slipped over the end of the supply tube in the centre of the combustion chamber. At about half its height the crucible is divided horizontally by a disc of sheet platinum. This disc has a great number of fine holes near its edge, but it is not perforated near the centre. Upon the centre of this plate the sample of coal to be burned is placed. The disc fits into the crucible loosely and may be taken out for cleaning, a series of indentations made in the outside of the crucible serving to keep it in position. A tight cover, perforated with many fine holes, is made of platinum somewhat thinner than the crucible walls. The upper parts of the crucible walls are perforated with fine holes. A fine platinum wire, heated by a current, serves as a fuse. It is insulated from the crucible by mica washers, and ends in stout insulated terminals in the walls of the combustion chamber.

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ELECTRIC TRACTION ON COMMON ROADS IN 1895.

BY DESMOND G. FITZ-GERALD.

It seems but the other day—though it is not far from two years ago—that Mr. H. H. Cunynghame, at the Society of Arts, was explaining to a large and scientific audience the simple reason why electrical energy happened to be inapplicable for the propulsion of "locomotive carriages for common roads." "Attempts to turn heat directly into electricity have failed," said Mr. Cunynghame, "and the accumulators at present necessary were very heavy. A storage of 1½ h.p. to 2 h.p. is necessary. A horse-power equals, say, 700 watts, which would be afforded by, say, 30 accumulators, giving a current of 22 amperes. The weight would be about 1½ tons, which practically robbed the carriage of any carrying margin."

That was in November, 1895. On the preceding June 18 had occurred the historical race, or scramble, over the whole or a portion of the 744 miles to be traversed from Paris to Bordeaux and back, of 17 petroleum carriages, seven steam vehicles, two electric carriages, and two petroleum bicycles. Of these only 12 were able to reach Bordeaux, and no electric carriage was amongst them. Eight carriages—one worked by steam and the others by petroleum—completed the journey within the allotted 100 hours.

It was not a case in this trial of rolling along paved streets, nearly level, at seven or eight miles an hour. During the first part of the journey the gradients rise, sometimes abruptly, until, at Limours, the highest point is 168 metres above the sea-level. The pavements of most of the towns and villages through which the vehicles passed were ill-made and ill-kept. Some portions of the road were so rough and steep that the passengers were obliged to "get down and push behind."

At that period electrical vehicles were, as they are at present, totally unfitted for such a competition. No accumulator, subject to the lowest coefficient of traction, can transport itself through a distance of 100 miles. No carriage has been built to jolt along, with impunity and 1,200lb. of accumulators, over rough roads, steep hills, and French pavements "fanged with hideous stones." No relays of charged accumulators are practicable without organisation and a distribution of suitable dynamo machines with skilled attendants. It was merely as an experiment that the pretty electrical carriage of M. Charles Jeantaud, to carry four or six persons, was entered for the race; and the experiment was an unfortunate one. Shortly after leaving Paris an axle heated, and the defect could not then be remedied. The motor, designed by M. Rechniewski to give 7 h.p., was frequently called upon for 14 h.p. and 15 h.p. This was bad for the motor, and worse for the accumulators. Nevertheless, the vehicle ultimately accomplished the distance between Paris and Bordeaux, though not within the prescribed period; and the experiment afforded data which it is of interest to compare, not only with those assumed by Mr. Cunynghame, but also with those obtained in London and in New York, to which I have referred in this journal.

The battery was that designed by M. Donato Tommasi, of which the main features have been extensively copied, but not very successfully, in this country. It was constructed by the Société Fulmen. It was composed of 38 cells, each weighing 33lb. The total weight of the accumulator, without containing boxes, etc., was thus 1,254lb.; with accessories, the accumulator weighed 1,870lb. The total traction weight was 7,040lb. = 3·14 tons. The speed obtained on the level was 15 miles-per hour. The distance traversed, with one charge of the accumulator, was from 25 to 43·5 miles, according to the nature of the road. This works out to 78 to 136 ton-miles. The weight of battery per ton-mile—taking the accumulator with accessories—is from 14lb. to 24lb. Considering the nature of the road, this appears a most noteworthy result. In the New York streets the weight of battery required per ton-mile is from 30lb. to 33lb. In this country the lowest value is 33lb.

With a discharge extending over 10 hours, the capacity of the 33lb. cell was 300 ampere-hours. Thus, when $\frac{\text{amperes}}{\text{lb.}} = \cdot 9$, $\frac{\text{ampere-hours}}{\text{lb.}} = 9$.

The normal rate of discharge was 70 amperes, giving a ratio $\frac{\text{amperes}}{\text{lb.}} = 2{\cdot}12$. With this rate, the capacity was 210 ampere-hours, giving a ratio $\frac{\text{ampere-hours}}{\text{lb.}} = 6{\cdot}36$.

These are *both* very high values, and strike one as being "too good to be true." Yet I doubt not that they can be substantiated. There remains, however, the question of permanency—more or less rapid deterioration, or comparative durability.

For short periods of time the discharge was 200 amperes, giving the ratio $\frac{\text{amperes}}{\text{lb.}} = 6$. Barring the Tudor cell, it would, I think, be difficult, outside of the laboratory, to find another accumulator that could without damage give this rate of discharge for a minute.

Reverting to normal rates, 1,870lb. total weight of accumulator and accessories gave 70 amperes at 70 volts = 4,900 watts = 6·57 h.p. electrical = 4·2 h.p. mechanical. A horse-power effective would therefore be obtained from 445lb. = ·2 ton of accumulator; and, at the time that Mr. Cunynghame was delivering his lecture at the Society of Arts, 2 h.p. effective had been obtained from ·4 ton (instead of 1·5 tons) of accumulator. So that there was really a very considerable "carrying margin."

Moreover, the capacity of the accumulator at the normal rate of discharge being 210 ampere-hours, the time during which the horse-power effective would be obtained from 445lb. of accumulator would be $\frac{210}{70} = 3$ hours.

THE BALLISTIC GALVANOMETER IN THEORY AND PRACTICE.

BY ELLIS H. CRAPPER, A.I.E.E.

(Concluded from page 359.)

V.—Simple Exercises with Ballistic Galvanometers and Condensers.

§ 9. *The Comparison of the Capacities of Condensers.*—The quantity of electricity stored in a condenser of capacity, C, charged to a difference of potential, E, is

$$Q = C\,E,$$

which, if discharged through a ballistic galvanometer, produces a deflection, α, and

$$Q = k \sin \frac{\alpha}{2}\left(1 + \frac{\lambda}{2}\right) = C\,E,$$

from which it is obvious that to make the comparison of the capacities of two or more condensers it is not necessary to know either the working constant, the damping constant, or the value of E, since by equating the respective capacities of the condensers as follows,

$$C = \frac{k \sin \frac{\alpha}{2}}{E}\left(1 + \frac{\lambda}{2}\right),$$

$$C_1 = \frac{k \sin \frac{\alpha_1}{2}}{E}\left(1 + \frac{\lambda}{2}\right),$$

it is clear that if the condensers are successively charged by one battery to the same potential, E, and then discharged through the same ballistic galvanometer, the capacities will be proportional to the throws obtained, since the throws are proportional to the quantities of electricity passing through the galvanometer. That is

$$C : C_1 :: \alpha : \alpha_1, \text{ or } C_1 = C \times \frac{\alpha_1}{\alpha}. \quad . \quad . \quad (19)$$

Again, if C be the capacity of a standard condenser and a known quantity, the capacity, C_1, is easily calculated.

The arrangement of the apparatus for conducting this test is the same as that represented in Fig. 8, and the method of working is also the same, the condensers being interchanged to obtain the different sets of observations. As in all practical work, it is a good plan to take a number

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of readings so as to get a good average result. This method of comparing capacities is very satisfactory, and, as only a transient current is used to charge the condensers, very little polarisation of the battery, if any, takes place; if, however, the battery does vary, the effects due to the fluctuation in the condition of the battery may be eliminated by repeating the observations for the first condenser after the readings for the second have been taken, and, if the E.M.F. of the battery has changed, let a^1 be the throw now obtained. Usually a^1 will differ very little from a, so that $\frac{1}{2}(a+a^1)$ may be substituted for a.

When the capacities of the condensers under test differ materially in magnitude, the deflections of the galvanometer needle will vary considerably, and the results will not be so satisfactory. In such cases there are two methods which may be adopted: (1) to charge the condensers to different potentials, say E and E_1, adjusted to suit the condensers, when

$$\frac{C_1}{C} = \frac{a_1}{a} \times \frac{E}{E_1} \quad . \quad . \quad . \quad . \quad . \quad (20)$$

(2) to shunt the galvanometer with a shunt, S, when

$$\frac{C_1}{C} = \frac{G+S}{S} \times \frac{a_1}{a} \quad . \quad . \quad . \quad . \quad (21)$$

where G is the resistance of the galvanometer. For general work the former modification is recommended, since the introduction of a shunt complicates the results.

The following is the method of tabulating the results:

Particulars of condenser.	Zero point on scale.	Extent of first kick.	Average of throws.	a, the deflection.
Standard, ⅓ microfarad.	192 to the right	60 to the right	59·8	192 − 59·8 = 132·4
	192 ,,	59 ,,		
	192 ,,	60 ,,		
	192 ,,	60 ,,		
Condenser under test of capacity, C.	192 to the right	6 to the left	6	192 + 6 = 198
	192 ,,	5 ,,		
	192 ,,	6 ,,		
	192 ,,	7 ,,		
	192 ,,	6 ,,		

Then $C : \frac{1}{3}$ microfarad :: 198 : 132·4,

and $$C = \frac{1}{3} \times \frac{198}{132{\cdot}4} = \frac{66}{132{\cdot}4} = \frac{1}{2{\cdot}006}$$

$= \frac{1}{2}$ microfarad.

The condenser was marked $\frac{1}{2}$ microfarad.

§ 10. *The Comparison of E.M.F.'s by Condensers. Law's Method.*—By transposing the equation $C = \frac{k \sin \frac{a}{2}}{E}\left(1 + \frac{\lambda}{2}\right)$ we get

$$E = \frac{k \sin \frac{a}{2}}{C}\left(1 + \frac{\lambda}{2}\right),$$

therefore, if the same condenser be charged from a source of E.M.F., E, and upon discharging it through a ballistic galvanometer produce a as the first throw, then if charged from another source of E.M.F., E_1, and a_1 be the first throw upon discharging it, it is clear that

$$E : E_1 :: a : a_1, \text{ or } E_1 = E \times \frac{a_1}{a} \quad . \quad . \quad (22)$$

The practice of the method is identical with that of § 8, the cells being interchanged instead of the condensers to obtain the different sets of observations. On account of absorption which occurs with condensers it is important that the condenser be completely discharged to get rid of residual charge before another set of readings is taken. For this reason also the weaker cells are tested first.

The results may be tabulated as in the last example.

§ 11. *The Comparison of Resistances by Condensers.*—As an introduction to the method of determining the absolute capacity of a condenser, a simple method of comparing resistances by means of condensers is given here.

Let S T and V W of resistances r and r_1 in Fig. 9 be two coils of wire, connected in series with a battery, B, and a make-and-break key, K_1. Since the fall of potential along a conductor is proportional to the resistance, it is evident that the ratio of e and e_1, the differences of potential between the terminals S and T and V and W respectively, will be equal to the ratio of r and r_1. Consequently, if a condenser, C, connected with the ballistic galvanometer, G, be arranged so that its terminals may be successively connected with the terminals, S T and V W, by means of the two-way key,

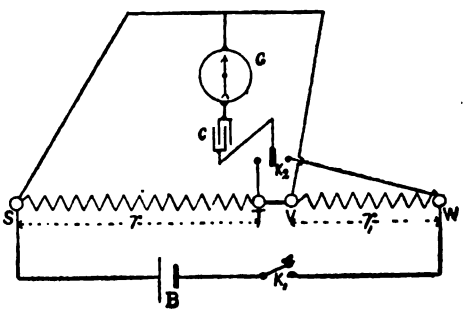

FIG. 9.

K_2, then the throws upon discharging through the galvanometer will be proportional to the differences of potential, e and e_1. That is—

$$\frac{e}{e_1} = \frac{a}{a_1}, \text{ but } \frac{e}{e_1} = \frac{r}{r_1} \quad \therefore \frac{a}{a_1} = \frac{r}{r_1} \quad . \quad . \quad (23)$$

or, in words, the throws are proportional to the resistances, r and r_1.

§ 12. *Determination of the Capacity of a Condenser in Absolute Measure.*—Since the capacity of a condenser charged or discharged through a ballistic galvanometer is given by the equation,

$$C = \frac{k \sin \frac{a}{2}\left(1 + \frac{\lambda}{2}\right)}{E},$$

it follows that if k, E, and λ be known accurately, the capacity of a condenser may be readily determined independently of the capacity of a standard condenser. If these quantities have been determined in absolute measure by the methods already explained, then C is given in absolute measure. An easier method, however, is that due to Fleeming Jenkins, which makes use of two different E.M.F.'s, neither of which need be known if the ratio between them is known.

Let B be a suitable battery (not affected by polarisation), the number of cells being such that (1) a small current may be sent through a high resistance, say 10,000 ohms, and (2) a suitable throw may be obtained on charging the condenser when the apparatus is arranged as shown in Fig. 10 I.

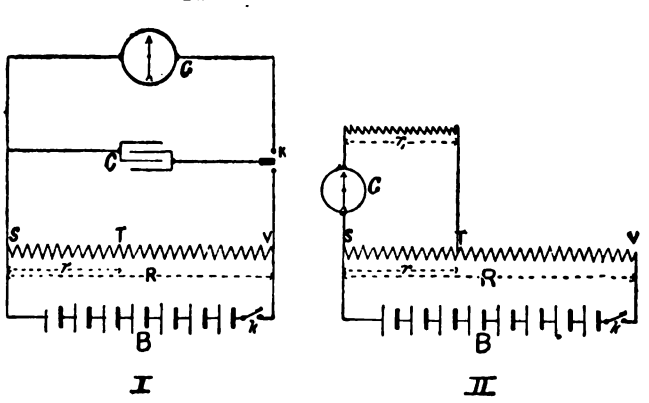

FIG. 10.

From Fig. 10 I. it will be observed that the condenser, C, to be tested, a high-resistance ballistic galvanometer, G, and a suitable key, K, are connected between the terminals, S and V, of the high resistance, S T V. The resistance, r, of the portion S T is a definite fraction of the resistance, R, of the whole S V, so that if a constant difference of potential, E, is maintained between the terminals, S and V, then e, the difference of potential between

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S and T, $= E \times \frac{r}{R}$. If desired, the galvanometer and condenser circuit may be connected to S and T instead of S and V, especially if E be great.

Before making the test care must be taken to completely discharge the condenser, after which the condenser circuit (Fig. 10 I) is closed by means of the key, K. The condenser is instantaneously charged with Q units of electricity, and this discharged through the galvanometer produces a throw, a, such that

$$Q = C \times E = \frac{H}{G} \times \frac{T}{2} \times \frac{a}{\pi}\left(1 + \frac{\lambda}{2}\right) \text{ see equation (6)}$$

where E is the difference of potential between the terminals S and V.

Now T, the time of vibration of the needle, can be determined accurately as already explained, whilst the unknown quantities H, G, and E may be eliminated by obtaining the relationship between these quantities and a deflection, a_1, which is produced by sending a steady current through the galvanometer.

Let A = the current through the galvanometer which produces the steady deflection a_1, when the apparatus is arranged as shown in Fig. 10 II. Then by the simple tangent law

$$A = \frac{H}{G} \tan a_1 = \frac{H}{G} \times a_1 \text{ if } a_1 \text{ be small.}$$

Dividing equation (6) by this equation we get

$$\frac{CE}{A} = \frac{T}{2} \times \frac{a}{a_1} \times \left(1 + \frac{\lambda}{2}\right) \times \frac{1}{\pi}$$

and

$$C = \frac{A}{E} \times \frac{T}{2} \times \frac{a}{a_1} \times \left(1 + \frac{\lambda}{2}\right) \times \frac{1}{\pi} \quad . \quad . \quad . \quad (24)$$

Now, from first principles,

$$A = \frac{e}{r_g + r_1} = \frac{r}{R} E \div (r_g + r_1)$$

where r_g = the resistance of the galvanometer

and r_1 = a high resistance in circuit with the galvanometer.

Substituting this value in (24) we get

$$C = \frac{r}{R(r_g + r_1)} \times \frac{T}{2} \times \frac{a}{a_1} \times \frac{1 + \frac{\lambda}{2}}{\pi} \quad . \quad . \quad . \quad (25)$$

It will be noticed that an assumption has been made—*i.e.*, that E is not changed by changing the arrangement of the apparatus from that of Fig. 10 I. to that of Fig. 10 II. This is correct within certain limits if the resistance of the galvanometer circuit ($r_1 + r_g$) is great compared to r. As this test is obviously an important one, the full working of a test will now be given.

In an experiment for the determination of the capacity of a condenser by the above method, current from a battery of Leclanché cells was allowed to pass continuously through a set of coils of total resistance 11,000 ohms (S V in Fig. 10). Then the condenser to be measured was charged by joining its terminals, one to each of two points in the circuit separated by an intervening resistance of 3,000 ohms (S T in Fig. 10 I.); after which it was discharged through a ballistic galvanometer, and the reading obtained was 64·2 scale divisions.

Then the condenser was removed, and the galvanometer was joined in multiple arc with a coil of 200 ohms (S T in Fig. 10 II.) forming part of the 11,000 ohms resistance and the battery circuit (Fig. 10 II.), and 20,000 (r_1) ohms was placed in series with the galvanometer. r_g, the galvanometer resistance, was 123 ohms. The galvanometer then showed a permanent deflection of 58·44 scale divisions.

Given, time of one complete vibration of galvanometer needle = 8·452 seconds, distance from galvanometer mirror to centre of scale = 85·75cm., and 300 scale divisions = 19·04cm.

Data for Determination of Damping.—The galvanometer needle having been set vibrating, the first elongation observed was 104 scale divisions, and the twenty-fourth elongation was 45·5 scale divisions. Given also that

$$\frac{1}{23} \log \frac{104}{45 \cdot 5} = \log 1 \cdot 0366.$$

Method of Calculating the Capacity of the Condenser.

(1) With condenser in circuit:

$$Q = E_1 C = \frac{H}{G} \times \frac{T}{2} \times \frac{a}{\pi}\left(1 + \frac{\lambda}{2}\right)$$

where E_1 = difference of potential between the ends of the condenser circuit

$$= \frac{3,000}{11,000} \text{ of E.M.F. of battery} = \frac{3}{11} E.$$

(2) With condenser removed:

$$A = \frac{H}{G} \tan a_1 = \frac{H}{G} \times a_1$$

$$= \frac{200}{20,123} \times \frac{E}{10,800 + \frac{200 \times 20,123}{200 + 20,123}}$$

from Ohm's law and the theory of divided currents

$$= \frac{E}{1,106,568}.$$

Now

$$\frac{E_1 C}{A} = \frac{\frac{3}{11} E C}{\frac{E}{1,106,568}} = \frac{3}{11} C \times 1,106,568$$

$$= \frac{T}{2} \times \frac{a}{a_1} \times \left(1 + \frac{\lambda}{2}\right) \times \frac{1}{\pi};$$

$$\therefore C = \frac{T}{2} \times \frac{a}{a_1} \times \left(1 + \frac{\lambda}{2}\right) \times \frac{1}{\pi} \times \frac{11}{3 \times 1,106,568},$$

in which T = 8·542;

$\frac{a}{a_1} = \frac{64 \cdot 2}{58 \cdot 44}$; since the angles are small enough to be identified with the sines or tangents.

Also $\lambda = \log^{\epsilon} \rho$, and $\rho = \epsilon^{\lambda} = 1 + \lambda$ (see § 5);

and ρ is given as 1·0366.

$$\therefore \frac{\lambda}{2} = \frac{\rho - 1}{2} = 0 \cdot 0183, \text{ and } 1 + \frac{\lambda}{2} = 1\ 0183.$$

Substituting the values of T, a, a_1, π, and $\left(1 + \frac{\lambda}{2}\right)$, we get

$$C = \frac{8 \cdot 542}{2} \times \frac{64 \cdot 2}{58 \cdot 44} \times \frac{1 \cdot 0183}{3\ 1416} \times \frac{11}{3 \times 1,106,568} \text{ farads,}$$

$$= 0 \cdot 000005039 \text{ farads} = 5 \cdot 039 \text{ microfarads.}$$

The practical units are used in this working, consequently the capacity is given in microfarads. If required in absolute unit it can be changed quite easily.

THE MECHANICAL CONSTRUCTION OF ELECTRICAL MACHINERY.

BY F. M. WEYMOUTH.

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THE DYNAMO.

(*Continued from page 362.*)

Shafts, Pulleys, and Flywheels.—Shafts are either turned in the lathe direct from round steel bar: or they are forged to shape leaving only a certain thickness of skin, say from $\frac{1}{8}$in. to $\frac{1}{4}$in. in thickness, to take off in the lathe. It is thus obvious that in the first case it saves expense to reduce the amount of turning, and so to leave metal on the shaft rather than turn it off, provided its presence will not be detrimental. In the second case there is no object in leaving on superfluous metal; and economy of material is effected by forging as near as possible to finished size; and the sizes, therefore, in the design may be figured at their lowest safe or scientific dimension, without special regard to economy in turning. An ideal shaft will thus be one

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whose most scientific proportions are also concomitant with the cheapest method of its production. Consideration will show that a shaft near to this ideal would be one for a triple-bearing belt-driven machine with a drum or Gramme armature. The presence of a bearing each side of the pulley obviates the necessity for a large diameter of shaft at that end, such as obtains in machines with two bearings, and there is hence but little variation in diameter throughout the length of the shaft.

In designing this item in a machine, it is important to determine not merely the diameter of the journals, but also of that part which carries the armature. Makers of long standing have past experience to guide them: without such experience, however, and when a first shaft is being designed, these points require considering *de novo*.

other, and the vibration of the belt added (this latter more especially in a two-bearing machine), the deflection will tend to increase. On the other hand, a tightly bolted or screwed-up armature core will have some effect in stiffening the shaft between the extremities of the core, and this will also afford some compensation for the loss of strength in the shaft within the same limits due to the featherways cut into it. These items, therefore, are those that leave room for judgment and experience with any particular class of machine; and it is to be noted that in some respects they cancel one another. Methods of calculating the journals are given in Geipel and Kilgour's "Electrical Engineering Formulæ" and elsewhere.

In Figs. 284 to 288 are shown various types of shaft, of which Figs. 284, 285, and 288 are taken from Prof. S. P.

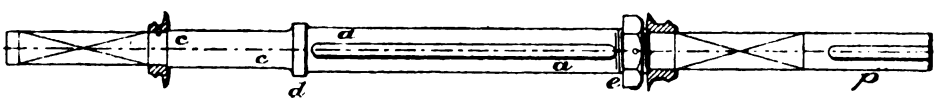

FIG. 284.

A quality of prime importance in a shaft, is that it should be stiff: with sufficient stiffness it will be more than amply strong for conveyance of horse-power and torsion, especially as regards two-bearing belt-driven, and direct-driven machines. It is thus stiffness that demands first attention. Stiffness, however, as may be noted, merely means absence of deflection: or, more closely considered, it practically signifies a minimum allowable deflection, inasmuch as absolute absence of deflection is unattainable. We thus find that to produce an inexpensive shaft from round bar, it will be at least useful, when there is no past experience to guide, to calculate the deflection of any proposed size of bar for any given length and load. Molesworth's pocket-book gives the formula for deflection of beams, with load distributed, as $d = \frac{5\,W\,L^3}{384\,E\,I}$ where d = deflection in inches, W = load in tons, L = length between supports in inches, E = modulus of elasticity = 13,000 for steel, and I = moment of inertia: for circular section $I = \cdot7854\ R^4$ where R = radius of the shaft in inches. It will be obvious, however, that the most direct way of attacking the problem would be to pre-determine some maximum allowable deflection, and thence to calculate the

Thompson's "Dynamo-Electric Machinery." The first is an example from a Kapp machine. Here, as in subsequent examples, the letters *a a* signify the portion carrying the armature, and *c c* that carrying the commutator, while the diagonal lines indicate the journals. Fig. 285 is taken from a continuous-current dynamo by Mr. C. E. L. Brown. The first three will be observed to be for pulley-driven machines. In Fig. 284, with two bearings, the pulley is outside and overhung: in Fig 285, also for a two-bearing machine, the pulley is between the bearings; while in Fig. 286 the shaft is a for a three-bearing machine with the pulley supported on both sides. In all cases the armature butts against a collar, *d*, and is secured by a nut at *e*; and this collar sometimes comes between the armature and commutator, and sometimes between the armature and the pulley. According to the position of this collar, therefore, an armature may be put on from either the pulley end or the commutator end of the shaft. Some makers, however, prefer not to have the collar, *d*, but a nut at each end instead; which omission allows of the original round bar from which the shaft is made to be proportionately smaller, and saves turning.

To put the pulley between the bearings, as in Fig. 285,

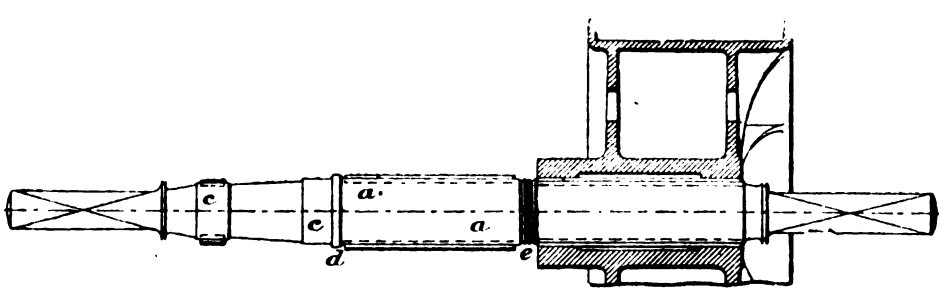

FIG. 285.

diameter. For this purpose, therefore, the formula will be altered by transposition to $I = \frac{5\,W\,L^3}{384\,E\,d}$ from whence the moment of inertia will be obtained; and similarly by altering $I = \cdot7854\ R^4$ to $R = \sqrt[4]{\frac{I}{\cdot7854}}$ we obtain the radius or half diameter of the shaft to yield the proposed deflection. Thus, for instance, if we suppose $d = \cdot01$in., L = 60in., and W = ·5 ton, we shall obtain $I = \frac{5\,W\,L^3}{384\,E\,d} = 10\cdot817$; and by the second formula we shall get $R = \sqrt[4]{\frac{I}{\cdot7854}} = 1\cdot926$, whence the diameter will be $1\cdot926 \times 2 = 3\cdot852$in. for finished size. A collar projecting ¼in. all round beyond this will then practically require the black round bar to be 4½in. in diameter.

The above, however, can only be said to bring the subject somewhat into view; as it deals with the load motionless. With the armature rotating, and possibly exposed to magnetic attraction more on one side than the

is doubtless more truly mechanical than outside as in Fig. 284. It causes the pull of the belt to be borne by both bearings, though mostly, of course, by that to which the pulley is nearest; and regarding the shaft as a lever, the bearing next the pulley is partly relieved from the strain of the belt. With the pulley outside the reverse is the case, and the leverage of the shaft magnifies the pull of the belt in its effect on the bearing. But the inside pulley does not apparently find favour in English practice in the case of two-bearing machines. It lengthens the distance between the supports of the shaft, and involves a more lengthy, and consequently heavier and more expensive bed-plate. Besides this the bearing intervening between the magnets and belt keeps the latter away from the field coils and armature and other such parts which are at any time sufficiently easily injured. The overhanging outside pulley further affords a greater facility for putting the belt on or off. It will be noted that the shaft shown Fig. 285, which is about 8ft. in length, is distinctly scientific in shape, with a great increase in the diameter toward the middle: the weight of the armature also is con-

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centrated at the middle; and thus the proportions of this shaft may well be calculated by the rules given in Unwin's "Machine Design" for shafts for flywheels.

In the case of the shaft for the three-bearing machine (Fig. 286), economy in turning may be effected by omitting the collars, *d* and *g*, and substituting a nut at *d* as at *e*; though, in this latter event, the diameter of the pulley seating must be made small enough to allow this nut to pass over. As has already been pointed out, it is usual practice to make all three bearings similar.

Methods of fixing the pulleys may receive some attention Thus, in Figs. 285 and 286, we find the pulleys are not at the end of the shaft. In the former the pulley engages with the shaft by means of two feathers, and as may be inferred from analogous designs by Mr. C. E. L. Brown, also illustrated in Prof. S. P. Thompson's "Dynamo-Electric Machinery," it is further secured by a set screw in the boss whose point penetrates the shaft. In Fig. 286 the pulley is fixed by a taper key driven in tight from one end, while the other end of the boss butts against the collar, *g*;

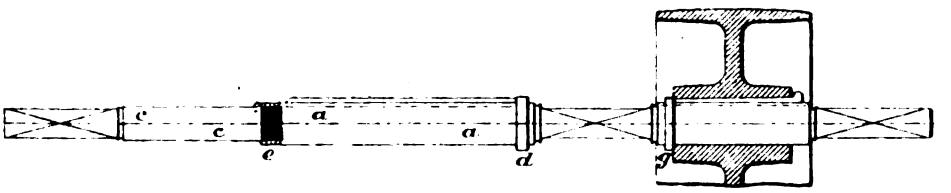

FIG. 286.

Figs. 287 and 288 illustrate two types of shaft for direct driving, of which the latter is only shown in part. These are distinguished by having a coupling at one end by which they are fastened end on to the engine shaft, and are thus made to rotate with it on a prolongation of the same centre line. In Fig. 287 this coupling is a separate feature of cast iron fixed by one or two taper keys as at *n n*: but in Fig. 288 the coupling takes the form of a flange forged on the end of the shaft after the manner of screw-propeller shafting. This latter is doubtless the better of the two methods. In the former the expense of forging is avoided, and to enable the key to be driven out if required, the key-way is continued through the collar. But this collar, though convenient, may be dispensed with.

In Fig. 289 herewith a method is shown for fixing a pulley when at the end of the shaft. The shaft end is turned down in the lathe so as to form a shoulder, *r r*, and the pulley seating, *p p*, is made a little shorter than the boss. The extreme end is then turned still smaller in diameter, and screwed to take a nut and washer. By these latter the boss is held tight against the shoulder, *r r*. The pulley engages the shaft by means of a feather, *t*. It is

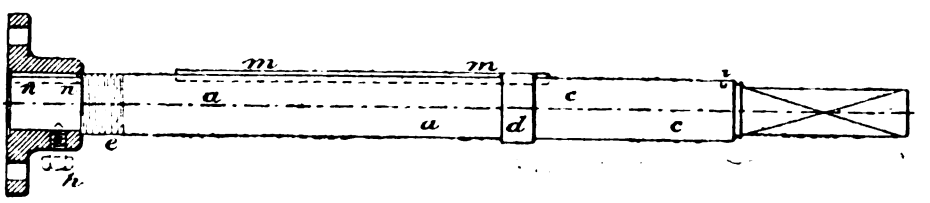

FIG. 287

and the shaft may be turned from round bar. The question of the comparative expense of the two methods, however, must largely depend on local circumstances and conveniences for manufacture. To further secure the cast-iron coupling, a set screw, with its point penetrating the shaft, may be added as depicted at *h*. The head of this latter is shown dotted, inasmuch as it is best cut off: for the coupling will not have its finishing cut taken off until after keying on; and moreover it is not safe for attendants to have a projection flying round at a high speed, rendering it nearly or quite invisible; and the boss is also useful for taking the belt from a tachometer.

It is to be noted that though in Fig. 288 the collar *d* is of necessity at the coupling end, this is optional with the separate coupling in Fig. 287. In this latter, as represented, the coupling cannot be keyed on until the armature core is also permanently fixed on. But with the collar next the coupling this is not so; and, moreover, the shaft becomes a more scientific shape, its diameter decreasing step

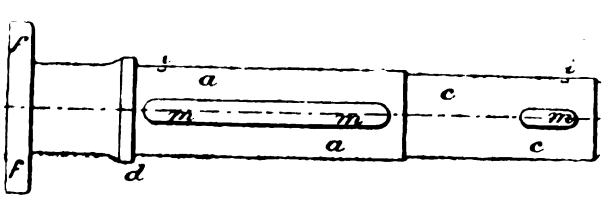

FIG. 288.

by step toward the journal at the far end, which only needs a small diameter on account of the weight of the armature falling mostly on the coupling. In Fig. 287 the armature and commutator are both driven by the same feather, *m m*, which is continued through the collar *d*; and the commutator is secured further by a set screw whose point takes into the shaft at *i*. In Fig. 288 the armature and commutator are driven by separate feathers, *m m*, and both are steadied endways by set screws at *i i*.

optional, instead of having the small screwed end, to drill a hole down the end of the shaft and tap it for a tap-bolt. But such a tap-bolt could not easily be locked, whereas a split pin can be put through a nut, as shown.

It is further optional to cone the end, *p p*, of the shaft, the base of the cone having a diameter equal to that at *r r*, and the effect of tightening the nut is then to drive the boss up the cone instead of against a shoulder. An advantage of the cone is that when removing the pulley subsequently, after it has once been started by ramming on

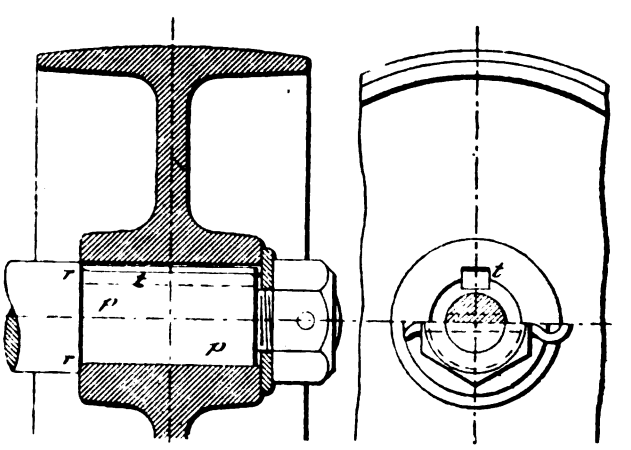

FIG. 289.

the end of the boss at *r r*, it then comes off easily. But a disadvantage, of course, is that, owing to a too excessive tightening of the nut, and due perhaps to the pulley having become rusted on as well, it is apt to be very difficult to get the pulley to start at all. With the parallel-sided seating, as at *p p*, the pulley may require ramming during the whole of its passage off the seating.

In Figs. 290 and 291 are represented two methods of fixing a flywheel. The former shows a section through the

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shaft ends, which are here also both assumed with forged couplings. On each a spigot, *c c*, is formed, which fits the bore of the wheel. A drawback, however, is that when the armature is dismounted the heavy flywheel must be dismounted also: and in putting together there are three holes with each bolt, all of which require exact lining up before the bolts can be inserted. It is simple, however, in turning up in the lathe in the first instance. In Fig. 291 the flywheel is permanently keyed on to the engine shaft: a cast-iron coupling also is shown on the armature shaft. A recess in the coupling fits over a spigot, *c c*, on the flywheel, turned flush with the end of the shaft. The recess is made deeper than the spigot, leaving a clearance as shown, so that the coupling bears only on the facing, *a a*. Set screws, *e e*, with their points penetrating the shaft, may be added in one or both cases as shown; and the flywheel may preferably be fixed with two keys, 90deg. or 120deg. apart, instead of with only one key. This method is more expensive in the first instance, but is subsequently more convenient,

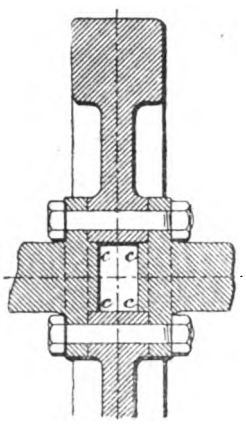

FIG. 290.

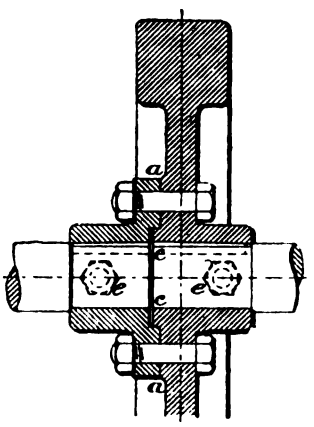

FIG. 291.

inasmuch as when the armature shaft is uncoupled it is not necessary also to loosen the flywheel.

(To be continued.)

THE COX INDUCTION COILS.

The introduction of the X-ray for medical purposes has given a great impulse to the manufacture of induction coils. Previous to the discovery of these rays the induction coil was a piece of experimental apparatus, whereas now it is required for most practical purposes. The manufacture of such coils is at first sight considered to be a most simple operation, but the high voltages employed in the secondary windings take away the simplicity. In fact, we suppose that no experimental apparatus breaks down more frequently. We were invited last week to inspect an 18in. spark coil made by Mr. H. W. Cox, of 10, Cursitor-street, in which there are many most interesting features. Commencing with the primary circuit, we note the ingenious arrangement of the contact breaker to ensure a rapid break. The armature, B (Fig. 1), of the contact breaker is not attached direct to the main spring, F, but is held by the subsidiary spring, E. The grooved wheel, A, at the back of the armature, however, limits the lateral motion of the armature, as, after moving through a certain space, the spring, F, comes against the cheeks of this wheel. In this way the momentum of the armature is not quickly checked, and the break is effected rapidly. The milled head, J, of the contact adjuster is covered with ebonite to prevent any shock, but other arrangements in the winding of the coil prevent any great potential from the secondary straying to the primary windings. The arrangements at *g* are for adjusting the position of the spring relative to the coil. Coming now to the coil itself, the primary wire is not specially insulated, and is wound direct on the core, which consists of a bundle of rusted iron wire. It is in the secondary coils that the special care is required. There are two sections in each coil, placed side by side on the core and separated by an ebonite disc. The inside layers of these two coils are connected together so that the full difference of potential is between the two outside layers. Between every layer of wire three layers of thin paper are placed and covered with a composition somewhat resembling paraffin wax. The composition, however, has a much higher melting point, so that it does not soften at ordinary tropical temperatures. This material is applied hot to each layer of paper, so that all air between them is avoided. The next layer of wire then sinks somewhat into

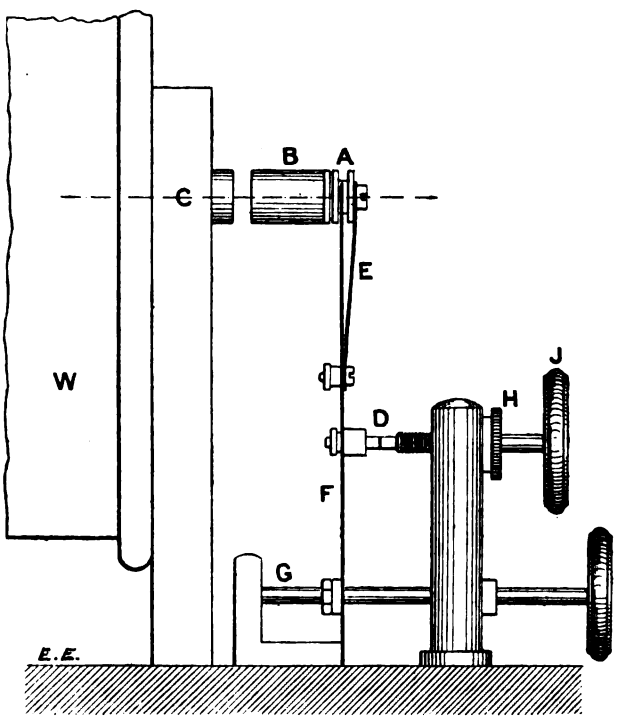

FIG. 1.

the warm layer of paper and wax. After the various layers are completed, the half section of the secondary is covered at the outside and two ends with ½in. of composition. The heat then applied also expels any air there may be left in the outside of the layers. After the coils have cooled down, the ends and outside are turned up in a lathe, so that a uniform cylinder of what looks like solid wax is obtained. Two such cylinders are placed side on the core, and the disc of ebonite between them, in addition to the wax, prevents leakage from one to the other. In the whole construction great care is taken to prevent air spaces in the secondary, and so in placing the two cylinders together vaseline is used to fill up any small space there may be between the turned ends and the ebonite disc. The two cylinders are then firmly clamped together. In each cylinder of the 18in. spark coil we saw there were 68,400 turns of wire, so that the total turns in the secondary amount to 136,800. In the construction of the condensers great care is also taken to exclude all chance of breakdown. The same waxy composition is employed with the triple insulation of paper between each layer. The layers are ironed down with a heated flat-iron, to ensure as thin a layer of dielectric as possible. In this way a solid block of tinfoil, wax, and paper is built up which is not liable to shake loose afterwards. We understand that in consequence of the care bestowed on these coils they find great favour abroad in hot climates, where other induction coils have given great trouble.

"Helsby" Cables and Wires.—We have received a catalogue from the Telegraph Manufacturing Company, Limited, of Helsby and Liverpool, containing particulars and prices of Helsby cables and wires. The greater portion of the catalogue is devoted to vulcanised rubber cables and wires for electric light and power, but it also contains some useful ready reckoner tables and such a mass of figures and prices that make it a most valuable book of its sort to have at one's hand.

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A METHOD OF DETERMINING MAGNETIC HYSTERESIS LOSS IN STRAIGHT IRON STRIPS.*

BY J. A. FLEMING, M.A., D.SC., F.R.S., PROFESSOR OF ELECTRICAL ENGINEERING IN UNIVERSITY COLLEGE, LONDON.

(Continued from page 367.)

It has been shown by Steinmetz and fully confirmed by others that for most varieties of iron used for electrotechnical purposes the hysteresis loss in the iron, per cycle of induction, per cubic centimetre varies as a power of the maximum value of the induction density, which is very nearly 1·6, when that maximum value of the induction density has any value below about 9,000 C.G.S. units. Hence if the ordinates of the above-mentioned induction curves are all raised to the 1·6th power, and a new curve plotted showing the variation of $B^{1\cdot6}$ along the half-length of the bar, we have another curve which represents the variation of the hysteresis loss per unit of volume along the half-length of the bar from point to point. A large series of such curves showing the variation of B and $B^{1\cdot6}$ were drawn for bundles of iron strips and steel of different length and sections, and the results are collected and represented in the form of curves in the diagrams.

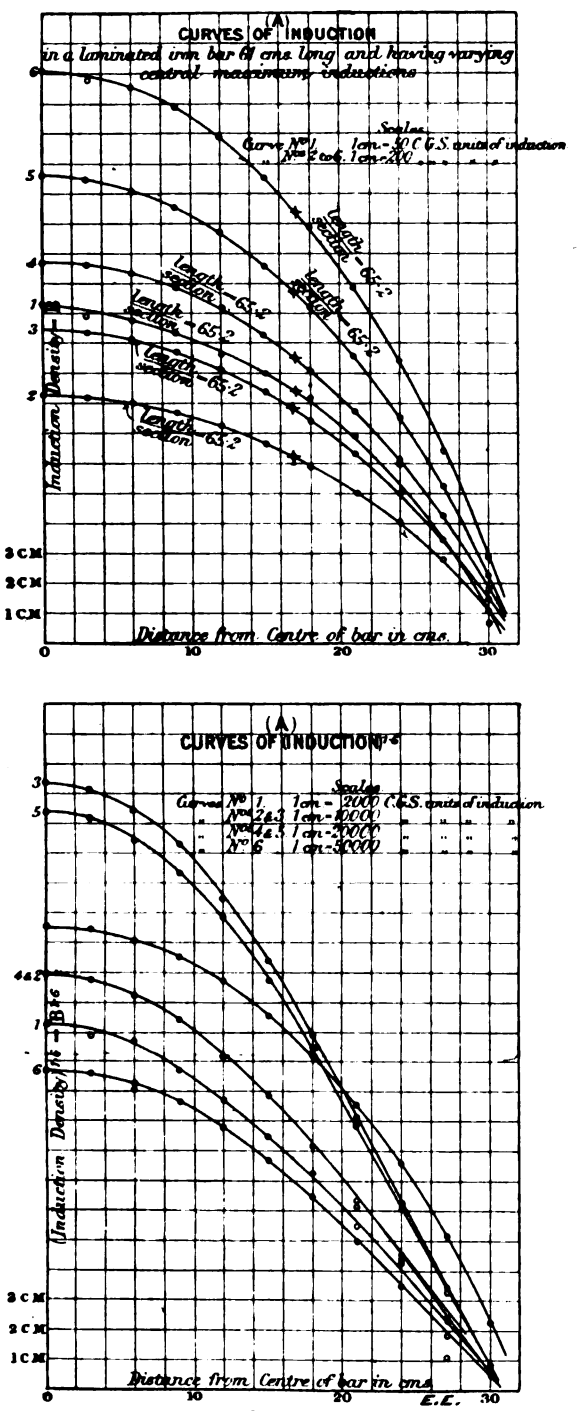
(A)
CURVES OF INDUCTION
in a laminated iron bar 61 cms. long and having varying central maximum inductions
Induction Density
Distance from Centre of bar in cms.
(A)
CURVES OF INDUCTION B^1·6
Induction Density B^1·6
Distance from Centre of bar in cms.
E.E.

FIG. 1.

The upper curves in each case in the Figs. 1, 2, and 3 represent the variation of B along the half-length of the bar, and the lower curves the corresponding curves for the variation of $B^{1\cdot6}$. The first pair of diagrams represent the result of varying the maximum induction density in the centre of a bundle of strips of iron of the same length and section.

The second pair of diagrams give the curves showing the same results for bundles of iron strips of varying lengths but the same section.

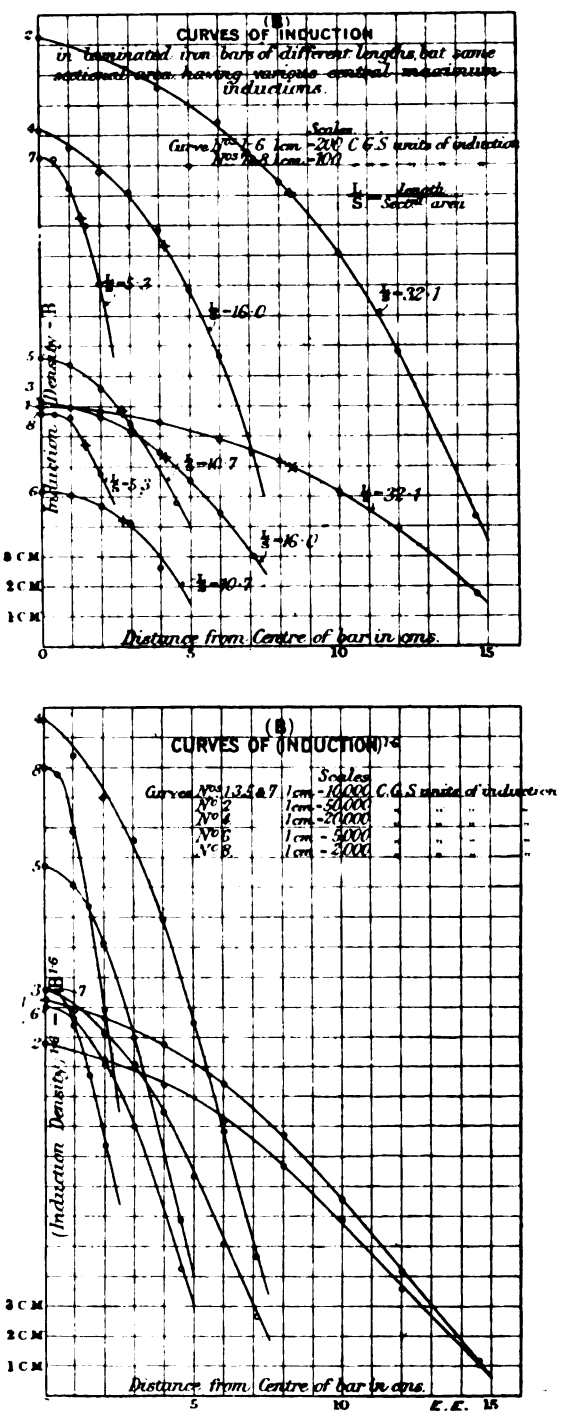
(B)
CURVES OF INDUCTION
in laminated iron bars of different lengths but same sectional area having various central maximum inductions
Induction Density B
Distance from Centre of bar in cms.
(B)
CURVES OF INDUCTION B^1·6
Induction Density B^1·6
Distance from Centre of bar in cms.
E.E.

FIG. 2.

The third pair for various samples of iron strips of the same length but different section.

It is clear from these diagrams, therefore, that such a bar or bundle of iron strips placed in an originally uniform magnetic field has a non-uniform induction density produced in it at its various points which is symmetrical about the centre; and a non-uniform hysteresis loss per unit of volume also symmetrical about the centre. The maximum values of each being at the centre of the bar.

If we take the true mean value of the varying distributed hysteresis loss per unit of volume, it is obvious that at some point in the half-length of the bar there must exist

* Paper read before the Physical Society on June 11, 1897.

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an actual induction density, B_1, such that the true mean hysteresis loss in the whole bar is proportional to $B_1^{1.6}$. Let this value of the induction density be called the effective value, and the point in the bar at which it occurs the effective point. Then the effective value, B_1, must be equal to the 1·6th root of the mean of the 1·6th powers of the actual induction densities taken at equidistant points all along the bar, or

$$B_1 = \sqrt[1.6]{m \,.\, \overline{B^{1.6}}}$$

where $m \,.\, \overline{B^{1.6}}$ stands for the mean ordinate of the curve representing the varying values of $B^{1.6}$ all along the half-length of the bar.

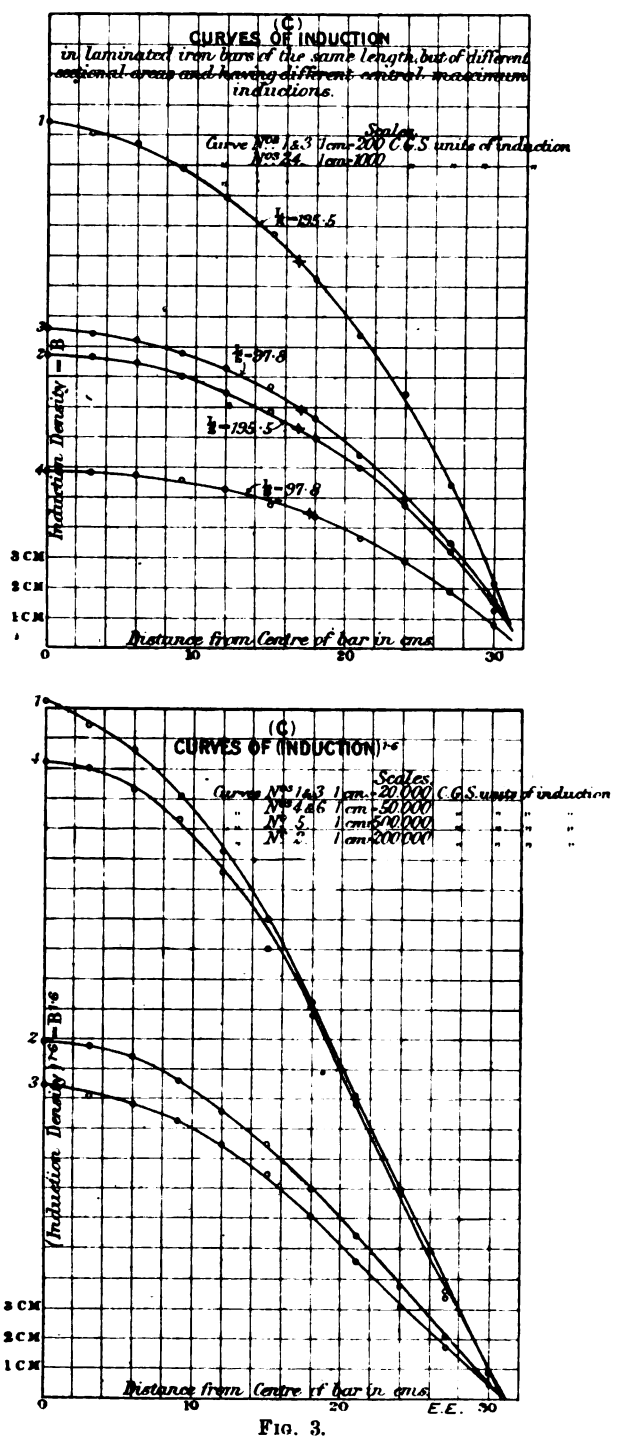
(C)
CURVES OF INDUCTION
in laminated iron bars of the same length, but of different sectional areas and having different central maximum inductions.
Scales.
Curve Nos 1 & 3 1 cm = 200 C.G.S units of induction
Nos 2 & 4 1 cm = 1000 " "
½ = 195·5
½ = 97·8
½ = 195·5
½ = 97·8
Induction Density = B
3 CM
2 CM
1 CM
Distance from Centre of bar in cms
0
10
20
30
(C)
CURVES OF (INDUCTION)^1·6
Scales.
Curve Nos 1 & 3 1 cm = 20,000 C.G.S units of induction
Nos 4 & 6 1 cm = 50,000 " "
No 5 1 cm = 500,000 " "
No 7 1 cm = 200,000 " "
(Induction Density)^1·6 = B^1·6
3 CM
2 CM
1 CM
Distance from Centre of bar in cms
0
10
20
30
E.E.

FIG. 3.

If then this effective value, B_1, of the induction density is calculated for each of the samples of iron strip used, and the position at which the actual induction has this effective value is marked off on the half-length of the bar (this position is represented by the cross on the curves given), we have noticed the remarkable fact that whatever the length or section of the iron strip may be, the point in the bar at which the actual induction density has a value equal to the effective value, always comes at the same proportional distance from the centre of the bar; and this distance is very nearly equal to ·56 of the half-length of the bar from the centre or at ·22 of the whole length of the bar from one end.

The following Table I. embodies all the results taken with bundles of annealed transformer iron strip (Sankey's of very different lengths and sections, and Table II. similar observations on rods of steel and hard iron; and it will be seen that the effective induction in the case of the iron strip is always found at a point in the bar or bundle which is very nearly 0·56 of the half-length of the bar from the centre. If, therefore, the secondary coil is placed at that spot and the secondary voltage then observed used to calculate the induction density, the value so obtained is that which corresponds to the true mean value of the varying hysteresis loss per unit of volume all along the bar In other words, if we suppose the bar magnetised by an alternating current uniformly and with a maximum induction density everywhere equal to that which it actually has under normal conditions at 0·56 of the half-length of the bar from the centre, then the hysteresis loss in such a bar would be equal to that found in the bar as it is. In all cases where induction density values are given, these are to be understood as being the maximum values during the cycle unless otherwise stated. The frequency of alternations used was 80.

We have, therefore, in this useful fact regarding the distribution of induction in iron strips in a uniform magnetic field, the foundation of a quick method of determining the hysteretic constant of a sample of iron.

If the iron sample, taken in strips, is placed as above in the interior of the long magnetising coil, and if a sensitive wattmeter, suitable for use with alternating currents, is connected therewith, we can measure the total power taken up in the iron and in the copper of the coils when any known alternating current is passing through the magnetising coil. If then the iron strips are withdrawn and another measurement of the same kind made with the current passing through the magnetising coil adjusted to the same value as in the first case, this last reading gives us the wattmeter reading corresponding to a known power taken up in the copper of the magnetising coils. Hence the first wattmeter reading gives us the iron loss, together with the copper loss, and the second reading gives us the copper loss alone. The iron loss gives us the true mean value of the hysteresis loss in the iron, assuming the iron is so well laminated that eddy-current loss is practically absent.

The above-mentioned law as to the distribution of the induction enables us, then, to assign the corresponding value of the maximum induction density. Unless this can be done the mere mean hysteresis loss measurement is no practical use.*

The operation of making the mean hysteresis measurement is effected by a sensitive mirror bifilar electrodynamometer. This was constructed in the following way: The fixed or series coil consists of 90 turns of No. 16 S.W.G. cotton-covered copper wire wound in five layers on a rectangular block of wood. The movable coil, or shunt coil, consists of a rectangular coil of 20 turns of No. 24 S.W.G. wire, the turns being fastened together with silk and shellac. This movable coil embraces, without touching, the fixed coil, as in a Siemens dynamometer. The movable coil is suspended by a bifilar suspension consisting of two silver wires 002in. in diameter and 37cm. long, fixed about 3mm. apart. These wires are attached to the ends of the suspended coil, and serve to convey the shunt current in and out of the coil. The movable coil carries a concave silver mirror by means of which a sharp image of an incandescent lamp filament is formed upon a scale at a fixed distance of 100cm. from the mirror. A torsion-head carries the upper ends of the bifilar suspension, and serves to adjust the zero.

In series with the shunt coil is a high non-inductive resistance of 1,000 ohms. The resistance of the thick-wire

* Methods of measuring hysteresis loss by one observation of an instrument have been suggested by other observers; but the practical value of these methods has been very small, because the investigators have not shown how the corresponding maximum value of the effective induction is to be obtained. The rule above given supplies this deficiency.

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TABLE I.—Summary of Experiments made to ascertain the "Effective Point" in Bundles of Annealed Transformer Iron Strips (Sankey's) when placed in a Uniform Alternating Magnetic Field.

Reference letter to diagram.	Length of specimen in cms.	Sectional area of specimen in sq. cm.	Induction at centre of bar, B. C.G.S. units.	Effective induction, B_1. C.G.S. units.	Ratio of $\frac{B_1}{B}$.	Distance of effective point from centre of bar.	Fraction of half-length of bar from centre at which effective induction exists.
A_1	61	·936	564	420	·744	17·01	·558
A_2	61	·936	1,648	1 240	·752	16·91	·554
A_3	61	·936	2,084	1,563	·750	16·92	·555
A_4	61	·936	2,536	1,900	·749	17·00	·557
A_5	61	·936	3,112	2,335	·712	17 00	·557
A_6	61	·936	3,816	2,870	·752	17·10	·561
B_1	30	·936	1,597	1,192	·746	8·36	·557
B_2	30	·936	4,052	3,012	·743	8·35	·557
B_3	15	·936	1,622	1,265	·780	4·11	·548
B_4	15	·936	3,430	2,660	·775	4·18	·557
B_5	10	·936	1,907	1,554	·815	2·73	·546
B_6	10	·936	1,025	833	·813	2·76	·552
B_7	5	·936	1,622	1,420	·875	1·39	·556
B_8	5	·936	778	678	·871	1·49	·596
C_1	61	·312	3,485	2,565	·736	16·84	·552
C_2	61	·312	9,673	7,250	·749	16·81	·551
C_3	61	·624	2,125	1,570	.739	17·07	·560
C_4	61	·624	5,834	4,420	·758	17·60	·577

Mean of last column = ·56.

TABLE II.—Summary of Tests made as in Table I. upon Steel and Hard Iron Rods.

Reference letter to diagram.	Length of specimen in cms.	Sectional area of specimen in sq. cms.	Induction in centre of bar, B. C.G.S. units.	Effective induction, B_1 C.G.S. units.	Ratio of $\frac{B_1}{B}$	Distance of effective point from centre of bar in cms.	Fraction of half-length of bar from centre at which effective induction exists.	Nature of bar.
C_6	61	·970	4,499	3,525	·783	6·90	·58	Round bar of silver steel $\frac{7}{16}$in. in diameter.
D_2	32	·178	5,997	4,784	·798	9·80	·61	Round rod of silver steel $\frac{3}{16}$in. in diameter.
D_3	32	·534	5,555	4,244	·764	9·31	·58	Three similar pieces of steel.
D_4	20·45	·645	4,746	3,587	·756	6·67	·65	Bundle of 60 iron wires of hard iron of rectangular section.
D_5	20·45	·645	2,545	1,912	·751	6·76	·66	

fixed coil of the wattmeter is ·133 of an ohm, and the resistance of the shunt coil and suspension, without the associated inductionless resistance, is 11·7 ohms.

When such a bifilar wattmeter is employed to measure electrical power, it can be shown that the deflections of the movable coil, when not large, are strictly proportional to the power passing through the wattmeter, so that each scale division has an assignable power value, which in our case was almost exactly ·01 of a watt per millimetre of scale. The arrangement of circuits was then as shown in the diagram on p. 366. The long magnetising coil above described was connected in series with the fixed coil of the wattmeter, and also with a sensitive electrodynamometer or ammeter suitable for measuring small alternating currents of about an ampere or less in value. The shunt coil of the wattmeter was joined across the ends of the long coil. Suitable resistances beyond controlled the current.

The process of measurement was then as follows: A bundle of straight iron strips was fitted with the secondary coil at the effective point—viz., ·56 of the half-length of the bar from the centre. The bundle was slipped into the magnetising coil, and an alternating current sent through the coil of such a magnitude (generally about ·2 of an ampere) as to give an induction density of not more than about 6,000 C.G.S. units at the effective point. The wattmeter deflection was then read. To interpret this reading the iron strips were removed from the coil and another wattmeter measurement made on the copper coil alone. As the removal of the iron sends up the current strength by decreasing the inductance of the circuit, it is necessary to readjust the current to the same value as before, and to know that value in amperes. The resistance of the coil being known, and also the current passing through it, we can calculate the power being taken up in the copper coil alone for this standard current; and hence know the power in watts producing the observed wattmeter deflection.

The wattmeter is, therefore, calibrated on the copper circuit of the magnetising coil, and from the known copper loss in this coil and the proportionality of its deflections we are enabled to assign at once the value in watts of its deflection when used to measure both the iron loss and copper loss together when the iron strip is inserted in the coil.

If the induction is carried up as far as 4,000 or 5,000 C.G.S. units at the effective point, and if the strips have a thickness over ·01in., then it becomes necessary to apply a small correction for the eddy-current loss set up in the iron. This can be at once done by using the following simple practical formula given by the author for this loss in rectangular sectioned strips.

If t is the thickness of the strip in mils (1 mil = ·001in.), n is the frequency of the current, and B is the maximum value of the induction density during the cycle at any point on the bar, then it can be shown that the eddy-current loss in watts per cubic centimetre at that point in the rectangular or sectional strip is closely given by the expression:

$$\left(\frac{B}{10^8}\ n\ t\right)^2,$$

and hence for a given frequency and thickness the eddy-current loss per pound of iron is very quickly found from a simple parabolic curve representing B^2 in terms of B.

(To be continued.)

KLEIN'S WATER-COOLER.

We illustrate a Klein's water-cooler as erected at the Bowesfield Steel Company's works at Stockton-on-Tees. The cooler has been working now for about a year, and has given great satisfaction. It cools about 31,500 gallons of tuyere water per hour from 100deg. to 72deg. F. during the summer.

The action of the cooler is simplicity itself. The heated water is pumped to the top of the apparatus, which is about 18ft. high. In the interior of the apparatus are arranged a large number of wooden shutters or plates, made of lathwork, fixed in a vertical position. The water

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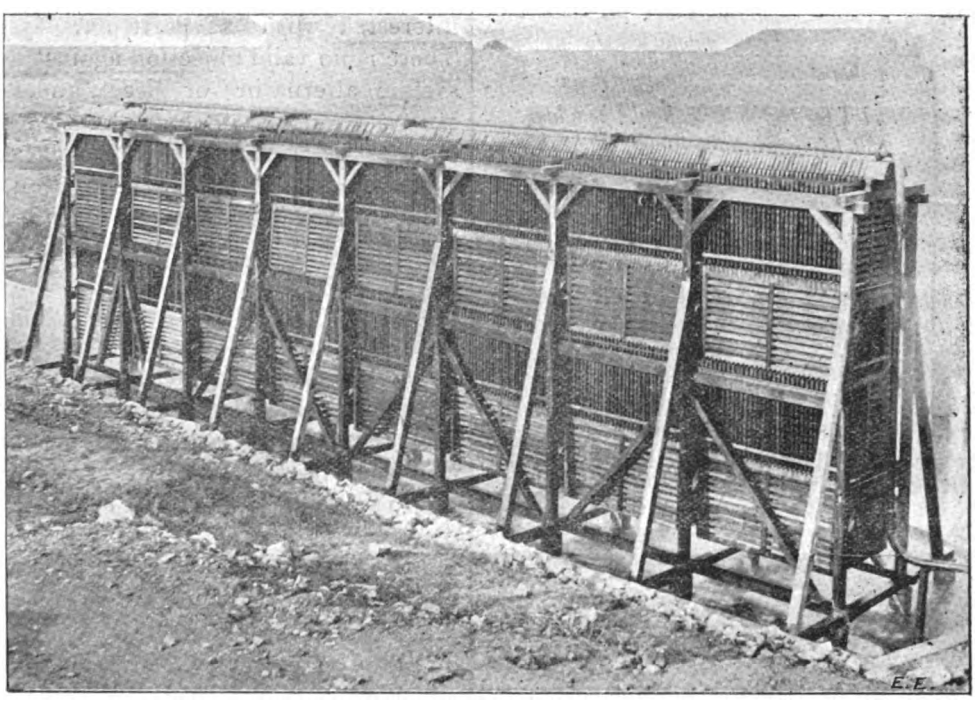
is by means of a very simple arrangement spread in a thin film over the whole surface of these plates, and flows slowly down. By contact with a large volume of air, which passes in the opposite direction through the cooler, the water is

Klein's Water-Cooler—End View.

very quickly cooled to the temperature of the air, and a further cooling, even as low as 15deg. to 20deg. F. below the temperature of the surrounding air, is effected by the evaporation of a small quantity of the water. During the summer the evaporation is much larger than in the winter, and consequently the water can, even on hot summer days, be cooled as low as on winter days, in spite of the great difference in the temperature of the air.

In cases where ground space is very limited the air is blown through by the help of a fan, or the plates are put into a high wooden chimney, so that a natural draught is produced.



Klein's Water-Cooler—Side View.

THE SOUTH-WEST LONDON POLYTECHNIC INSTITUTE.

We have received a prospectus of day classes and a prospectus of evening classes held at this institute, which contain much information that is interesting. The technical day college is on the lines of the Finsbury Technical College, and provides a course of training extending over two years in electrical engineering, mechanical engineering, and applied chemistry. Similar classes are held in the evening. We notice that during last session the physics and electrical engineering evening classes were attended by nearly 170 students engaged in either applied physics, electrical technology, electric wiring and fitting, and instrument-making. None of the technical courses are run on examination lines. Something like £10,000 has been spent on the plant requisite for electrical and mechanical engineering, and for the apparatus required in the chemical and physical laboratories. The physics and electrical laboratories are fully equipped. The first year's course in electrical technology embraces the study of magnets and magnetism and their laws, and then deals with electric currents, their effects, methods of measuring, resistances, etc. It goes on to deal with the elementary theory of the dynamo, the laws of electrolysis, thermo-electric effects, measuring instruments of all kinds, and concludes with the methods of testing and localising faults. In the second year's course a lecture is given each week, followed by two hours' drawing and design. The course also includes practical instruction in cable jointing and house wiring, and generally is intended to fit the student for a position of responsibility in an electricity station. The evening classes include an advanced class, at which lectures are given on mains and cables, instruments, testing and calibrating, engine testing, dynamos and motors, alternating currents, and secondary batteries. The advanced practical work includes electrical testing, engine trials, and dynamo and motor trials, electrical jointing and connecting, and specifying and estimating, etc. There are also evening classes for electric wiring and fitting and instrument-making. The professor is Mr. A. Schwartz, A.M.I.C.E., A.I.E.E., and the instructor Mr. James Hall, Wh.Ex. We have endeavoured in as condensed form as possible to give some idea of the electric instruction that can be had at this institute, and all further particulars can be obtained by applying for prospectuses. We have purposely confined our remarks to the electricity instruction, for the simple reason that space is too limited to give even a correct general estimate of the value of the institute and the wide scope it covers.

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ELECTRIC LIGHT GRIEVANCES.

This is the title of an article which appears in No. 3 of a new paper entitled *City Affairs*. Like most new papers which enter an arena already well and ably filled, its policy seems to be destructive rather than constructive, to have a tilt at everything and everybody. Such work is easy. There is hardly a single concern of any kind under the sun not open to adverse criticism, and most electric light concerns are exceptionally open to such criticism, but—— There is a world of underlying romance or history in a "but." It is only those who have watched the introduction of electric lighting that can appreciate the almost herculean task it had to undergo in order to obtain a footing in the City of London. The article we have referred to is evidently an inspiration. Its texts are: the charges for current are too high; the system adopted is not suitable for motors; the system was adopted because the success of the Grosvenor Gallery installation and "certain great electrical authorities" made it fashionable; the danger of the high-pressure system; compared with the Charing Cross Company, the City Company shows "a huge waste of money *somewhere*." This is a pretty indictment, and all the worse to answer, because in a measure it is true. These half-truths are, indeed, the most difficult to deal with simply because they contain the germs of truth, hence cannot be directly contradicted. When the history of the City Company comes to be written—if ever it does or can so be written—it will be found that, speaking generally, the assent to electric lighting had to be forced from the City Fathers. Negotiations went on for years. Interested parties fought each other tooth and nail, and ultimately those interested with a particular system prevailed. There is no valid objection against an high-pressure system, alternating or direct, under suitable conditions. Probably in the not very far distant future all central stations will supply on a combined system, and the larger the station, the easier this will be—that is, there will be a low-pressure system radiating from the station as well as a high-pressure system—and each station will be adapted for power purposes as well as for lighting purposes. With regard to the City Company, it must be remembered that it was opened in 1891. The system must have been selected and settled some years prior to that date, and we are fain to say, excepting in this journal, the question of power purposes was then usually ignored. The cry was, light is required by everybody. There is no man so densely ignorant but he can understand this necessity. Then the plan of the workers was to peg away on the text of "Light, more light, healthier light," and to leave the question of power, which was not so well understood, in the background. If we can get central stations for light, the rest will come in due course. There was a good deal in that contention, and at the date we believe the financial parties interested struck the correct note so far as finance was concerned. Had they prepared for power supply they would have fatally handicapped their stations so far as financial support was concerned; no one then would have subscribed

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large sums of money to put in plant and power mains upon which no immediate return could be promised. It is absurd arguing that because folks in 1897 are a little more prepared to use electrical energy in motors, that this should have been arranged for in 1891. We do not know the minds of the directors of the City Company—nor do we especially care to know their minds, for our experience of the company as regards giving information is of the worst—but we are pretty sure if they found a sufficient demand for power they could easily supply it. Our contemporary probably knows as much about electrical affairs as it is told, otherwise it would have known that it is not an insuperable difficulty to run continuous-current motors from alternate-current stations. There is another point which our contemporary has certainly not considered, or, if it has considered, has quietly ignored. Is it prepared to advocate anything but a high-pressure system for street-lighting purposes over the City area, or, in fact, anywhere? The system of house-lighting is by low pressure, obtained by means of transformer stations. No accident, so far as we remember, has occurred to users; the accidents have been principally in sub-stations and central stations, and to workmen, not users Possibly with low-pressure systems some of these accidents would not have occurred, but then comes the question, are we to limit the area to low-pressure work because there may be a source of danger to wilfully careless men? If every occupation which bears a spice of danger is to be closed, then we must close most of our manufactories and mines. Our contention is, and always has been, that even the generation and distribution of high-pressure electricity can be made so practically safe that only gross carelessness and the breaking of rules can lead to accident. The cost to consumers is high; that is hard upon the consumers. It is a matter which the directors can remedy when they like. The suggestion that the City should erect a central station in opposition to the one now existing is another absurdity. We have always supported municipal action, but not to the extent of advising competition in such a case as this. The influence of *City Affairs* will not do much good or harm, but it is just as well to notice these sporadic attacks.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TESTS OF SUPPLY METERS.

SIR,—There appears in a paper by Mr. Ricks, read before the British Association at Toronto, a description of certain tests made in my laboratory on various electric supply meters. From the results there given, it would appear that the Elihu Thomson energy meter (or so-called "recording wattmeter"), when used at ordinary temperatures, reads about 13 per cent. too low at one-tenth full load; and that, when measuring ordinary direct-current loads, an increase of temperature of 39deg. C. raises the speed of the meter by about 11 per cent.

I have no reason to doubt the accuracy of Mr. Rick's results—indeed, the very careful and painstaking way in which he carried out the investigation described in his paper leads me to think it highly probable that the figures and curves which he publishes do really record the behaviour of the meters which he tested. But during my recent visit to the works of the General Electric Company at Schenectady, and at Lynn, I have become convinced that the particular meter which was lent Mr. Ricks by the British Thomson-Houston Company for testing cannot be regarded as a sample of the instruments which are now being manufactured in large quantities.

From his tests of the Thomson meter Mr. Ricks states it may therefore be surmised that the coefficient "(of change of resistance with temperature) of the pressure coil is very much less than that of the copper disc." To construct an energy meter with this difference in the temperature coefficients is, of course, quite wrong scientifically; and Prof. Elihu Thomson tells me that in his instructions he has emphasised the fact that the temperature coefficient of the pressure circuit should be equal to that of the copper pressure disc. As a proof that this condition is really fulfilled in the Thomson meters constructed in the States various curves have been shown me, from which it appears that at ordinary loads a change of 40deg. C. in the temperature of the meter alters the constant only $3\frac{1}{2}$ per cent., instead of by the 11 per cent. found by Mr. Ricks.

Further, I have watched tests being made on one of these meters at Lynn at temperatures of 65deg. C. and at 24deg. C. The meter in question was a 50-volt 15-ampere meter, and when tested at 52 volts and 11·75 amperes—that is, at about three-quarters of full load—there was only 1 per cent. difference between the results obtained at these two temperatures, although they differed by 41deg. C.

Next, as regards the difference between the value of the constant of this type of meter at low and high loads, it would appear from the curves which have been shown me recording the results of various tests that with some specimens there is practically no appreciable difference in the value of the constant anywhere between full load and one-twentieth full load, while with other specimens the constant is about 2 per cent. higher at one-tenth of full load than at full load. These are very different results from those obtained by Mr. Ricks with the meter lent him for testing, for he found that the constant at full load had to be increased by 19 per cent. to make the meter read correctly at twentieth of full load.

Some hurried tests at various loads were made in my presence here of the meter already referred to. The results at low loads were not very satisfactory, as the meter armature turns very slowly, of course, at small loads, and time pressed, as the factory was on the point of being closed for three days. Hence we had to content ourselves with timing one revolution only of the armature instead of waiting to take many, as was done in the very much more accurate tests carried out by Mr. Ricks. But it seemed clear that the variation of the constant between full and one-*thirtieth* of full load was not as large as was found by Mr. Ricks between full and one-*twentieth* of full load.

Hence, I conclude, both from the curves of previous tests as well as from the tests which I saw carried out, that the Elihu Thomson meter tested by Mr. Ricks had not merely a much higher temperature coefficient than meters constructed at Lynn, but possessed a greater frictional resistance, or had "an initial energy coil" which was not powerful enough.—Yours, etc., W. E. AYRTON.

Lynn, Massachusetts, September 6, 1897.

ACCUMULATORS FOR TRACTION.

SIR,—In your article on electric motor-cabs in New York in the current issue of your paper, p. 362, we notice the following:

"Some of the batteries consist of Manchester type plates, by which is probably meant Planté plates of the Tudor form, but in most cases Chloride plates are used."

The assumption that by "Manchester plates" is meant Planté plates of the Tudor form we beg to advise you is totally erroneous. Manchester type plates as known in America are identical in every respect with what are known in England as "R" type Chloride plates, the distinguishing name of "Manchester" having been given to

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them owing to their having been invented here, and are manufactured under royalty by our affiliated company, the Electric Storage Battery Company, of Philadelphia, New York, and Boston.

It may possibly be of interest to your readers to know that the above American company controls the principal storage battery patents in the United States, including the Tudor, but the result of extended and careful experiment has proved the "R" or "Manchester" type of plate to be unapproached by any other type for traction purposes.—Yours, etc.,

CHLORIDE ELECTRICAL STORAGE SYNDICATE, LIMITED,
(G. A. Grindle, Manager.)

SHOREDITCH DESTRUCTOR.

SIR,—Perhaps Mr. Willshear will explain, if it is found to be economical to use town's refuse as fuel in preference to coal, why, instead of employing the refuse on week-days in simply heating water, is not sufficient week-day refuse retained for burning on Sunday night, when steam raising is necessary ?

Again, if there is any economy in using refuse fuel in place of coal, why not arrange for the removal of this material from some adjoining vestry or district ? There should be no difficulty in obtaining a supply for the mere cost of carting.—Yours, etc., ENQUIRER.

THE VALUE OF TOWN'S REFUSE AT ROCHDALE.

SIR,—I have read with great pleasure the careful report of Mr. Lacey upon the electric lighting of Rochdale. I should be glad if he would kindly tell me whether I am correct in deducting from his report the following figures and opinions :

He says that "the value of the steam power for electric lighting obtainable from the destructors at Rochdale is equal to some £45 per annum," which would consequently only justify a capital expenditure of plant of some £500 after an adequate allowance for depreciation and interest had been provided for.

I should say that allowing for the power that the evaporation of water represents, and the other elements of steam consumption, that the entire refuse of the large town of Rochdale will not provide more than some 250 i.h.p. to 300 i.h.p. of some 10 hours a day !—Yours, etc.,

STEAM POWER.

REVIEWS.

Electricity and Magnetism for Beginners. By F. W. SANDERSON, M.A. Illustrated. Macmillan and Co. 1897.

A holiday task is not loved by schoolboys, and is generally left till just before going back. The notice of this little book is not a holiday task, but nevertheless the reading of it has helped to wile away some rainy hours when in Rhineland. Although the book is "intended to form a first course for boys," it might with great advantage be studied by many older students. Its faults are faults of the method adopted and a too little experience with practical work, hence from one point of view its utility is lessened. Thus a great many people of wide practical experience would be unfamiliar with the term joining cells in "arc." It may be a term well known to certain examiners and examinees, and may be justified by consideration of the case of an arc lamp; but to talk about putting machines in arc instead of in parallel would cause a stare amongst most men in central stations. It is true that "in parallel" is used as synonymous to "parallel arc." We object, not to the use of the latter term, but to "arranged in arc" as the equivalent of "multiple arc" or "in parallel." We contend that the authors of school books should, in the interests of their readers, use the notation and nomenclature generally adopted. Thus, again, to use i for current when C is the symbol generally adopted, is a mistake, though our author is not singular in this respect. While upon the objecting course, we ought to say the book has no index. That may be a venial fault in an elementary school book, but it is a fault. The author commences the book with a chapter on magnetism, and a good feature is that the experiments throughout the book are numerous. Immediately we commence to examine the book we are led to doubt whether the method adopted is the best, for we are met with such statements as "Induction explains why a magnet always attracts soft iron." The idea of lines of force being closed curves and of the magnetic circuit does not come till later on, and we think these ideas—conventional as they may be—are calculated to give more insight into the "why" than the above bald statement, though it is based upon experiments with iron filings and tacks. No doubt Lord Kelvin's view that the study of the subject should commence with electrostatics—Chapter III. in this book—has much to commend it, though we incline to the views of Dr. Hopkinson and Prof. Ayrton that voltaic or current electricity—Chapter II. in this book—should form the starting point. Mr. Sanderson follows neither of these courses, hence is compelled to deal more with, and, as it were, to build upon, topics, measurements, and instruments that applied belong to the small laboratory apparatus rather than to the apparatus used in engineering work. Thus we have treated—and admirably treated, we must admit—such questions as the strength of poles of small permanent magnets measured with the aid of the torsion balance. If the author would rearrange his chapters and fall in with the common notation and nomenclature, making his experiments a little more practical from the engineering point of view, it would be difficult to find an adverse word for the book. The greater part is excellent, the paragraphs well arranged, well illustrated, explanations terse and simple, illustrations worked out, problems just such as to show the student how to proceed in the solution of the many questions given in the exercises.

Power Distribution for Electric Railroads. By LOUIS BELL, PhD. Street Publishing Railroad Company, New York.

We must acknowledge considerable remissness in not sooner having noticed this book. So far as its contents and method of treatment are concerned it is the best we know of its kind for the general reader, be he a practical man or student. Of course the references to practical apparatus and to installations are almost wholly American, as are the costs; hence the English reader has to make a variety of allowances for due comparison with English work. It is a great relief to find an author bold enough to write common sense in formulæ and calculations, and not to grovel among four to eight places of decimals for fear of being thought inaccurate by a few scholiasts. The method adopted is the synthetic rather than the analytic. The author builds up, each successive chapter adding to the edifice. Thus he commences with fundamental principles, showing the three classes of working traction systems—the linear, the branched, and the meshed or network. Like all practical writers, the author evidently commenced writing with a strong determination to use nothing but common units, measures, and language, hence he commends to our notice length in feet and inches and area in circular mils; but fate is too strong for him, and before the fiftieth page he has forgotten to translate, so comes the inevitable metres, centimetres, square centimetres, etc. From Ohm's law in its simplest form, $C = \frac{E}{R}$, he obtains the fundamental equation of electrical distribution $c.\,m. = \frac{11\,C\,L}{E}$.

The coefficient 11 is "the constant connecting L in feet and A in circular mils ($c.\,m.$) with the resistance in ohms for copper wire of ordinary quality at ordinary temperatures." From this again the author obtains the formula $W_m = 33\frac{C\,L_m}{E}$, because a "copper wire 1,000 $c.\,m.$ in section weighs almost exactly 3lb. per 1,000ft." Of course in the equation W_m is the weight per 1,000ft., while L_m is the length per 1,000ft. The drop under various conditions is discussed, with the conclusion that "the area of the line can be calculated for average terminal drop just as if the load were concentrated at its middle point." But we cannot touch

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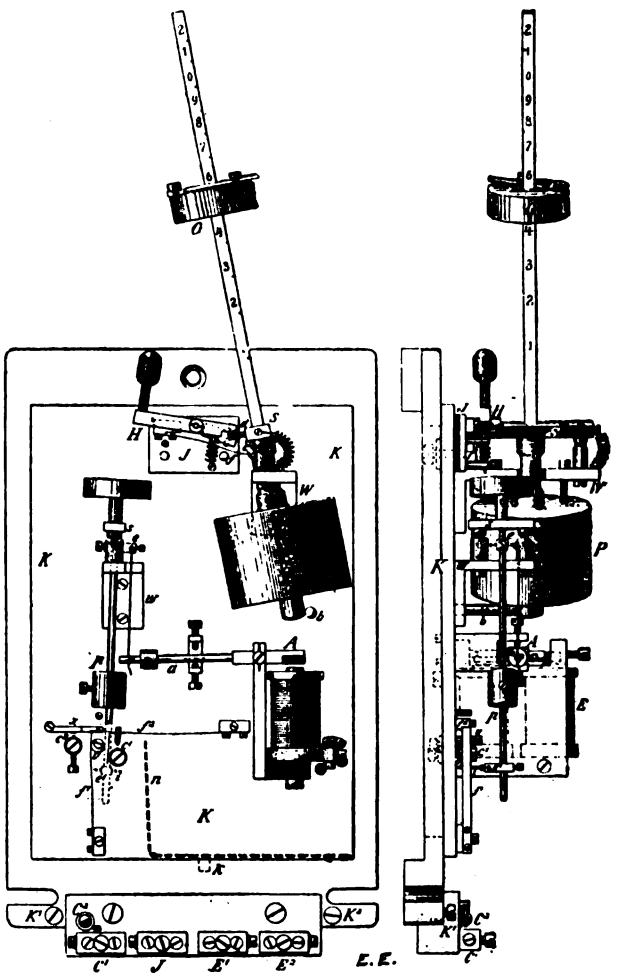
the many points made clear—such as the "centre of gravity of the load," which determines more or less the site of the station, the calculations relating to networks, the load factor, etc.—and must refer readers to the book itself. If we were asked to select the best chapter in the book it would be difficult, seeing all are good, but we should be inclined to give the palm to Chapter II., on the "return circuit." Let us give an example of the author's direct method of treating this subject. He says:

"In the early days of electric railroading, the resistance of this strange assortment was assumed to be zero, on the theory that the earth was the conductor concerned and was practically of infinite cross-section. This was shockingly far from the truth, and although data are rather scarce, we may properly take up the return circuit piecemeal and see what the actual state of things may be. First as to the rails. Mild rail steel is a very fair conductor. Weight for weight it is, comparing the commercial metals, just about one-seventh as good a conductor as copper. Now a copper wire weighing 1lb. per yard has an area of about 110,000 c. m.; hence an iron bar weighing 1lb. per yard is equivalent to about 16,000 c. m. of copper, very nearly equal to No. 8 B. & S. gauge. This enables us at once to get the equivalent conductivity of any rail, *neglecting the joints*. The result is somewhat startling, for since ordinary rail runs 60lb. per yard or more, the conductivity of a pair of such rails is equivalent to about 1,900,000 c. m. of copper, in some cases nearly 10 times the cross-section of the outgoing circuit. The resistance of a copper wire of 16,000 c. m. is, roughly, six-tenths of an ohm per thousand feet. Hence the resistance of any single rail in ohms is, per thousand feet, $R = \frac{\cdot 6}{W}$, where W is the weight per yard. Or since two rails form the track, $R = \frac{\cdot 3}{W}$. That is, if the rail used weighs 60lb. per yard the track resistance is approximately $\frac{1}{200}$ ohm per thousand feet."

It must not be expected from this that "joints" are passed over. Not so; the question of bonding is very carefully discussed, and the resistances introduced thereby. Electrolytic action is looked upon as "so serious that it is worth detailed study as one of the gravest factors bearing on the design of the return circuit." At the end of an excellent chapter on direct feeding systems which follows that on the return circuit, Dr. Bell is bold enough to say: "The art of feeder design is one that calls for great *finesse* and skilled judgment in assigning the proper values to the somewhat uncertain maximum load. It cannot be reduced to formulæ that will be of use in anything save special and unusual circumstances." These sentences show how important in the author's opinion is the practical experience of a skilled consulting engineer. He does not say so in so many words, but he lets the reader infer that a good designer must have not only book knowledge, but practical knowledge, which can only be obtained in actual work. We shall not refer at length to the remaining chapters, there being altogether nine chapters, each of which is carefully written, amply illustrated, and filled with "points" of a practical character. If we have an adverse word to say, it is to protest against the issue of any book, and especially of a book like this, without an index. The chapter contents may be as full as you please, but that will not replace an index. In fact, nothing will; and though this book throughout is full of important matter, a great many people will justly put it aside because they cannot refer as they require for lack of index. Men, after they enter the working period of life, cannot afford to waste time in hunting through a book to find something they imagine is there, and such a book as this is really valuable as a work of reference as well as a book to study. We trust the author will amend his ways in this respect.

A SYNCHRONOUS CALLING APPARATUS FOR TELEGRAPH STATIONS.

The present method of calling up an individual station on a telegraph line to which many instruments are attached is, in England, somewhat a laborious process. It consists of repeating the calling signal for that station till the man in charge takes note that he is wanted. On the Continent clockwork calling-gears are sometimes used, which are both advantageous and disadvantageous. Mr. H. Wetzer, of Pfronten, has designed the apparatus we illustrate and describe herewith, and he claims that by it many of the disadvantages of the older apparatus are avoided. He has reduced the gear required to a simple pendulum, which is only put into motion at the moment a call is made, and the movement of which ceases immediately afterwards. This pendulum is not worked by clockwork, but by an electromagnet, which is acted upon by the station calling when the call is being made.



The above illustration shows the details of the construction of this apparatus. Each station is fitted with a pendulum, *p*. The length of the latter, and in consequence its time of oscillation, is different for each station. The call is made—that is to say, the pendulum is put into motion—by the electromagnet, E, being excited from the calling station at certain predetermined intervals. Each excitation of E gives an impulse to the pendulum, *p*, when the core is attracted. This is done through the core, A, by the rod, *a*, and the cord attached to the latter. If the current through E, and, in consequence, the movements of the core, occasion the intervals corresponding to the period of the pendulum, *p*, of the station, then the oscillation of *p* increases in amplitude until the pin, *i*, on the lower end of the pendulum touches the spring f_1 and frees the spring f_2, which closes the circuit of the call-bell. Each station is fitted with an apparatus which enables them to cause at every other station of the circuit current impulses which correspond to the periods of vibration of the various pendulums. This is effected by the pendulum, P, which rests on the two V supports on the brass angle plate, W, attached to the base of the instrument. The pendulum is kept in its normal position by the pin, *d*, on the bar, *s*, and a spiral spring. A pressure upon the button, H, frees the pendulum, P, and sets it oscillating, making and breaking contact at every oscillation. Upon the pendel-bar is a weight, G, which has a steel spring attached to

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it. This spring is made to grip any of the 12 station numbers which are cut into the bar. This change in the position of the weight causes the 12 different times of oscillations. In consequence of the time of oscillation of pendulums P and p being the same, the latter swings out so far as to free the spring, f_2, as already indicated, and so causes the closing of the circuit of the alarm. A pressure upon button, R, stops the bell, and bring springs f_1 and f_2 back into their former position.

This method of giving a distinctive signal to any one station on the line is exceedingly neat.

SOME TESTS ON THE VARIATION OF THE CONSTANTS OF ELECTRICITY SUPPLY METERS, WITH TEMPERATURE AND WITH CURRENT.*

BY G. W. DONALD RICKS.

(Continued from page 365.)

Schuckert Meter.

This meter is exactly the same in principle as the Elihu Thomson meter, and is very similar to it in construction. It consists essentially of a small electrometer in which no iron is used, and whose motion is retarded by Foucault current friction. In Fig. 4, A is the armature, wound with

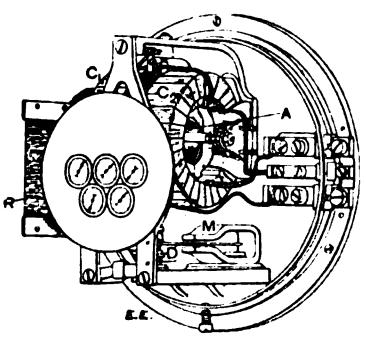

FIG. 4.

fine wire, and having in series with it a high resistance, part of which is wound to give a permanent driving torque, the remainder, R, being wound non-inductively. The field is produced by the main current in the series coil, C_1 C_2, and the retarding torque is obtained by the action of the permanent magnets, M, on the copper brake disc, D. The equation of motion of this meter is, of course, identical with that of the Elihu Thomson meter, which has just been described, and the statement given there is equally applicable to the Schuckert meter.

The curves on Diagram 2 show the results of the tests on this meter. Referring to the curves, it will be seen that

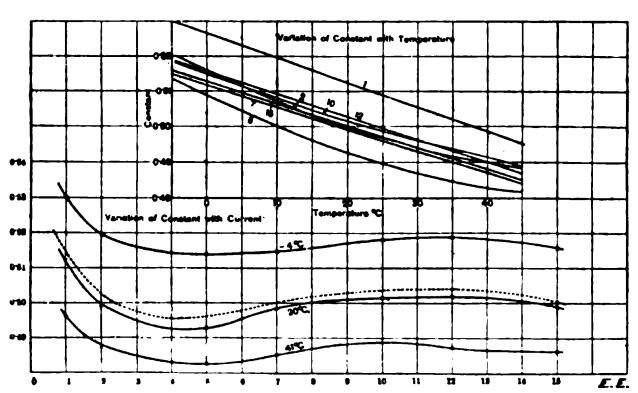

DIAGRAM II.—Schuckert Meter.
Maximum Current, 15 Amperes; Pressure, 110 Volts.

the constant, after starting, as the current is increased, rapidly approaches its declared value, falling below it at about 15 per cent. of the maximum current. The curve then dips down, but rising again crosses the declared value at about 50 per cent. of maximum current, after which it remains fairly constant till near the maximum, when it decreases slightly. The high value at low current is, of course, due to the uncompensated solid friction, but the reason for the shape of the remaining part of the curve is not apparent.

The effect of temperature is also shown on Diagram 2; the mean temperature coefficient is about 0·13 per cent. per degree C. This is much lower than the coefficient of the Thomson meter, and may possibly be due to a larger coefficient in the pressure circuit. It will be seen from Table 2 that varying the pressure has no appreciable effect on the accuracy of the meter.

The starting current was found to be rather high, being 0 29 ampere, or 1·93 per cent. of the maximum. The absorption of power is also very considerable, being 14·7 watts at maximum load and 4·8 watts at no load. The fall of potential in the series coils is 0·66 per cent.

The general characteristics of this meter are much the same as those of the Thomson meter. The constant approaches its normal value at a much lower percentage current, but, on the other hand, the remaining part of the curve is less regular.

TABLE 2.—Schuckert Meter.

Maximum current, 15 amperes. Pressure, 110 volts. $a = 1$, $K = 0{\cdot}5$. Current varied.

Current A.	At -4deg. C.		At 20deg. C.		At 41deg. C.	
	w	K	w	K	w	K
1	0 0577	0·530	0 0597	0·512	0·616	0·496
2	0·1178	0·519	0·1225	0·499	0·1256	0·487
5	0·2975	0·514	0·3110	0·492	0 3180	0·482
7	0·4160	0·515	0·4290	0·499	0·442	0·485
10	0·5910	0 518	0·6105	0·5015	0·625	0·489
12	0·7065	0·519	0·7300	0·5025	0·754	0·487
15	0 8925	0·516	0·9205	0·499	0·946	0·486

TABLE 2A.—Pressure varied. Current = 15 amperes.

V.	w.	K.
100	0·546	0·510
105	0·574	0·509
108	0·590	0·509
110	0·599	0·510
112	0·6125	0 509
115	0 627	0·510
120	0·645	0 509

Ferranti Meter.

The action of this meter is dependent on the principle that when a current is passed radially through a fluid which

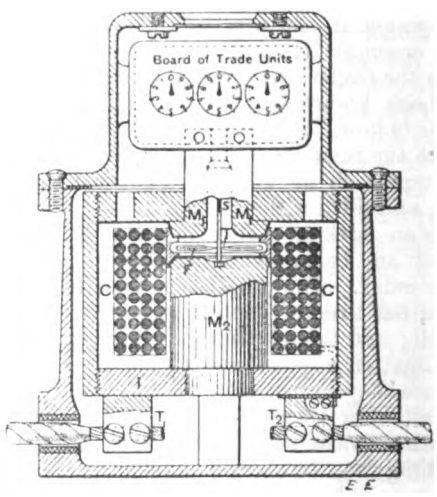

FIG 5.

is in a perpendicular magnetic field, the fluid tends to move in a direction at right angles to the directions of both the current and the field.

A diagram of its construction is shown in Fig. 5, where T is a disc-shaped insulated chamber, containing mercury. It is made of vulcanised fibre, and is fixed to the magne pole, M_2, the other pole, M_1, being close above it. The electromagnet is energised by the main current in the coil,

* Paper presented by Prof. W. E. Ayrton to the British Association meeting at Toronto.

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e, and is so designed that only the comparatively straight part of the magnetisation curve is employed—that is, the magnetic field is very nearly proportional to the main current. The current enters the meter at the terminal, T_1, which is connected with the iron case, I, it passes up M_2, and enters the mercury at the central part, T, and flowing radially outwards, enters the coil, e, by means of a metal ring, and then leaves the meter by the insulated terminal, T_2.

The chief retarding force is that due to fluid friction of the mercury against the sides of its chamber, which are stamped with radial grooves to increase the effect and make it proportional to the square of the speed over as large a range as possible. The counting mechanism introduces a small amount of solid friction, which is practically constant and is compensated for by using mild steel for the magnet core, which then has a small amount of permanent residual magnetism. The motion of the mercury is transmitted to a very delicately made counting mechanism by means of a vane immersed in it, and having a small vertical spindle which gears into the counting mechanism. Very pure mercury is used and the spindle is of very small section at the part where it breaks the surface, so that skin friction is not very great.

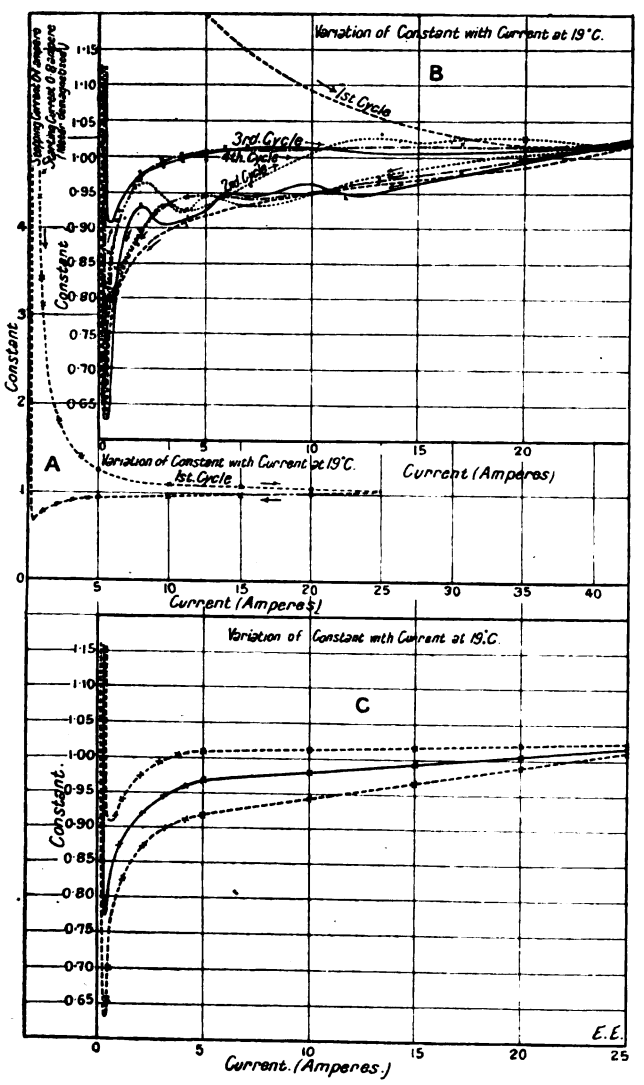

DIAGRAM III.—Ferranti Meter. Maximum Current, 25 Amperes.

The law of the meter may be expressed thus, assuming, however, that the fluid friction is proportional to the square of the speed throughout the whole range:

Let A = main current.
M_A = magnetisation due to the current A.
M_R = residual magnetisation.
w = angular speed of the armature.
$q w^2$ = force due to fluid friction.
p = force due to solid friction.
k = a constant.

Then $k\,A\,(M_A + M_R) =$ total driving force,

and $p + q\,w^2 =$ total retarding force.

For steady motion

$$k\,A\,(M_A + M_R) = p + q\,w^2.$$

Assuming magnetisation proportional to the current,

$$M_A = b\,A,$$

and residual magnetisation constant,

$$M_R = r,$$

then

$$k\,A\,(b\,A + r) = p + q\,w^2,$$

$$k\,b\,A^2 = q\,w^2 + p - k\,A\,r.$$

If the retarding force due to solid friction is exactly neutralised by the driving force due to residual magnetism,

$$p = k\,A\,r,$$

and

$$A^2 = \frac{q}{k\,b}\,w^2.$$

That is, the speed is proportional to the current.

This meter is made up in an extremely compact form, and has the great advantage of simplicity of construction. The substitution of residual magnetism for that produced by shunt windings used in an earlier pattern has removed one of its principal drawbacks, the waste of energy in the shunt. It possesses, however, the disadvantages attendant upon comparatively small driving and brake forces, necessitating the employment of an extremely light and frictionless counting mechanism, which, owing to its very delicate construction, must require very careful handling. It is also essential that the mercury used should be of the highest degree of purity, for the law of the meter depends directly on its viscosity, which would be seriously affected by impurities even in small quantity.

The tests on this meter revealed several characteristic points not found in any of the other meters tested. In the first place the constant at low currents was found to have a low value, giving a curve of quite a different shape. Then it was noticed that for any given value of the current the constant varied according to whether the current had risen or fallen to that value, and a third peculiarity is that its temperature coefficient is very small and positive as the constant increases and the temperature rises. Its mean value is about 0·07 per cent. per degree C.

TABLE 3.—Ferranti Meter.

Maximum current, 25 amperes. Current varied. Temperature, 19deg. C. $\alpha = 430$. $K^1 = 1$.

Current A.	Current increasing.		Current decreasing.		Mean.
	w	K	w	K	
0·5	0·0658	0·906	0·085	0·700	0·803
1	0·1285	0·930	0·1458	0·820	0·875
2	0·2460	0 972	0 2755	0·867	0·920
3	0·3622	0·990	0·4020	0·894	0·942
4	0·4775	1·001	0·527	0·909	0·955
5	0·5940	1·005	0·653	0·917	0 961
10	1·180	1·012	1·266	0·943	0·978
15	1·755	1·020	1·856	0·965	0·993
20	2·330	1·024	2·419	0·988	1·006
25	2·915	1·025	2·950	1·013	1·019

The same meter was very carefully tested for variation of constant with current by Messrs. Nelson, Kerr, and Gray, students at the Central Technical College, as well as by myself, and I am indebted to them for some of the following results. Previous tests had shown the nature of the curve—viz., that the constant apparently began at a very low value just after the meter started, and rapidly increased with increasing current. A few preliminary readings gave a similar result, and as it appeared to be due to the residual magnetism over-balancing the friction, the effect of demagnetising was tried, and gave the marked result shown graphically on Diagram III. In carrying out all the tests with this meter it was found necessary to put it through a regular cycle of current, starting from zero, increasing to a maximum, and decreasing again to zero. The constant was taken at frequent intervals, and the first cycle shown completely at A on Diagram III. clearly indicates the effect of unbalanced friction. As the current is increased from zero to a maximum, the constant, commencing at a high value, descends in a sort of hyperbolic curve, exactly as

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one would expect it would if there were a constant excess of retarding torque over driving torque. During the remaining half cycle we have again what would be looked for if there were a constant excess of driving torque over retarding torque—namely, an inverted hyperbola. This course bends up very sharply just before reaching the stopping current.

This operation was continued until the curves for two succeeding cycles were nearly coincident, which occurred with those of the third and fourth cycles. These are shown graphically at B on Diagram III., from which it will be seen that although the curves for the different cycles appear to be very irregular, still they all lie chiefly within an area enclosed by the descending half of the first cycle and the ascending half of the fourth cycle. The irregularities may be accounted for by variations in the lag of magnetisation caused by some such disturbing influence as vibration.

Curves showing the maximum variation of the constant with current and the mean value at any given current are shown at C on Diagram 3. The dotted curve indicates the amount to which the constant may vary at any given current by reason of variation in the lag of magnetisation. For increasing current this lag causes a decrease in the driving torque, and consequently a higher value of the constant than is the case when the current is decreasing. In ordinary working, however, these effects of lag would probably neutralise each other, and the mean curve shown in full line would represent mean working value of the constant.

(To be continued.)

ON CHARGING OPEN-HEARTH FURNACES BY MACHINERY.*

BY JEREMIAH HEAD, M.I.C.E.

(Concluded from page 374.)

Locking Gear.—In the most recent machines the rather complicated method adopted in the Thurlow example for locking the charging bar to the boxes has been superseded by a very simple device. The charging bar is hollowed throughout its length, and the interior is occupied by a steel rod connected with a lever on the operator's platform. When the front end of the charging bar has been lowered into the socket of the box, the operator, in order to lock them together, pushes forward the locking bar by means of the lever, until the front end projects into a recess provided for that purpose in the socket of the box. A reversal of the process releases the box. The front portion of the charging bar is separate from but keyed to the back portion, so as to facilitate renewal in case of wear or accident. The motor and gear for moving the machine longitudinally is upon the main carriage, and, as in the case of the charger truck, acts on one axle only. The motor and gear for twisting the charging bar is upon the operator's platform, as are also the controllers and switches for all the motors. The accumulation of these weights in that position balances to some extent the weights lifted by the charging bar. It will be noticed that in this machine, as in the original one at the Otis Steelworks, the operator is always opposite to his work, and moves to and from the furnace with the charging bar and box. He is therefore able to see into the interior of the furnace when depositing materials therein, and at other times remain in a cool place.

Electric Arrangements.—The motors for producing the requisite movements are each 25 h.p., except that on the operator's platform for twisting the charging bar, which is only 3½ h.p. But as the maximum effort is seldom required in any of the movements, and as they are successive and not concurrent, 25 h.p. may be considered the maximum used by them all at any one time. The power continuously used does not in all probability exceed an average of 10 h.p. whilst the machine is at work. The electric current is brought from the central generating station, a department with which large steelworks in the States are now almost always provided. The current, which is brought by a single pair of conductors running overhead along the charging platform, is conveyed to the operator's platform by sliding contacts, to be there distributed to the various motors. The new high-framed machine has a great advantage over the old low-framed ones, in that it admits of the necessarily bare conductors and contacts being kept high up and well out of the way of the traffic on the floor. The power at the central station may and should be generated by economical engines under favourable conditions. Little pressure is lost in transit, and no current is taken by the machine except when at work, and then only in proportion to the work actually done. The motors are of a simple type, encased in iron, like those so common in America for use under electric street cars. The current is a continuous one, and the voltage used is 220 to 250.

Forty-eight Tons Charged in an Hour.—The charging boxes are 6ft. long by 2ft. broad and 1¾ft. deep, which gives a capacity of 21 cubic feet. This is sufficient to contain a ton of ore or scrap and more than a ton of pig iron. Except when heavy castings and cobbles are to be dealt with, a ton is a convenient average load for a charging box, and three or four tons for a charging bogie, according to whether it is made to carry three or four boxes. If the boxes are properly loaded, the machine will pick up and empty one every minute, which is equivalent to dealing with an entire charge of 48 tons in 48 minutes. Allowing 12 minutes for contingencies, a charge would occupy one hour instead of 3½ hours, which is an ordinary time required for charging a 40-ton furnace, exclusive, say, of one hour for fettling. This would be required in either case. Thus a saving of 2½ hours per charge is effected by the machine.

Output increased 11 per cent.—The time gained per week by using machine against hand labour may be expected to be at least 2½ hours × 9 heats = 22½ hours, which is more than sufficient for an extra heat, or an increase in the total output of one-ninth, or 11 per cent.

Labour Saving.—The saving to be effected by using electrical charging machinery is not one of time only. I have shown that at present eight picked men (two shifts) are employed (in British steelworks) at each 40-ton furnace, and that these men handle among them 48 tons × 9 heats = 432 tons of material every full week, the handling being done in 9 heats × 3½ hours = 31½ hours. This is equal to $\frac{432 \text{ tons}}{31{\cdot}5 \text{ hours}} = 13{\cdot}7$ tons per hour while charging, or $\frac{13{\cdot}7 \text{ hours}}{4 \text{ men}} = 3{\cdot}4$ tons per hour per man for a period of $3{\cdot}4 \times \frac{9 \text{ heats}}{2 \text{ shifts}} = 15{\cdot}3$ hours per week. Now, where the machine is employed, the whole of this heavy labour is done by it, and the material need never be touched by the men at all unless something goes wrong, or unless it be necessary at any time to adjust the position of any portion of the charge in the furnace. It is clear, therefore, that the machine is a labour-saving as well as a time-saving appliance.

Economies Effected in America.—I give later on an estimate made from information supplied by Mr. Wellman of the saving in cost of labour by the use of machine-charging as against hand-charging in two 20-ton to 30-ton furnaces in the United States. It will be seen therefrom that in that country, even when working with fewer and smaller furnaces than we are accustomed to here, they are able to reduce the number of men required by one half, and the weekly labour cost to the same extent.

ESTIMATE OF SAVING OF LABOUR BY THE USE IN THE UNITED STATES OF MACHINE OVER HAND CHARGING.

Cost of Labour in Operating by Hand Two 20-ton to 30-ton Furnaces.

1	melter, wages per week	$30·00
2	first helpers (22½ cents per hour each)	32·40
2	second helpers (15 cents per hour each)	21·60
6	stockers (13½ cents per hour each)	58·32
1	door-boy	5·40
12	Cost of labour in one week, single turn	147·72
	Multiply for double turn by	2
		$295·44

$295·44 = 2s. 6d. per ton at 500 tons per week.

* Paper read before the Iron and Steel Institute

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Total number of men employed hand-charging (including stockers).

	Per two furnaces.	Per one furnace.
Per turn	12	6
Per double turn	24	12

With Charging Machine.

1 melter, wages per week	$30·00
1 first helper (22½ cents per hour)	16·20
2 yard loaders (12 cents per hour each)	14·40
1 machine operator (20 cents per hour)	15·40
1 boy	5·40
6 Cost of labour in one week single turn	81·40
Multiply for double turn by	2
	$162 80

Net saving labour in one week—

$162·80 = 1s. 3d. per ton at 550 tons per week.

132 64

40

$5,305·60

Net saving labour in 40 weeks	$5,305·60
Less 10 per cent. depreciation and repairs	750·00
Less 6 per cent. interest on cost of machine	450·00
	$1,200 00

Net saving in 40 weeks—

$4,105 60 = £844.

Total number of men employed machine-charging (including yard loaders).

	Per two furnaces.	Per one furnace.
Per turn	6	3
Per double turn	12	6

Nothing is deducted for wear of cars and boxes, as it is not estimated that this will be any more than that on the barrows, tools, and cars used in hand-work. Ten heats per week is assumed with hand-charging and eleven with machine-charging. The machine and its operator are charged to two small furnaces, whereas they could easily work six large ones. Taking 40 working weeks only as a year, and allowing 16 per cent. on the cost of the machine for interest, depreciation, and repairs, the savings by each machine appear to be £844 per annum. This estimate takes no account of the gain in lower establishment charges by increased output. If we take the output of the two furnaces at 500 tons per week with hand-charging, and £550 with machine charging, we shall find that by the former method the labour costs 2s. 6d. per ton of ingots, and by the latter only 1s. 3d. per ton. The use of the machine, therefore, converts the advantage we have hitherto had in England over our American competitors in cost of labour to a similar advantage to them over us. In America lessened labour is generally synonymous with lessened cost for labour. It is not always so here.

Two Machines to Six Persons.—If the machine will charge one furnace in an hour, it is obvious that it will charge at least a dozen in the 15⅔ hours, which we have taken as the average duration of the heats, including charging and fettling, of a 40-ton furnace. But in practice this cannot be done, because the charges cannot be relied to follow one another with precise regularity. One machine will, however, easily serve six furnaces. But bearing in mind the possibility of a breakdown, and the serious loss which might result therefrom, it is recommended that they should be used in pairs—that is, one to each six furnaces at work and one in reserve.* It will be noticed that the operator in the United States is paid at the rate of 45s. per week.

Supply of Materials.—The effectual employment of a charging machine is dependent on the materials being brought in charging boxes on specially constructed bogies to the charging platform, between the machine and the furnace front. The best arrangement is that shown in the diagrams, the full bogies arriving in succession at one end of the platform and the empties leaving at the other end. They are supposed to have been loaded at the stock heaps or input sidings, and to be returned straightway thereto. Charging platforms where machine-charging is in operation are free from stocks of material, standing wagons, and other impediments to a remarkable degree, and their coolness and cleanliness is at once remarked by those accustomed to hand-charging.

Narrow-Gauge Bogie Line.—The charging bogies may reach the platform level by an incline fitted with a continuous creeper, which is an excellent device, and they may descend the same way, or be pushed up by a small locomotive, or be raised by lifts. Where, as in some British works, it is difficult to make these arrangements, the materials may continue, as previously, to arrive at the back of the platform and be there loaded into the charging boxes on bogies. These by aid of a few small turntables, such as are common on pit banks at collieries, can easily be pushed round by hand to a position where the charging bar can operate upon them. But the arrangement shown is best. The charging machine itself is frequently used as a locomotive to push away empties and bring forward full bogies.

Doors Lifted by Power.—In the United States the furnace doors are usually lifted by hydraulic or pneumatic power, operated by a boy in a pulpit at the back of the platform. One boy works the doors for two furnaces. This seems better than the plan of lifting them by levers attached to the furnaces, which is usual here.

Charging Castings and Cobbles.—For loading broken castings and heavy cobbles such as waster ingots, the machine may be used with great advantage. In that case the cobble would arrive on a charging bogie in the usual way, but the charging boxes would be dispensed with, and a broad fork having a socket shank would have been placed upon the bogie before the cobble was loaded up. The machine would lift the fork with the cobble on it and introduce it into the furnace just as if it were ordinary material. In case the weight of the casting or cobble were sufficient to overbalance the machine, the stability of the latter might be largely increased by depositing pig iron into the back box columns of the framework.

Where Machine Charging is in Operation.—Charging machines are now in regular operation at several works in the United States. These include the Otis Steelworks, Cleveland, Ohio; the Homestead Works of the Carnegie Company at Pittsburg; the Illinois Steelworks, South Chicago; the Cambria Ironworks, Johnstown, Pennsylvania. In Germany there are two or three examples, but they are believed to be all of the Thurlow type, or closely allied thereto. In this country none are yet in operation, but two have been ordered by the Llanelly Steel Company, of Llanelly, and these will probably be at work in the course of the autumn.

All Laborious Work done by Machine.—Even if it were not found possible here to lessen the labour cost per ton of steel produced, it is clear that the use of a charging machine must make a manager less dependent upon men selected largely for their physical strength. The machine would do all the hard labour and the men would be reserved for more strictly human work.

Conclusion.—In conclusion, I desire to tender my thanks to Mr. S. J. Wellman, and his brother, Mr. C. S. Wellman, and their partner, Mr. Seaver, for much of the information I have been able to put before you; also to the Carnegie Company for allowing me to see the machines at their Homestead Works; also to Mr. G. Bartol, superintendent of the Otis Steelworks, and to my son and partner, Mr. A. P. Head, for preparing the illustrations, and otherwise affording me valuable assistance.

* There is no doubt that eight or more 40-ton furnaces might safely be worked with two machines.

Discussion.

Mr. A P. Head wished to offer a few brief remarks, especially on the electrical part of the machine. He thought that what must strike every mechanical engineer was the successful way in which motors had been adopted instead of the usual hydraulic rams. It might naturally be supposed that the very delicate, gingerly motions of the machine would be better accomplished by the slow, steady, rectilinear motion of a ram than by the rapid rotary motion of an armature. He might emphasise that high speed by saying that if the front end of the charging bar were moved from the lowest to the highest position through a distance of only 20in., the armature of the motor would have to perform no less than 40 revolutions; while to rotate the charging bar once, in order to empty a box, the armature of the motor which drove it would turn 48 times. Yet, in spite of those high velocities, by having the armatures very light and with a minimum of inertia, the various motions could be stopped, started, and reversed very quickly, and the whole machine could be handled with as much nicety and precision as if it were hydraulic. All the motors were series wound, the object being to get a strong starting torque rather than uniformity of speed. All the motions, with one exception, were stable—that was, they would stop where they were put without running back.

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The one exception was the rising and falling motion. If the weight of the front end of the bar more than counterbalanced the platform, the platform would tend to rise to its highest position, and, on the contrary, if the front end had no load, the platform would tend to fall. It was therefore necessary to provide a brake. The object of the brake was that when the current was turned on to the motor the gear should be automatically released, and when the current was turned off the gear was locked. On the shaft was keyed a square cast iron bush, which drove seven brass discs. These were fitted loosely enough to be moved sideways. Alternating with these were seven mild-steel discs, which were prevented from revolving by grooves in the periphery which fitted projections on the inner surface of the outer case, which was itself bolted to the frame. Under ordinary circumstances a strong spiral spring kept the discs squeezed up sideways, and the large amount of contact surface between the revolving and fixed discs prevented the armature from rotating and locked the whole gear. When the operator wished to start the motor the current was made to pass through the coil, and in doing so it converted the mild-steel brake cover into a powerful magnet, which attracted the outermost disc against the force of the spring, thus relieving the pressure and enabling the motor to start. Similarly, when the current was cut off, the discs were squeezed up by the spring, and the gear stopped dead. Thus, whenever the front end of the charging bar was not moving up and down it was absolutely fixed and rigid

Mr. James Riley, vice-president, said that anyone who had witnessed the operations of the charging of a large melting furnace must have felt some degree of sympathy for the men engaged in that operation. In the earliest days, when furnaces held only six or eight tons, that feeling came over him very frequently, and he had no doubt that all who were engaged in Siemens steelworks had, like himself, devoted a good deal of thought to the question of how that severe manual labour could be avoided. In the early days, and frequently since, he had given attention to the subject, but almost invariably he arrived at the conclusion that there was no economy in the use of machines as compared with the cost of manual labour for that purpose. But undoubtedly nowadays, when they had to do with such heavy charges, the whole conditions were altered, and he thought most of them would feel that, given a thoroughly good and trustworthy machine which would do the work expeditiously and well, it must be of great service to those who possessed it. He had considered the earlier machines made by Mr. Wellman, but he was bound to say he had the impression that they were cumbersome, and that although they might do in America, where there were large spaces, and where they had also to pay very high rates of wages to their employés, in this country, at all events, he did not see that there was sufficient attraction in them to warrant his recommending their adoption. The latest machine, which had been exhibited to them that morning, undoubtedly had a great deal to recommend it. He did not know whether it was due to his conservatism or not, or whether it was common to all of them, but the one thing he should hesitate about was the application of electricity. It seemed to him to involve a good many considerations. In the first place, if they had not—as was almost universally the case in this country—those large electric installations, that was a cost which had to be faced before those machines could be put into operation. If they did exist, and there was a skilled man in charge of the electrical apparatus, then, of course, that objection was removed. Then came the thought of the position in the works which the machine occupied, the trouble which might arise from dust, or other causes with which they were all acquainted, which might interfere with its successful working. At all events, he did not think that this country had yet got such a strong confidence in the use of electrical apparatus in steelworks as that they might venture readily, at all events without full consideration, to expend the large sum of money necessary for an installation, not of one machine, but in large works of two, or three, or four of those machines. They would like to know and see more of the actual working of that electrical apparatus. Those were the thoughts that had passed through his mind in the course of reading the paper, for he had not seen the machine; but he should be tempted, notwithstanding his doubts on the few small points he had mentioned, to venture to make use of that machine in connection with very large furnaces.

Mr. Lauder (Edgar-Thomson Steelworks, Pittsburgh) was not at all prepared to go into any details about the machine, but he was glad of the chance of speaking about it for a minute or two. With regard to the objections which had been urged, he could assure them as a fact that there were no objections whatever to the use of electricity in steelworks. Like a great many, he was very much opposed to the use of electricity so extensively when it was first proposed, but he had become a complete convert. It was said that facts spoke, and the facts that had caused him to form this opinion had been the financial result. They had made wonderful reductions in cost since they began using electricity so extensively as they had done. The writer of the paper had shown all the details of the machine so accurately and so nicely that he really had nothing further to add in that respect. He could simply tell them that his firm were entirely satisfied with the working of the machine, and they thought Mr. Wellman was entitled to a great deal of credit for the manner in which he had designed and put it into operation.

Mr. W. R. Stirling (Illinois Steelworks, Chicago) did not think he could add anything to what Mr. Head had said in his paper, for he had covered the ground very fully, and he was unable to go further into the matter in detail, for the reason that the Illinois Steel Company never had any hand-charging for their open-hearth plant; they considered it impossible, or at least unadvisable, to contemplate going into a business of that kind without automatic means of charging. He knew that the machines gave great satisfaction, and there was no fault to be found regarding the use of electricity, which was increasing more and more every day in all the large establishments.

Mr. E. Windsor Richards (past-president) said that, through the courtesy of Mr. Lauder and Mr. Carnegie, he had had the pleasure of accompanying them to Homestead a few years ago, and he had seen some of those machines charging the basic furnaces. He felt envious of the whole arrangement. The large space of ground mentioned by Mr. Riley, that was impossible here, made one wish that they could pull down the whole works at Bolckow's and start afresh. He was bound to say that the machine worked remarkably well. They were charging very large ingots, perhaps not, for one reason or another, quite right into the furnace, but in nearly as easy a manner as it was done just now by Mr. Archibald Head in his demonstration of the model exhibited. The main question was, after all, was there any great saving in it? He was inclined to believe that there was. There must be a great deal less wear and tear on the furnace and in the cooling down, which was a very important matter. He supposed the roof of a Siemens furnace of, say, 40 tons, would be about as troublesome a thing in a steelworks as one could well imagine. Mr. Riley was, of course, much more competent to speak on that point than he was. On the whole, he should say it was a most desirable thing, and if anyone could, with the old existing plants in this country, adopt something like this, which was really a simple machine—there was nothing very complicated about it—he thought it would be very advantageous that they should do so. They were all surprised at the enormous outputs in America, whether from the Siemens furnace or from the blast furnace, or the rolling-mill, or other plant. There must be some reason for this; it was that they were so quick to adopt any new device. In Great Britain, on the other hand, there was always hesitation, owing to fear of the machine breaking down and stopping the works. British manufacturers must not be so slow in the future as they had been in the past in taking up these improvements.

Mr. George Ainsworth was afraid he could not add very much to the discussion. There was no doubt that everyone connected with the Siemens furnace would be only too glad if something could be brought before them in the shape of a practicable machine for saving the laborious charging which now had to be gone through. He was inclined to think, however, that they sometimes magnified the saving to be effected, because all of them knew that whilst they were charging a furnace it was not altogether time lost. A certain amount of melting during this period was always going on, and the consequent gain therefore by shortening the operation was not altogether so great as it at first sight appeared to be. At the same time there was no doubt that an important saving might be effected by some machine. The only point which struck him, so far as he had seen the working of the model of the machine before them, was that he did not quite see how they could lay the material round the furnace in the way it was done by hand, and which was generally supposed to be absolutely necessary. He was not prepared to say whether that was so or not; but it was a belief amongst them that they must have some means of carefully laying the pig iron round the sides of the furnace, to allow them to dispose properly of their scrap, and prevent excessive wear and tear of the hearth of the furnace. Of course what struck them on the face of it was that no charging machine such as that ought to be necessary. The simplest charging machine they could possibly have would be a ladle with fluid metal. Unfortunately, at that stage they had not yet arrived.

Mr. F. W. Paul said he thought Mr. Ainsworth had fairly well covered the points which he had contemplated speaking about. As regarded any mechanical difficulties in the working of the machine, he thought the fact of its being in daily operation in America would largely discount any fears that they might have on that point. With respect to its replacing of men, he did not feel very sanguine that such an arrangement would cheapen the total cost of labour per ton of ingots in this country, for in the operation of a 40-ton furnace, such as tapping, fettling, and feeding ore whilst the charge was on the boil, three men were required; but he was strongly of opinion that the high-rated first hand ought to be replaced by cheaper labour for charging irrespective of a charging machine, because the skill of a first hand consisted in safely maintaining the furnace at a high temperature and in properly working the charge. It was therefore unreasonable that this high-rated skilled man should be employed in the purely manual work of charging. He was also of opinion that it was desirable to cover the banks with pig iron, so that the oxide of iron (which formed whilst melting the steel scrap) did not come in contact with the acid banks of the furnace, which would necessitate longer time in repairing and fettling the furnace. In America basic furnaces were chiefly used, and probably that difficulty had not been experienced there in connection with the charging machine, but it was a point worthy of consideration in this country, where acid bottoms were more exclusively used.

Mr. Enoch James had given some attention to the matter, and having had some experience with electrical cranes in melting shops, he was able to assure Mr. Riley that electrical work was not attended with those difficulties which he assumed. He had had the notion of constructing a charging machine himself, and he thought that he had attempted more than had been attempted here. He conceived the idea of bringing the pig iron from the blast furnace to the charging tool without a man touching it. As some of them were aware, at the Dowlais Cardiff Works, with which he was connected until recently, the pig iron was broken by machinery, and was delivered by means of a shoot into trucks.

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That shoot would be very suitable to deliver the pig iron into boxes. He contemplated bringing the boxes there, and instead of having separate boxes to go into the furnace, he thought of getting one box only with a sliding bottom, thinking possibly that the tipping over of a ton of pig iron would damage the bottom of the furnace a great deal more than withdrawing the bottom and letting the charge of the pig iron just find its level in the furnace. He thought a great deal remained to be done in that particular direction, and no one need have any apprehension as to making use of electrical work in connection with steelmaking. He might add that, having arrived at the same conclusion as Mr. Ainsworth with regard to fluid metal, he had left the mechanical charger in abeyance, and had proceeded to use molten metal. That was done by means of a 30-ton overhead travelling crane, driven by electric power, lifting the ladle which conveyed the molten iron from the blast furnaces and placing it in front of the melting furnace. The ladle was tilted by worm-wheel gearing, and the metal flowed over a short trough into the furnace. During the brief period these trials were being made, upwards of 2,000 tons of molten pig iron were charged most successfully in this way. He had satisfied himself as to the great advantages to be derived from this method of working.

Mr. J. W. Spencer said he did not know that he could add anything to the discussion, but should like to say he did not think steel manufacturers were quite so bad as painted by Mr. Windsor Richards, in not availing themselves of new inventions that came forward. He did not think they were always in a position to do so. There were at least two factors to contend with—one that in most cases their works were laid down some time ago, and it was not always possible to adapt all these improvements to existing plant, as in the case before us; and secondly, few could afford to reconstruct in a country where the supply was largely in advance of demand. Besides, they had another factor which he thought would probably interfere with the adaptation of this machine in numbers to their furnaces, and that was the consent of the men. They had not in the past got the returns from the men they should have for the capital laid down for labour-saving. Whether they were to be more fortunate in adopting an installation like this he did not know, but if they did, where it could be used it might be a very valuable addition to the appliances they had for steelmaking.

Sir Edward Carbutt, Bart, thought that, as a mechanical contrivance, Mr. Head's machine was very good indeed. They were very much obliged to him for bringing the paper before them. He rose more to emphasise what had been said by their past president, Mr. Windsor Richards. He thought there was no doubt that in this country manufacturers were a little too conservative, and considering that they formed part of a country that had the money, and that money was so cheap that people did not know what to do with it, they need not be quite so frightened as they had been. Mr. Windsor Richards had done a large amount of good to his country in calling attention some time ago to what had been done in America; and by his speech that morning he had earned some credit in the same direction, because it was a great pity to be frightened at going ahead because they had old machinery, and did not want to spend the money. If they were going to fight a battle, it was only by spending money that they could fight it successfully. He wanted to call attention to one point. It struck him that Mr. Head did not take sufficient credit for what he (Sir Edward Carbutt) conceived would be an advantage—that was, that the door of the furnce would only be opened a third of the time that it was open if they were charging by hand. They all knew that a furnace was getting pulled to pieces throughout when it was hot and they had got the furnace door open; and he believed the less wear and tear in having the door open one hour instead of 3½ hours would very soon pay for a good deal of extra machinery.

Mr. David Evans (member of council) said they were greatly indebted to the author for his valuable paper, and for bringing the Wellman charging machine before their notice. They all knew the laborious work the men had in charging the Siemens furnaces. When he (Mr. Evans) went to the United States in the autumn of 1895, he visited the Carnegie Works and also the Chicago Works, where they had 50-ton furnaces. A Wellman's machine was working there, and he was very much struck with the rapidity and the ease with which it did its work. He saw no difficulty there with reference to what Mr. Ainsworth spoke about as to placing the charge and spreading it properly over the furnace hearth. They did it without any difficulty, and he was very much surprised at the enormous quantity that they were turning out per furnace. He had thought a great deal of adopting it, but the present arrangements of the plant at Eston would not admit of its ready adoption, but at the same time they were drawing out a scheme which he hoped would overcome the difficulty. As Mr. Riley and Mr. Windsor Richards said, they did not in old works always have plenty of room to enable them to put down further appliances, but he had such faith in it that he strongly recommended Mr. Trubshaw (who came to see him when he was making a tour of the various works in the country) to adopt this apparatus in the new works which he was putting down.

Mr. Ernest Trubshaw said that when he was at Middlesbrough last autumn Mr. David Evans had been good enough to suggest that his firm should go in for mechanical charging at the Siemens furnaces at their proposed new steelworks at Llanelly, and that in laying out the works they should provide ample room for such a machine as that described in Mr. Head's paper. He need only say that he and his colleagues had fully considered the matter, and after having seen a similar machine working satisfactorily in Germany they had decided to adopt it.

Mr. J. Maybery said he had been pleased to hear the discussion which had taken place. His company had ordered two of the machines, and he did not think that they had gone far wrong in so doing.

Mr. Ravenshaw said that, as an electrical engineer, he should like to say a few words about reliance on electrical machinery of this kind. He had principally had to do with it in coal-mines and engineering works generally, and he had always found that, for electrical cranes, lifts, and hauling engines and pumping engines in mines, the use of electricity was most satisfactory. There was an immense number of electrical machines running in coal-mines at the present time under very bad conditions indeed. The wet and the dust were, of course, injurious to the machines if they were not properly enclosed; but they could be entirely enclosed, and when that was done they ran for years practically without any trouble at all. He had not had any experience in steelworks themselves, but he had the honour of describing a large electrical crane before the Institution of Civil Engineers a few weeks ago, and that crane was working in Woolwich Arsenal, where the steel tubes were annealed, the fumes and dirt being very considerable, and there had been no difficulty whatever in the electrical arrangements.

Mr. Jeremiah Head, in reply, said he had not a very difficult task to perform, because in many cases the objections of some members had been answered by others. He was much obliged for the kind reception which they had given to his paper, and for the lenient tone in which they had discussed it. Mr. Riley was wise in refraining from recommending the earlier machines, which were actuated by hydraulic power, for the reasons pointed out in the paper. Indeed, it could not be said to have attained real success until electricity was adopted as the motive power. Mr. Riley hesitated as to the use of electricity in such a machine as this. He need not attempt to remove Mr. Riley's doubts, because all which it was necessary to say on that point had already been so well said by Mr. Lauder and Mr. Stirling. They had had considerable experience of the machine and other electrically-driven machinery, and they were satisfied that Mr. Riley would presently change his mind. He (Mr. Head) had seen so much of the successful application of electricity for power purposes in the States and elsewhere that he had long since ceased to regard it as a matter for hesitation. In fact, in this country there was no doubt that we were behind the times in the use of electricity, both for lighting and power purposes, as compared with our Transatlantic friends. Mr. Windsor Richards had remarked that as a nation we were apt to be too conservative, and that we were slower than our American cousins in the adoption of new ideas. There was no doubt that that was the case. The principal cure for that excess of conservatism was, he thought, to travel more. If we only went abroad more, and saw what our competitors were doing—and he was sure they were always glad to see us—if we only did that to the same extent that Americans visited us, and inquired into what we were doing, he was quite sure that we should acquire some of their more go-ahead tendencies, and that would be to our advantage. The chief opposers of improved methods were generally those who had not taken the trouble to make themselves acquainted with them. It was impossible in these days to keep to the front without maintaining a constant acquaintance with all improvements in our own line of business wherever made. Mr. Ainsworth's difficulty, as to disposal of the charge inside the furnace, had been answered by Mr. David Evans, who, after having seen the machine in operation in the States, was satisfied that there was in practice no trouble at all of that nature. As to charging with ladles full of molten metal, that was a plan eminently suitable for the Bessemer process, which dealt with pig iron only—that is, provided an intermediate desulphuring mixer was used. But open-hearth furnaces were not fed with pig iron only, but also with ore and scrap. As he had shown, the pig iron was sometimes only 27 per cent. of the entire charge. The question would arise how the other materials were to be dealt with. The 67 per cent. of scrap could not well be melted except in the furnace itself. Then, again, if the materials were brought in a molten state, their composition would have to be guessed at, more or less, and the result would be less under control. Charging with molten metal both in the steel-melting and the puddling furnace had been tried over and over again during the last 30 years, but so far without any marked success. He had no doubt whatever that what Mr. Paul and the president had said as regards labour was well worthy of attention. At each furnace there must be one man of skill and experience, and they must expect to pay him well. If his time was not fully occupied, as it certainly would not be by a single furnace, there was no reason whatever why he should not attend to two, three, or four furnaces. In fact, he ought to rank as a foreman rather than as a workman. The use of the machine would certainly help to enable them to make such an arrangement. There was no sense in making a highly-skilled and highly-paid man do ordinary labour, such as putting pig iron into a furnace. It had been said by Mr. Spencer and others that in old works it was not easy to make improvements involving structural changes. That was so; but at the same time they must remember that Nature, in its economic laws, as well as other laws, was inexorable, and that if we were to retain our position in the face of the competition of the whole world, we must keep up to date whether we liked it or not. The fittest would always survive, and the weakest always go to the wall, however hard it might seem. He thought Sir Edward Carbutt's point—namely, that by means of this machine they would minimise the time during which the doors were open—was a very important one in preserving the life of the furnace. Mr. Trubshaw and Mr. Maybery had given the very best proof they possibly could of their belief in the machine by having actually

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ordered two, which were now under construction. They had the distinction of being the first in this country to adopt it.

The **President** said he rather agreed with some of the remarks which had fallen from Mr. Windsor Richards as to their slowness of adopting new improvements. But there was another point that sometimes, perhaps, was at the root of the difficulty—namely, that the iron and steel trades generally were not so prosperous as to encourage them to go in for expenditure that they otherwise would do. There was another point to which he wished to call special attention to, and that was: Why was it that on the Continent furnaces of about 15 tons were charged and drawn so much oftener than we could get them drawn in this country? He knew as a fact that furnaces working with about 60 per cent. of scrap and the remainder of pig iron were making five heats in 24 hours, whereas similar furnaces in this country, and working on very much the same mixtures, were barely drawing more than two charges, or, at the outside, three charges, in 24 hours. He also agreed with the remarks that fell from Mr. Paul. He thought that they should adopt the plan which had been adopted for some time in the States, of one man being responsible for the quality and the working of three or four furnaces. There was no reason whatever why a skilled man should throw away his time simply handling pig iron and charging furnaces.

COMPANIES' MEETINGS AND REPORTS.

BRUSH ELECTRICAL ENGINEERING COMPANY, LIMITED.

The eighth annual meeting was held on September 17 at the Cannon-street Hotel under the presidency of Mr. J. B. Braithwaite, jun., the chairman of the Company. There was a large attendance of shareholders.

The **Chairman** in the course of a lengthy statement, referred to the balance of profit of £18,962 carried forward to the balance-sheet as compared with £4,615 last year, showing an increase of £14,347 in the profits available for dividend. Roughly speaking, that sum was made up of increase in the earnings £10,000, and reduction in expense £4,300. The gross profit on trading had been £32,655, compared with £33,298 last year, which was really a very great improvement, because last year's figure included the profits made on the Vienna factory and the profit realised on the sale of the Vienna business. This year, therefore, they had had to be without the profits from the Vienna business, and in addition they had had to make up the profit they made last year on the resale of the Vienna property to their Continental friends. The amount realised on securities sold, interest account, and dividends on securities held, £7,224, showed a considerable increase on the year, which was largely due to the sale of the Vienna business. Turning to the other side of the profit and loss account, the directors had again agreed to waive half their fees, and the salaries showed a reduction of £700. The total result of the general charges was that they came to £11,970, as against £13,116 last year, a reduction of about £1,000. Turning to the balance-sheet, they would see that there were some considerable changes in the figures there, owing to the resolution passed last year for a reduction of the capital to the extent of £90 000. That had now been approved by the Court, and consequently the balance-sheet was made out in accordance with the revised figures—a reduction of £99,000 in the capital account on the debit side and the corresponding reduction in the assets on the other side. The creditors showed a slight increase over the amount last year, standing at £35,533 this year, against £28,982 last year; that was due to the increased turnover of the past year. Last year they had a loan from the bankers against security of £26,775; this year that item disappeared, and instead of it they had various large sums of cash available. They had £18,799 cash in the hands of the trustees for the second debenture stock holders in preparation for the redemption of £26,770 stock on October 1; also, on the other side, there was an item of £9,800 cash in hand at bank and head office, and in addition to that they would notice, under debtors' sundry accounts, £45,194 instalments on contracts. Altogether they had something like £75,000 of cash assets available, besides shares and debentures in other companies. With regard to the liability on shares in other companies, which stood at the date of the balance-sheet at £3,700, £2,500 has since been paid, so that at the present moment the liability on shares in other companies is £1,200, as compared with £11,142 this time last year. On the credit side of the balance-sheet they took in the freehold factory and plant at Loughborough at the figure of Messrs. Fuller, Horsey, Sons, and Cassell's valuation last year, plus the amount expended on the extensions to the factory during the year, £11 348. They were still carrying out further extensions at Loughborough, but he hoped that during the current year their arrangements there would be entirely completed in their new form. Patents and goodwill, which last year stood at £206,397, this year appeared as £181,397, showing a reduction of £25,000. That was part of the appropriation of the reduction of capital which they authorised last year. The stock now stood at £92,318, and with the Australian branch at £103,454, as against a total figure last year of £100,662. The total figure of the debtors this year was £143,281, which compares with £140,433 last year. The bonus to be paid to the employés under the profit-sharing scheme amounted to £1,600, and they recommended that £5,000 be placed to the reserve fund and that £3,000 be carried forward. As regards the work, their orders were largely increasing, and in consequence of the comprehensive character of their business they were always busy, because one department balanced another. Mr. Raworth had resigned his position as engineer, but they had retained his services as consulting engineer, and also as a director. Mr. C. E. Hodgkin had been appointed manager of the Falcon-road works. In place of Mr. Geipel, who had left to take up another position, they had appointed Mr. Dalbary as superintendent engineer. In conclusion, the Chairman moved the adoption of the report and accounts.

Mr. B H. Van Tromp seconded the motion, which, after a brief discussion, was put and unanimously agreed to.

On the motion of the **Chairman**, seconded by **Mr. Arthur Ayres, M.I.C.E.**, the following was also agreed to: "That the recommendation of the directors to pay a dividend at the rate of 4 per cent. for the year ended June 30, 1897, on the preference shares be, and is hereby, adopted."

Mr. A. H. Sanderson and Colonel F. G. Steuart (the retiring directors, were unanimously re-elected on the motion of **Mr. Lamont**, seconded by **Mr. Barford**; the auditors (Messrs. Cooper Bros. and Co.) were also re elected.

The proceedings then closed with a vote of thanks to the chairman and directors.

BURY TRAMWAY COMPANY.

The half-yearly meeting of the shareholders of the Bury, Rochdale, and Oldham Tramway Company was held at the Grand Hotel, Aytoun-street, Manchester, this week. Mr. Coomer presided, and there were present Mr. James Byrom and Mr. Brown (Bury).

The **Chairman** said he had pleasure in moving the adoption of the report and the recommendation of a dividend of 5 per cent. per annum. With regard to electric traction, they would remember that at their last meeting he mentioned that they had offered to convert to an overhead electric system the section running between Rochdale and Littleborough. The terms which they named were undoubtedly not favourable to the local authorities if they wished the Company to do the work. As he stated then, they never contemplated entering upon the work except with the approval and goodwill of the authorities. Rochdale seemed to approve that they should, for the present at any rate, continue the working by steam under the present arrangement, and so there the matter at present rested.

Mr. Byrom seconded the adoption of the report.

Mr. Leighton said he wondered whether there was a probability of Rochdale and the Bury Corporations taking over the tramways. He saw that in Manchester, Burnley, and Blackburn these things had been entertained, and he thought that in some cases they had been passed by the Corporations. Now that that Company's tramways were in such good order and everything in first-rate condition, he should think it would be time to pass them over if they were disposed to take them.

Mr. Johnson (Winnington) said that it had been the customary thing in most towns for the corporations to buy the tramways and then let them on lease for 21 years.

Mr. Leighton said that that was not his idea, if they passed it. His idea was to sell to the Corporations out and out.

Mr. Johnson: Yes, that is perfectly right. They buy them, and then lease them to the company afterwards for a term.

The **Chairman** said that they were aware, as had been stated once or twice, that the tenure under which they held the tramways had somewhere about five years to run yet, so that he did not know that they could profitably anticipate what the Corporations might do at the present time.

The motion was carried, and on the proposition of **Mr. Brown** (Bury), a vote of thanks was passed to the chairman. The meeting then terminated.

BABCOCK AND WILCOX.

The report of the directors for the year ended June 30 states that the profit amounts to £82,378. From this amount has been written off purchase of business account the sum of £20,000, leaving £62,378. To this has been added the balance brought forward from last account—£5,276. 14s. 3d.—making a balance of £67,654. 16s. Deduct from this the interim dividend for the half-year to December 31, 1896 (paid February 12, 1897), at the rate of 6 per cent. per annum on the preference shares and 5 per cent. for the first six months of the financial year on the ordinary shares, amounting to £10,000, and it leaves a balance of £57,654, from which the directors recommend that the following dividends be paid for the half-year ended June 30, 1897—viz., dividend at the rate of 6 per cent. per annum on the preference shares (from which income tax to be deducted), £3,000; dividend of 10 per cent. for the second half-year on the ordinary shares (free of income tax), £14,000. They also recommend that £35,000 be placed to reserve, leaving a balance to be carried forward of £5,654. The directors have the pleasure of reporting that the new works at Renfrew are now in complete working order, and that the general office in Glasgow has been removed to the works at Renfrew, a smaller office, for selling purposes, being retained in Glasgow, at 21, St. Vincent-place.

ROCKHAMPTON (QUEENSLAND) GAS AND COKE COMPANY, LIMITED.

Report of the directors to the shareholders for the half-year ended June 30, 1897 (forty-ninth half-year); together with the profit and loss account of the electric light operations:

The directors, while regretting their inability to intimate an

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increase in the revenue through the medium of either gas or electricity, would state at the same time that the gas consumption during the last two months, compared with the corresponding periods of the previous two years, indicates a substantial improvement, which it may be hoped will be maintained. It may also be mentioned that the existing plant is capable of supplying a very much larger consumption, and it will be the constant effort of the directors to endeavour to increase the number of consumers in both branches of the Company's operations. Reference has already been made in a former report to the introduction by the Government of an Electric Light and Power Act, which deals with the whole question of the conduct of electric light enterprises in Queensland. On and after January 1, 1898, this Company will be subject to the clauses of that Act, and in pursuance of the provisions thereof the directors are now applying to the various local authorities in whose areas it is proposed to operate, for their sanction to the granting of an order to the Company by the Governor-in-Council. During the half-year the plant and buildings have been carefully maintained, and the cost of such maintenance has been charged, as usual, to the fund devoted to that special purpose. The gas operations show a profit of £1,718. 5s. 8d. The electrical operations show a return of £189. 3s. 11d., which has gone towards the payment of the interest upon the debentures, leaving a difference of £110. 16s. 1d., represented in the debit balance of the profit and loss account of this section of the business. The net profit for the whole of the Company's business is £1,607. 9s. 7d., which, in order to strengthen the position of the Company, the directors recommend shall be appropriated in the following manner—viz., £1,000 to be placed to the credit of the reserve fund for equalisation of dividends, and £607. 9s. 7d. to be placed to the credit of the reserve fund for maintenance and improvement of plant. In terms of the articles of association, you will be called upon at the half-yearly meeting to elect two directors in the place of Mr. Henry Jones and Mr. Henry Mills, both of whom retire, but are eligible for re-election, and to elect two auditors in the place of Messrs. J. C. Dove and C. Hitchcock, who retire, but only one of whom, Mr. J. C. Dove, is eligible for re-election.

PROFIT AND LOSS ACCOUNT.—ELECTRIC LIGHT OPERATIONS FOR THE HALF-YEAR ENDED JUNE 30, 1897.

Dr.	£	s.	d.
Generating electric current	470	3	6
Management, etc.	63	10	9
Printing	9	15	8
Interest	300	0	0
Stationery	5	11	7
Insurance	20	0	0
Private arc maintenance	12	9	11
Advertising	5	14	8
	£887	6	1

Cr.	£	s.	d.
Electric current sales	640	13	6
Sundries	13	6	5
Electric light fitting account	83	12	3
Interest	8	17	1
Rental on electric light fittings	30	0	9
Balance	110	16	1
	£887	6	1

LEGAL INTELLIGENCE.

ROAD OBSTRUCTION.

Fred Collard, agent of Callender's Cable and Construction Company, Limited, London, was charged with causing an obstruction on the highway at Morley at 8.20 p.m. on the 1st inst., and pleaded not guilty. The company were putting the electric lighting cables down under the causeway, and the road was obstructed by stones, etc., and excavated matter.

Defendant, addressing the Bench, said that in his contract he had not to make good the reinstatement of the paving. That had to be done by the Corporation. He finished his contract on Tuesday night, August 31, and told the foreman pavior to light the place, but he did not seem prepared to do so, and he (defendant) agreed to do it that night. On the Wednesday none of his men were working at the place at all, but were at another place a mile away. He told the foreman pavior that he should not be responsible at all. The Corporation men brought the ashes there and threw them up, so that he should say they were responsible.

The **Mayor** said the Bench realised that there was difficulty about the case. The police were bound in the discharge of their duty to summon anyone who caused an obstruction in the public roads which constituted a danger, and in this case they had only done what they were absolutely bound to do. At the same time the Bench felt that there was a *bonâ fide* question as to whether the defendant was personally responsible for the obstruction or whether the Corporation were, and they were inclined to take the view that, whilst it was not for them to decide where the responsibility lay, the police were bound to say whether a man had caused an obstruction. If the Corporation declined to discharge what the defendant considered to be their duty, he had no right to leave the road in a dangerous state for the public, but at the same time the Bench believed he had acted in a *bonâ fide* manner, and what they proposed to do was to order him to pay the costs, and that the case should be withdrawn.

CONTRACTS FOR ELECTRICAL SUPPLIES

CONTRACTS OPEN.

Copenhagen.—Tenders are invited for an elevator worked by electricity, electromotor. etc. Applications are to be addressed to Boulevard de la Vestre 22, Copenhagen. Tenders by October 1.

Glasgow.—The Corporation are prepared to receive tenders for the electrical equipment of the Springburn and Mitchell-street route, particulars of which appear in our advertising columns. Tenders by October 18.

Russia.—The Municipal Authorities of Novorossisk, South Russia, are inviting tenders for the concession for the construction and working of an electric tramway, and for the electric lighting of the town. Tenders by November 1.

Ploesti (Roumania).—Tenders are invited for lease of lighting the town by electricity for a period of 40 years, also for power transmission purposes. Particulars may be obtained on application to the Municipal Authorities at Ploesti. Tenders by Nov. 15.

Southampton.—The Corporation invite tenders for the supply and erection of various engines, alternators, motor-alternator, rectifiers, high-tension switchboards, continuous current generators, balancing and volt raising transformers, low-tension switchboards, and a battery of accumulators and accessories, particulars of which appear in our advertising columns. Tenders by October 18.

Brussels.—Tenders are invited by the Administration of the Belgian Government Railways for the installation of electric lighting at the Brussels Railway Station (South). Specification No. 268 can be obtained from that authority. Tenders will be adjudicated publicly on October 6 at the (Bourse) Exchange at Brussels. On the same day the same authority will accept tenders for lamp-posts, reflectors, etc.

Sydney (New South Wales).—Tenders are required by October 18, at noon, at the General Post Office, for supplies to the Telegraph, Telephone, and Post Office Departments, including iron, copper, and insulated wire, insulators, nails, screws, nuts, bolts, electric batteries with all accessories and chemicals, diaphragms, arc lamps, incandescent lights, 11,000ft. carbon for arc lamps, and various other appliances.

Leeds.—Tenders are invited by the Guardians for the electric lighting of the Board room, East-parade, Leeds. Plans may be seen and specifications obtained by application at the offices of Mr. T. Butler Wilson, F.R.I.B.A., architect, 12, East-parade, Leeds. Sealed tenders to be delivered to Mr. James H. Ford, clerk, Poor-Law Offices, East-parade, Leeds, endorsed "Electric Lighting of Board-room," before 12 noon on 25th inst.

Singapore.—The Municipal Commissioners of the town of Singapore, Straits Settlement, invite proposals for the lighting of the public street lamps for five years from January 1, 1899. Tenderers may submit proposals for lighting by gas or oil, or partly with one illuminant and partly with the other. Further particulars may be obtained on application to Mr. C C. Lindsay, M.I.C.E , 167, St. Vincent-street, Glasgow, or to Mr. J. Polglase, secretary to the Municipal Commissioners of Singapore, Singapore. Tenders may be sent either to Mr. Lindsay, up to November 30 next, or to the Secretary up to December 31.

Queensland (Australia).—The Municipal Council of Ipswich, Queensland, is inviting tenders for the supply and erection of the following electric lighting plant, etc.: tubular boilers, pipes, pumps and heaters, alternators and exciters, switchboard, high and low tension mains, junction boxes, transformers, etc. Specifications and all particulars as to conditions, etc., may be obtained from Messrs. Gordon and Gotch, St. Bride-street, Ludgate-circus, London, E C., and tenders have to be forwarded to the town clerk (Mr. Albion Hayne), Council Chambers, Ipswich, Queensland. Tenders by November 15.

Russia.—Two concessions for the erection and lease of street railways are open for tender. These tramways may be worked either by electricity or any other means. Tenders for the works at Penza will close September 30. Particulars are to be obtained at the offices of the Municipal Administration. The second lot of contracts is for a similar undertaking in the town of Kontais, in the Caucasus. The municipal authorities will furnish applicants with particulars as to this work. For the benefit of intending contractors, we observe that they will save themselves time, and probably disappointment, if they will write their letters in French.

Ludlow.—The Corporation offers a prize of £20 for the best and most economical scheme of electric lighting for the borough. The scheme must deal exhaustively with the whole matter, and give definite information of the cost of steam and water power for the purpose of comparison with the total cost of the undertaking and working expenses. Schemes to be delivered at the offices of Mr. John Herbert Williams, town clerk, Ludlow, marked "Scheme for Electric Lighting," before 4 p m. on October 1. Should the Corporation employ the engineer whose scheme is awarded the prize to carry the work out, then the £20 will merge in the commission to which he would then be entitled to.

Belize (British Honduras).—Tenders are invited by the District Board of Belize for the lighting by electricity of the town of Belize. The system decided upon is that known as the three-wire or neutral-wire system, and comprises boilers, engines, dynamos, accumulators, copper mains, flexible leads, iron lamp standards, switches, fuses, lamps (glow), and lamps (arc), meters, etc. Full particulars of the requirements of the Board can be obtained on application to Mr. A. R. M. Simkins, M.I.E.E., care of F. Otto, Esq., Tower-chambers, Moorgate-street, London, E.C. (Telegraphic address,

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Helios, London). Tenders should be addressed and should reach Mr. Simkins by October 20, and should be enclosed in a sealed package, marked "Tender for Electric Lighting."

Plymouth.—The Corporation are prepared to receive tenders for engineering works in connection with the tramways of the borough, full particulars of which appear in our advertising columns. The contracts are divided into two—viz. (Contract No. 10) overhead trolley line, posts, brackets, etc.; (Contract No. 11) tramcars, trucks, motors, trolley arms, etc. Contractors may tender for either of the contracts, but not for a part of any contract. Copies of the conditions, specifications, and forms of tender, bound up together, may be obtained on deposit of £2. 2s., for each copy, which will be returned on receipt of a bona fide tender upon the prescribed form and within the stated time. A copy of the drawing of posts will be sent to those wishing to tender for Contract No. 10. Sealed tenders, endorsed "Engineering Contract No. —," must be delivered to Mr. J. H. Ellis, town clerk, Plymouth, not later than October 2. The acceptance of any tender will be subject to the contractor paying the standard rate of wages obtaining in the district where the work may be carried on.

Hull.—The Corporation are advertising for tenders for the electrical equipment of their tramways, to the extent of about nine miles double track and half mile single track. It will be open to contractors to submit tenders for various systems, and the contract, which will not be divided, will include engines and generators, switchboards, feeders, poles, brackets, trolley wire, rail bonding, and all accessories, also the first instalment of cars (15 motorcars and five trailers). It is expected that the specification, lithographed plans of the routes, and other particulars will be ready for issue early in September, and copies, when ready, may be obtained from Mr. A. E. White, city engineer, Town Hall, Hull, by persons proposing to tender, upon payment of a deposit of £10, which will be refunded upon receipt of a bona fide tender and return of the papers and plans supplied. Cheques to be made payable to Mr. Thos. G. Milner, city treasurer. Tenders, endorsed "Tender for Tramway Equipment," are to be addressed to the Chairman of the Works Committee, and delivered at the Town Clerk's Office, Hull, before noon on November 5.

Madras.—Tenders are invited for the utilisation of water flowing from the Periyár Lake for purposes other than irrigation and not incompatible with the use of the water for drinking. The irrigating season extends over nine to ten months, during which time the discharge is likely to be from 1,100 to about 500 cubic feet a second, according to the demands for irrigation and the available quantity in the lake. Subject to the risk of interruption by accident or drought, supply can be given throughout the irrigation season. No supply can be guaranteed at other times, but, so long as water is available, the Government will be prepared to issue it in such daily quantities as may seem to it advisable with reference to the time which is likely to elapse before the supply is replenished by the setting in of the rains. The fall from the tunnel to the foot of the hills is approximately 900ft., and the distance measured along the course of the stream about 6,800ft. One cubic foot per second falling 900ft. is estimated to produce over 60 effective horse-power. Intending lessees should state the quantity of water required in cubic feet per second and the annual rent offered for each cubic foot per second. No rent will be charged for the first year from the date of the concession; for the second year the charge will be one-fifth, and an additional charge of one fifth will be made every year until the full rent is reached. The whole or part of the concession may be surrendered on a year's notice being given. Lessees will construct at their own expense, on plans to be approved by Government, all the weirs and other works required to divert the water from the river below the tunnel. For further information, application may be made to the Chief Engineer for Irrigation, Madras, by whom tenders will be received up to October 31, 1897.

RESULTS OF TENDERS.

Huddersfield.—The following are the tenders received by the Guardians for fitting up the union offices, Ramsden street, with the electric light:

Read, Holliday, and Sons, Huddersfield (accepted)	£61	18	3
Martin, Smith and Co., Ramsden-street, Huddersfield	118	0	0
J. H. Taylor and Co., Macaulay-street Huddersfield	84	18	0
T. W. Broadbent, Huddersfield	87	0	0
Fellows, Wheatcroft, and Co., Walsall	189	5	6
A. Sykes, Huddersfield	89	10	0
Fowler, Lancaster, and Co., Birmingham	178	0	0
C. Walkers, Darlington	133	16	0

BUSINESS NOTES.

Port Glasgow.—A battery-room for electric lighting purposes is to be constructed.

Berwick.—The National Telephone Company have now commenced operations in connection with their trunk-line system for Berwick.

Appointment Vacant.—We beg to draw attention to an advertisement of the Hull Corporation regarding a vacancy for an improver in their electricity works.

Willans and Robinson.—The registers of transfers and members will be closed prior to the ordinary general meeting, as from September 21 to 6th prox., both days inclusive.

Paddington.—Plans are being prepared for the extension of the Regents Park lighting station, as there is now no room for the new machinery about to be purchased at a cost of £11,600.

Buxton.—At the fortnightly meeting of the Urban District Council a letter was read from Messrs. Farrer, Morgan, and Co. respecting the electric lighting of the town. It was resolved by six votes to two that it lie on the table.

Middlesbrough.—At a meeting of the Middlesbrough Electric Lighting Committee of the Middlesbrough Town Council, it was decided, subject to confirmation by the Council, to appoint Mr. Hammond, of London, as electrical engineer.

Walsall.—The Electric Lighting Committee reported to the Council at the monthly meeting this week that arrangements were in progress for laying down additional plant, and that the engineer had been instructed to report on desired extensions of mains.

Chichester.—The Corporation have discussed at length the report of the Finance Committee, recommending the Council to take the necessary steps to procure a provisional order, with a view to the city keeping in its own hands the powers to supply electricity for lighting and other purposes.

Cheltenham.—Last week another step was taken in the street-lighting by electricity, the lower part of the High-street, from St. George's-square to the Gloucester-road, being supplied with arc lamps in the same proportion as other parts of the town. The use of the electric light by private consumers is increasing rapidly.

Cardiff.—The Chairman of the Cardiff Lighting and Electrical Committee stated incidentally at the monthly Council meeting on Monday that the committee had now turned the corner, and the receipts from electric lighting were not only sufficient to meet the expenditure, but also to relieve the rates to the extent of ½d. in the £.

Ireland.—The sub-committee appointed by the District Council to enquire as to the advisability of installing the electric light in the district are prosecuting their researches. They have visited Nelson and Burnley, where electricity works are established, and they will shortly present to the Council the information they have gathered.

Cheltenham.—A special meeting of the Town Council is to be held to take into consideration the minutes of the Town Improvement Committee, which contain the recommendation that the Lighting Committee be asked to make arrangements for lighting with electricity such parts of the winter garden as the committee may decide on.

Alton.—The Urban District Council have received a contract from the postal authorities with regard to electric communication between the houses of the firemen, and it has been agreed that the royalty be paid by the Council, and the contract referred to a committee for investigation. An extra number of lamps are to be lighted on account of hop-picking.

Grimsby.—The Town Council have adopted the following resolution: "That the Urban Sanitary Authority carry out the electric lighting provisional order in Grimsby, and that the Public Lighting Committee be authorised to employ an expert, if necessary, to prepare plans, specifications, and estimates for carrying out the works, and report to the Urban Sanitary Authority."

Batley.—A meeting of the General Purposes Committee of the Batley Town Council was held this week to consider the advisability of applying to the Board of Trade for a provisional order authorising the Corporation to supply electricity for public and private lighting purposes. The town clerk was instructed to take the necessary steps for procuring the order required on behalf of the Corporation.

Wimbledon.—At the meeting of the Urban District Council the Clerk (Mr. W. H. Whitfield) reported that the Board of Trade had transmitted the electric lighting scheme which they were prepared to approve, subject to it ensuring the safety of the public and furnishing a proper supply of energy. The document they had forwarded was entirely technical, and he had forwarded it to Mr. Preece, who had intimated that it was quite satisfactory.

Weston-super-Mare.—Mr. Hawtayne's report *re* the best means of putting into effect the provisional order for electric lighting in Weston-super-Mare was before a committee of the whole Council on the 21st inst., when 15 out of 18 councillors were present. After more than two hours' discussion, a resolution was carried by eight to seven approving of the report, subject to such reductions and modifications as the Council in general meeting may desire.

Lowestoft.—The Town Council have adopted the report of the General Purposes Committee, which, among other things, recommended that the Council should take all steps to obtain a provisional order from the Board of Trade for the electric lighting of the borough, and that the whole matter be referred to this committee to prepare plans and make reports, and take all other necessary steps for that purpose, and report to the October Council meeting.

Ossett.—At a meeting of the Ossett Town Council, held on Monday, the mayor was authorised to call a special meeting of the Council to pass the following resolution: "That the town clerk be and is hereby empowered to make application to the Board of Trade for an order or license authorising the local authority for this borough to supply electricity for public and private purposes, and to take all the necessary steps for carrying out this resolution."

Liverpool.—Major W. H. Edwards presided on the 17th inst. at a meeting of the Tramways Working Committee of the Corporation. Mr. John O'Neill, secretary of the old tramways

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company, was instructed to prepare and present to the next meeting of the committee a report as to the men's hours of labour and a revision of the fares. He was also asked to embody in his report a statement as to the effect the alterations would have upon the finances and traffic of the tramways.

Birmingham.—We are informed that the laying of the subterranean telegraphic cable under the superintendence of Mr. W. H. Preece, F.R.S., between London and Birmingham is being carried out with great success. Watford is the headquarters of the operations, and the cable has now been laid over nine miles on both sides of this town. The cable contains 76 conductors, each conductor weighing about 150lb per mile. The paper which covers the conductors is kept dry by air pumped by artificial means.

Dundee.—At a meeting of a special committee of the Dundee Town Council on the 16th inst., a long report was submitted by the consulting engineers in reference to the proposed extension of the tramway system and the method of traction to be employed. The engineers stated that there would be no difficulty in providing sufficient electric power to drive the tramway cars. After hearing the report, the meeting decided that further information was necessary, and it was agreed to obtain estimates from both the consulting engineer and the burgh engineer.

Paisley.—The Electric Lighting Committee have submitted to the Town Council a recommendation that the proposed high-tension mains in St. James-street be extended a further length of 250 yards or thereby beyond that contracted for at schedule rates, the extra cost being estimated at about £35. The engineer (Mr. Teague) was instructed to lay before the next meeting of the committee a detailed statement of the cost of the works as contracted for till date, and an estimate of the amount required to complete them. The recommendations have been approved.

Catalogue.—We have received from the Phœnix Dynamo Company, of Hubert-street, Leeds-road, Bradford, a copy of their illustrated price-list (Section "A") of dynamos and motors for continuous currents. We notice that, in addition to the prices of dynamos and motors, there is a price-list of new enclosed motors, and specifications and prices of standard equipments for electrical cranes. The manager to the company (Mr. Claude W. Hill, M.I.C.E., M.I.E E.) has included some useful notes for electrical engineers when designing installations for power and lighting. This section will be found of great value to engineers.

Newington.—The meeting of the Vestry last week adopted the report of the Electric Lighting Committee, which recommended: "(*a*) That an application be made to the London County Council for permission to erect the generating station to the forecourt line of the Vestry's property in Penrose-street. (*b*) That the committee be empowered to inspect the recent station erected by the Vestry of St. Pancras, the station of the Westminster Electric Supply Company, the station provided by the Brighton Corporation, and such other stations as the engineers may advise as being applicable to the system of supply granted by the order."

St Albans.—A special meeting of the City Council have adopted the following report of the Urban Sanitary and General Purposes Committee regarding the electric lighting question; "Your committee have had under their careful consideration the question of electric lighting in the city, and having had conferences with Mr. A. F. Phillips, Mr. Gripper (of Edmundson's, Limited), and Mr. H. Barringer Cox, they recommend that the Council apply forthwith to the Board of Trade for a provisional order under the Electric Lighting Act for supplying electric light in the city, and that the town clerk be instructed to take the necessary steps in the matter."

Dublin.—The Lighting Committee of the Corporation, at a meeting this week considered a special report from their electrical engineer in reference to the recent interruptions of the electric light to private consumers and in the public thoroughfares. It is understood the report stated that the cables were worn out, and that the whole system would require to be renewed. This will involve an expenditure of about £20,000. It is only about five years since the present cables were laid. How to make them more durable is an electrical engineering question of pressing importance. The committee will place the whole matter before the next meeting of the Corporation, to be held on October 4.

Private Wires.—The rates for private wires in London have been reduced as follows: Charges for wire—overhouse or underground, £5 a year for a single wire and £7 a year for a double wire for telephone lines; on the roads, £4 a year for a single wire and £6 a year for a double wire for telephone lines. Charges for instruments—A B C, £4; extra bell, 10s.; single needle, £3 a year; Morse printer, £10 a year; telephone, £2; extra bell, 5s. Telephone wires to the Central Telegraph Office can be used by the renters for communicating with Paris over the London-Paris telephone, and with towns on the inland trunk-wire system, on payment of the appropriate fee for each conversation.

Llandrindod Wells.—It was agreed at the monthly meeting of the Urban District Council that the Lighting Committee obtain four lamps and place them where considered most necessary, and to make the best terms possible with the electric light company. The Clerk read a letter from the engineer stating that the street lamps were duly lit on August 18, in accordance with the agreement, and such light would be continued each evening as arranged. A resolution was passed signifying the Council's satisfaction with the way in which the electric light had been carried out at Llandrindod Wells. Visitors from other districts told them there was nothing that could be compared with it anywhere. The street-lighting there was equal, and they could venture to say better, than any other electric light installation in the United Kingdom.

Morley.—At a meeting of the Town Council, a lengthy discussion took place on the recommendation of the Electric Light Committee (reported in our last issue): "That the plan of extension drawn out for the Local Government Board by Mr. Hammond be approved, and that in view of the fact that the contracts for paving had been let in the Bruncliffe-road, St. Andrew's-avenue, and Park-street districts, the mains be laid in those streets in accordance with the plans presented by Mr. Hammond, at an estimated cost of £1,500." An amendment that the last-named minute be struck out was proposed, in support of which it was said that the cost of the scheme had crept up until now, with this £1,500, it had amounted to £24,000. The amendment was lost, and therefore the minutes were confirmed.

Bath.—A meeting of the Town Council, sitting as the Urban Sanitary Authority for that city, was held on the 21st inst. The minutes of the Electric Lighting Committee, which embodied a detailed report from Mr. R. Hammond upon the progress of the new machinery being constructed for the works, were adopted. The proposer of the resolution said everything was in proper order, but there remained the unpleasant duty of paying the bills. Mr. Hammond had the highest possible faith as to results, and things were going on very favourably. It was enquired how much longer Mr. Hammond's engagement would last. They had a good officer in Mr. Metzger, their manager, but he was superintended by an outsider. The reply was that Mr. Hammond's appointment lasted until the work was completed. He received a commission of 5 per cent.

Chelsea.—The Vestry surveyor's annual report, which has just been issued, contains the following remarks about the electric lighting of the district: The number of houses in Chelsea lighted by electricity supplied by the Chelsea Electricity Supply Company for the last three years was as follows: 1894-5, 598; 1895-6, 777; 1896-7, 1,032 On June 23 the Board of Trade issued an order directing that the portion of the parish west of Beaufort-street should be added to the area of supply of the Chelsea Electricity Supply Company. The whole of the home district can now be supplied with electricity by this company. From time to time the records, which show at what pressure the supply is given to consumers by the Chelsea Electricity Supply Company, have been examined. As the network of mains increases the pressure becomes more constant, and the supply seems most satisfactory.

Wakefield.—At the monthly meeting of the City Council, held on the 17th inst., the question was raised as to whether or not the works were progressing satisfactorily, whether or not the engineers' strike was interfering with the completion of any portion of the works, and if any time could be fixed when the proposed light would be supplied to the inhabitants. In reply, it was stated that the works were not progressing as fast as the committee would like. The committee had been looking after the matter, and they found a mistake had been made in the building of the chimney, the rectification of which would consume some time. Mr. Hammond (the engineer) and himself had made arrangements for the temporary use of an engine. So that the electric light would be supplied within 14 days of the 10th inst. After some discussion, the Mayor said that the committee would investigate the matter all round.

Aldrington.—The Hove District Council have held a special meeting to consider the expediency of applying to the Board of Trade for a provisional order, under and in accordance with the Electric Lighting Acts of 1882 and 1890, to authorise the supply of electricity by the said Council for public and private purposes in Aldrington. It was explained that the Hove Electric Company had intended asking for the power, but the committee thought it better that the Council should secure the power for themselves. As they were aware, the Hove Company had a provisional order to supply that town, and in that order the Council were given power to purchase the whole undertaking in 21 years—1913. If the company obtained the order for Aldrington, the Council would not get the power there for 42 years. This would be an anomalous position. A formal resolution to apply for the order was carried.

New Companies.—A company under the name of John Haynes Lighting Company, Limited, has been registered by Lydall and Sons, 37, John-street, Bedford-row, W.C., with a capital of £2,000 in £100 shares. Object: to carry on the business of electrical and mechanical engineers and suppliers of electricity. The directors are T. H. W. Walker, E. Totty, R. F. Atkinson, H. Isaac, G. F. Ransome, I. C. Glover, and L. Hughes. Qualification, £100. Remuneration as fixed by the company.—A new company has been registered, under the title of the Tudor Accumulator Company, Limited, with a capital of £50,000 to take over as a going concern the business of an electrical engineer and manufacturer of accumulators carried on by Antoine B. Pescatore at 5, Cross-street, Manchester, and at the Barn Meadow Works, Dukinfield, to acquire certain patents of Henry O. Tudor, and to carry on the business of electricians, etc.

Coventry.—At the meeting of the City Council last week the Electric Light Committee presented a modified scheme reducing the lengths of mains to be laid and omitting the lighting of certain streets with the arc light. The estimated cost of the scheme is thus brought down from £37,900 to £31,000. They quoted paragraphs from the original report as explaining the grounds upon which they based their recommendations—*i.e.*, that a 300-kw. steam alternator, with other additions, sewer and railway siding, be provided at £8 000; that mains be laid on the sub-station system, described by Mr. Hammond in his report, in streets to be determined by the committee, at the estimated cost of £23,000, the low-tension mains to be of the armoured con-

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centric type now in use, laid in the ground, and that the high-tension mains be laid on the "solid" system—*i.e.*, in troughs filled in with bitumen—and that application be made for sanction to a loan of £31,000. This report was adopted after a protracted debate.

Brierley Hill.—A special meeting of the District Council was held this week with reference to the tramway question noticed in our last issue. A further letter was read from the clerk to the Worcestershire County Council asking the Council if it were disposed to enter into an agreement with the County Council to enable the latter authority to have ample opportunity of considering the kind of motive power to be used by the City of Birmingham Tramways Company within the Council's district; and, also, that the Council would consent not to approve of any motive power which in the opinion of the County Council was opposed to the public safety, nor approve of any system of motive power for periods exceeding five years. The request had been submitted to the Council's solicitors, who pointed out that negotiations had already been made by them with the tramway company, and as they did not advise an unqualified consent being given, the Council decided to leave the matter in the hands of its clerk and solicitors to confer with the county authority.

Huddersfield.—The Town Council at their last meeting discussed the proposal to apply for a provisional order authorising the extension of the tramways from Salindine Nook to Outlane, from Paddock Head to Quarmby Clough Mill, from Birkhouse-lane to Pinfold Wells, near Milnsbridge, and the construction of double lines in New-street and Buxton-road. An amendment which in effect meant the entire rejection of the proposal was defeated by 25 votes against 21. The Council struck out the proposal as to double lines in New-street and Buxton-road, but confirmed the recommendation as to the extensions to Salindine Nook and Quarmby Clough Mill. During the course of the discussion it was urged that it would be a wise policy to give the tramway system a rest. For a long time the system had been unremunerative, and had swallowed up £40 000 or £43,000 of the ratepayers' money. It was said that the Council should not make great extensions in view of the tendency to change the methods of propulsion from steam to electric power.

Bradford.—The Tramways, Baths, and Team Labour Committee of the Bradford Corporation on the 22nd inst. considered a report from the sub-committee with reference to the proposals to run tramcars by electricity to Horton and Bolton The sub-committee reported that they had inspected electric tramways at Prescot, Brixton, Leeds, Birmingham, and Bristol. As a result of their enquiries they recommended that the overhead system of electric haulage, known as the trolley system, should be adopted for Horton and Bolton, and that the work should be proceeded with as soon as possible. The committee arrived at a unanimous decision to ask the Council to adopt the system recommended by the sub-committee. The committee further decided not to lease the proposed new lines, but to work them themselves. Although the preliminaries will be immediately proceeded with in the event of the committee sanctioning the recommendations of the Tramway Committee the work cannot, we understand, be commenced much before the beginning of next year—probably in February.

Brechin.—We understand that for some time past the Police Commission have been in negotiation with the Edmundson Electricity Corporation, Limited, who were desirous of introducing electric lighting within the burgh. The terms offered were considered very favourable, and it was resolved to appoint a deputation to visit Shrewsbury, where the Messrs. Edmundson already supply the electric light, and other places, to enquire into the working of the system before coming to any definite conclusion. A deputation has visited the places selected, and has had an interview with the representative of the firm. A special meeting of the Commissioners has been held in committee to consider the whole matter. The deputation having reported favourably on the scheme, it was, after discussion, moved that the clerk be instructed to issue the statutory notice for a meeting to consider and decide on the whole question, to be held on the second Monday of October. After it having been explained that the adoption of this motion did not bind the Commission in any way, it was unanimously agreed to.

Worcestershire County Council.—At the last quarterly meeting of this Council, the Highways and Bridges Committee's report contained the following: "The Lord Chairman of Committees of the House of Lords having objected to certain clauses being included in the Bill as finally settled with the promoters of the tramways, on the ground that it was unnecessary to incorporate such clauses in an Act of Parliament, as they could be formally entered into by deed between the parties—the solicitors to the promoters had since given an undertaking that within a month the tramways company should execute an agreement with the Council embodying the provisions of the clauses in question. Such an agreement had been prepared and was in course of completion, and the committee recommended the Council to order the common seal to be affixed to the agreement when completed. The committee had taken the necessary steps for securing to the Council a *locus standi* before the Light Railway Commissioners with regard to the Dudley and district light railway scheme, promoted by the British Electric Traction Company."

Blackpool.—The borough electrical engineer has submitted to the Town Council a report on the advisability of effecting the immediate substitution of the present conduit system of electric traction on the Corporation tramways by the overhead trolley system of electric traction, and it has been resolved that the overhead trolley system of electric traction be forthwith substituted for the present electric conduit system on the Corporation tramways, under the direction of the borough electrical engineer, subject to the approval of the Board of Trade, and that the town clerk be authorised to apply to the Board of Trade for their sanction to the proposed substitution, and to the borrowing by the Corporation of such sum as may be necessary for the purposes of carrying out such substitution. The borough electrical engineer has also reported that prior to the meeting of the Markets and Gas Committee he had been engaged upon measures for the removal of the transformer in the market cellar, and that the same would be removed soon. The members of the committee are to visit Leeds to inspect the overhead system there.

Burnley.—At a meeting of the Parliamentary Sub-Committee of the Corporation the question of taking steps to remove the present prohibition against the local authority working tramways was considered. This was done in view of the possibility of the Corporation acquiring the tramway undertaking upon the expiration of the company's term in August, 1900. It was ultimately decided to recommend the Council to apply for a Bill in the next session of Parliament to enable the Corporation to work the tramways should it be resolved to acquire them, subject to the Tramways Act of 1870. This action on the part of the Corporation is necessary, because the Tramways Act of 1870, which authorises the laying down of tramlines, distinctly provides that local authorities shall not run trams themselves, though they may lease the lines and the trams to a company or to private individuals. Upon the expiration of the tramway company's term in 1900 the Corporation will have power to purchase the undertaking at its ordinary value, and without goodwill, and the Parliamentary Sub-Committee recommend the Council to procure an Act of Parliament in order that they will have power to run the trams if they think proper.

Coseley.—At the Council meeting this week the Clerk stated that, with respect to the question of electric lighting, if the Council considered it wise to obtain an order, there was really no time to lose. He had been instructed to ask the three companies concerned their terms, and schemes were being formulated. The order would cost £100, and when they had that they could move when they pleased. Several of the councillors pressed for an adjournment of the subject to a special meeting, and the Clerk stated that that meeting had been called as a special meeting in the proper legal way. It was said that the companies could supply electricity cheaper than the Council. Eventually the consideration of the matter was adjourned until Friday next in order to finally decide the question. On the suggestion of the Clerk, it was decided to hear certain correspondence with the South Staffordshire Blast Furnace and Power Company, the Midland Electric Corporation for Power Distribution, Limited, and the Imperial Electric Light and Power Company, all of which were desirous of putting into force a scheme for electric lighting. It was stated that schemes were being prepared with a view to supplying electric lighting at advantageous rates.

Morecambe.—At the last meeting of the District Council a recommendation from the newly-appointed residential engineer, to the effect that extra cases for the mains be provided at a cost of £309, was accepted, the Chairman remarking that this would ultimately save £292. The committee recommended that tenders be obtained for printing 5,000 application forms for using the electric light, and that the price of the electric light be 6d. per unit for lighting purposes; 6d. per unit for motive power from sunset to sunrise and 4d. from sunrise to sunset, and that meters be charged for at the rate of 2s. 6d. per quarter up to 15 c.p. or 16 c.p.; beyond that by arrangement. It was also recommended that the Council should undertake to fix the wires in private premises, the Chairman remarking that, as in the case of the meters, the Council would make no profit whatever from putting in the fittings. The minutes were adopted, also Mr. Parker's suggestions for amendment of the Morecambe Electric Lighting Order, 1897; and it was resolved that the clerk forward the description with Mr. Parker's amendment to the parliamentary agents to lay same before the Board of Trade and apply that the description of the system be amended by introducing the alteration as suggested by Mr. Parker. It was also resolved to appoint a valuer along with Mr. Parkinson, the valuer appointed by the Council, to inspect the plant, stock-in-trade, articles, and things specified in the agreement dated February 10, 1896, and made between the Morecambe Electric Light and Power Company, Limited, of the one part and the District Council on the other part, with the view of ascertaining the state of repair and condition of that plant.

Gloucester.—The *Gloucestershire Chronicle*, commenting upon the electric light scheme, says: "The unanimity—in fact, the marvellous unanimity—of the City Council in adopting the electric light and refuse destructor scheme, without a word of adverse criticism, nay, further, without a word of comment even, leads us to the conclusion that we are within actual, measurable distance of the old-fashioned gas being superseded by the more modern, the more economical, and the more cleanly method of electric lighting, which has now emerged from the test of criticism into the full light of general acceptance." One of the main points to which attention was directed throughout the extended series of visits made by the committee to Newport and other towns was the relative superiority of the high and low tension schemes, and the committee unanimously came to the conclusion that, in their opinion, the low tension was the most suitable and less expensive. The result of the sub-committee's visit is to convince them more than ever of the desirability of carrying out the scheme. Since their return they have had a consultation with the engineer, have chosen a site in the centre of

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the city, and agreed to recommend to the Council the laying of mains to the extreme boundary of the city in each direction. Mr. Hammond proposed a smaller area, but the committee felt that the electric light has come to stay, and that it will be the most economical plan in the long run to lay down a complete set of mains at the outset and render further opening of the streets unnecessary. We believe the committee are also of opinion that it would be desirable to light with the large arc lamps as far as the railway bridge in Northgate-street to the railway gates in Barton-street to the Spa gates in Southgate-street, and to the Shirehall in Westgate-street. From these four points to the city boundaries the smaller incandescent lamps will be used, probably in clusters of two or three. From the four large mains, one in each direction of the city, smaller feeders will be affixed for extensions to the other streets as necessity requires. The committee are more than satisfied with the result of their inspection so far, they have found Mr. Hammond's report corroborated, and even amplified, in every particular, and we believe they are prepared to recommend the Council to lay down a complete installation on the low-tension system without further delay.

Salford.—A member of the Council writes to the *Salford Chronicle* about the electric light undertaking as follows: "The proposal to spend £90,000 in the extension of the electric light plant, which came up for consideration at the meeting of the Salford Council on Wednesday, September 1, is an important matter. Permission was given to the Electric Light Committee to apply to the Local Government Board for power to borrow £10,000 for a battery sub-station for the Regent-road district and for cables; but the proposal to apply for authority to borrow £80,000 to cover the cost of land, building, and machinery was withdrawn pending the preparation of plans and estimates. The electric light undertaking has been an unfortunate piece of business from its inception. A sum of over £40,000 has been spent on the undertaking already, and no one acquainted with similar undertakings can come to any other conclusion than that there has been a prodigal, if not a criminal, expenditure of money. So high do the capital charges stand to-day that it would be impossible, even with customers ready to take all the light which the plant is capable of producing, to make the concern pay its way. During the past two years almost £8,000 have been lost on the undertaking. The system is not adapted for a town like Salford. An alternating current cannot be applied effectively to work motors, and it is sheer folly to expect to make the concern a profitable one unless the current is capable of being utilised in the daytime as well as at night. Practically all the current generated during the day is now lost; the engines and dynamos are run, and the current generated cannot be used. Again, the foolish, expensive, and arbitrary conditions which the old committee attached to the use of the light when the system was first launched frightened the people against its use, and it will take many years to remove the prejudice which was then created. All these mistakes discount in a large measure the criticism of Councillor Phillips, for it cannot be forgotten that he was the deputy-chairman of the Gas Committee, under whose management they occurred. With experts or no experts it would be a triumph to exceed the blunders that were made by the Gas Committee. Mr. Phillips sneers at the ability of our electric light engineer who, at least, is a man that knows what electricity is, and how it should be produced. But can that be said of the late gas engineer, who Mr. Phillips assisted to place at the head of the concern? A terrible mistake! I believe if Mr. Turner had had the erection of the plant and buildings, he could have saved from £10,000 to £20,000. Something must be done, and that without any undue delay, to place the department on a sound financial basis. It is too early to quarrel with the engineer; he has had no opportunity to justify his appointment; he was originally under the gas engineer. Still, I agree with Mr. Phillips, that it would be a mistake to spend £80,000 without Mr. Turner's scheme, when prepared, being approved by experts of undoubted ability. There is no need, however, for them to carry out the work. The experts who designed the original scheme supervised the work, and they were paid a percentage on the actual cost—a practice which lends itself to extravagant expenditure. I hope the Council will continue to support the present Electric Light Committee against the querulous criticism of Mr. Phillips."

Glasgow.—A statement has been issued by the Committee on Electricity with reference to their refusal to acquiesce in the proposal by the Lord Provost for the consolidation of the tramways and electricity enterprises reported in our last issue. The committee state that their sphere of usefulness is quite distinct and apart from the conducting of the tramway enterprise. The technical details of the supply for lighting, with the wide field for motive power (outside of tramways), were beyond the scope of one committee to deal with in the interests of the public. The mains for lighting had to be laid on both sides of the street as nearly as possible to the building line, and therefore those mains could not be laid along with the feeders necessary for tramway traction, as the latter would require to be put down in the centre of the street. The principal streets had already lighting cables laid therein, and the conduits required for tramway traction would necessarily have to be laid apart from the lighting conduits in those streets. It would be too expensive to provide one wide channel for both conduits. The argument used by the Lord Provost, that the lighting and traction ought to be from the same poles in the street, was based on a groundless supposition that the Committee on Electricity were anxious to erect poles of their own. That, however, was not the case, as the Watching and Lighting Committee had to do with the kind of poles to be used, and the Committee on Electricity always hoped that the one pole would do for both lighting and tramways. With reference to the suggestion of the Lord Provost that the existing tramway depôts might be utilised for electricity purposes, it had to be pointed out that, so far as lighting was concerned, it would be practically impossible to use those depôts for generating stations, owing to the want of railway or other facilities for the conveyance of coal, and the great expense that would be involved in laying feeders from such stations to the centres of supply.—The question of the control of the electrical supply, turning on the point of whether the new electric tramways should be supplied by the electrical department or vested in the Tramway Committee, was discussed by the Glasgow Corporation this week. The Lord Provost's scheme to amalgamate the two committees was supported by the Tramways, but was opposed by the Electrical Committee. After a lengthy discussion, the proposed amalgamation was rejected by 26 to 25 votes.—Councillor James Gray has received the following letter from the Right Hon. Sir Arthur B. Forwood, chairman of the Liverpool Corporation Tramway Committee, regarding the proposed introduction of electric motors for the Glasgow system: "6, Rumford-street, Liverpool, September 14.—My Dear Sir,—I gladly respond to your request to give my opinion upon the present position of tramway traction. It is a great advantage to the public of our respective communities that those in responsible charge of public affairs should freely communicate their opinions, and especially their experiences. There is no doubt that at the present moment the only mode of traction that has got beyond an experimental stage is that by electric power. It is equally clear that the only other form of motor that seriously promises to compete with electricity, and has made very rapid strides, is compressed air. For over 12 months it has been in such successful operation in New York that its use is being extended to other car lines. Incidentally, I may say it is now being experimentally used on the elevated roads of New York in lieu of steam locomotion. The Liverpool Corporation, by their committee, of which I am chairman, are about trying on a short length (three miles) the overhead trolley. There is a prejudice against the use of this system in our principal streets, and we feel that only by trial as an object-lesson can we fairly determine whether the scheme should be applied to our entire system of 100 miles. If the result of the experiment should satisfy our people that an overhead trolley is objectionable, then we are brought face to face with electricity by the underground conduit system at a cost of double for installation and very expensive maintenance. Against such an application of electricity compressed air must, on the ground of expense, be a successful competitor. It is cheaper to instal than the overhead trolley, and fully as economical in working and maintenance, whilst the streets are unencumbered with poles, wires, etc. My suggestion would be to relay a section of your system with rails suitable for mechanical traction, and when laying the line bond the metals, a small expense, and so make them available for electric motors. Before installing electricity, erecting poles, etc., let a trial be made on the lines so laid with compressed-air cars. This could be done at quite a moderate cost, and which the Compressed Air Company would share for the sake of showing the working of their scheme. If your Corporation should adopt this plan we should have two experiments on trial—we one and you the other. If our electricity does not give satisfaction our lines are usable for compressed air at a small sacrifice; whilst if the latter fails to please your people the cost would be comparatively trifling, and the lines be available for electricity. The weight of compressed-air and electric cars is practically the same, each requiring a substantial track."

TRAFFIC RECEIPTS.

Bristol Tramways.—The traffic returns for the week ended September 17 were £2,725. 1s. 3d., compared with £2,317. 4s. 10d. for the corresponding period of last year, being an increase of £407. 16s. 5d.

Birmingham Tramways.—The traffic receipts for the week ending September 18, 1897, were £3,732. 15s. 8d., as compared with £3,435 19s. 4d. in the corresponding week in 1896, being an increase of £296. 16s. 4d.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended September 19 amounted to £1,401, as compared with £1,214 in the corresponding week of the previous year, being an increase of £187.

City and South London Railway.—The returns for the week ended September 19 were £897, compared with £872 for the corresponding period of last year, being an increase of £25. The total receipts for the half-year 1897 amounted to £10,802, compared with £10,887 for the corresponding period last year, being a decrease of £85.

South Staffordshire Tramways.—The traffic returns for the week ending September 17 were £667. 1s., as compared with £629. 4s. 2d. in the corresponding week of the previous year. The aggregate receipts so far this year were £23,466. 6s. 9d., as compared with £22,898. 13s. 9d. in the corresponding period in 1896.

D.S.D. Tramways, Dublin.—The traffic receipts for the week ending September 17 were £730. 11s. 3d., as compared with £681. 9s. 2d. in the corresponding week in the previous year, being an increase of £49. 2s. 1d. The number of passengers carried was 104,938 in 1897 and 92,780 in 1896. The aggregate returns up to date are £9 146. 14s. 3d., as compared with £9,987. 17s. 5d., being a decrease of £841. 3s. 2d. The mileage open is the same as last year—viz., eight miles.

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PROVISIONAL PATENTS, 1897.

SEPTEMBER 13.

20972. Improvements in or relating to contact breakers for X-ray induction coils, etc. Harry William Cox, 10, Cursitor-street, Chancery-lane, London.

20985. Improvements connected with electric lamps and switches. William Miller Walters, 4, Clayton-square, Liverpool.

20996. Improvements in electrical cut-outs. Charles Mark Dorman and Reginald Arthur Smith, Ordsal Electrical Works, Salford, Manchester.

SEPTEMBER 14.

21036. Self-registering meter for an alternating electrical current. George Walker Walker, Trinity College, Cambridge.

21054. Improvements in and relating to surface-contact electric railway systems, electric cars and their equipment, and automatic switches for use therewith. The British Thomson-Houston Company, Limited, 70, Chancery lane, London. (Edward M. Hewlett, United States.) (Complete specification.)

21055. Improvements in and relating to electric cars and surface-contact railways. The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. (Edward M. Hewlett, United States.) (Complete specification.)

21074. Improvements in electrical receivers for actuating clock and similar mechanism. Denys Mathieu, 60, Queen Victoria-street, London.

21078. Improvements in the method of utilising the rise and fall of the tide, canals, rivers, and surface-waters for generating electricity for lighting, and all its various purposes, or creating other motive power by its use. Thomas McNamee, 2, Ballybough road, Dublin.

21100. Improvements in alternating electric current generators. William Robert Lake, 45, Southampton-buildings, Chancery-lane, London. (Henry Fairbanks, United States.) (Complete specification.)

21109. Improvements in the bobbins and cores of solenoids for enclosed electric arc lamps. William James Davy and George Thomas Davies, 40, Chancery-lane, London.

21110. Improvements in arc lamps with double globes. William Humphrey Wheatley, 40, Chancery-lane, London. (Allgemeine Elektricitäts-Gesellschaft, Germany.) (Complete specification.)

21111. Improvements in the attachment of pole-pieces. William Humphrey Wheatley, 40, Chancery-lane, London. (Allgemeine Elektricitäts-Gesellschaft, Germany.) (Complete specification.)

21119. An improved reflector for electric incandescent lamps. Jean Houbois, 6, Lord-street, Liverpool.

SEPTEMBER 15.

21157. Magnetic and electric measuring instruments. James Russell, 154, St. Vincent-street, Glasgow.

21178. Improvements in and relating to the treatment of solutions of carbonates of soda resulting from electrolysis of chloride of sodium and in apparatus applicable for use therein. John Hargreaves, 191, Fleet-street, London.

21180. Improvements in dynamo-electric machinery. Joseph Slater Lewis and Felix John Howitt, 322, High Holborn, London.

21184. Improvements in switches for use in electric traction systems. Miles Walker, 322, High Holborn, London.

21186. Improvements in primary batteries. Frederick Hanson Perry, 6, Lord-street, Liverpool.

21195. An improved continuous-current dynamo-electric machine. Arthur Edwin Badger, 31, Southampton-buildings, Chancery-lane, London. (Complete specification.)

SEPTEMBER 16.

21229. An improved portable electric battery. David Forbes, 321, High Holborn, London.

21249. Methods of and apparatus for preventing the sticking through leakage currents or the like of electric railway section switches. James Grieve Lorrain, Norfolk House, Victoria-embankment, London. (The Esmond International Electric Traction Company, United States.)

21293. Improvements in signal telegraph apparatus. Claudius Victor Boughton, 28, Southampton-buildings, Chancery-lane, London.

SEPTEMBER 17.

21357. Improvements in and connected with electric traction on the accumulator system. Edward John Wade and Alfred William Southey, 16, Elm-street, Gray's inn-road, London.

21366. An improved electric arc light reflector. Charles Morris Bolles, Fairfield, Kingston-on-Thames.

21395. Improvements in electric cables and in the manufacture of the same. Mervyn Joseph Pius O'Gorman, 24, Southampton-buildings, Chancery-lane, London.

SEPTEMBER 18.

21437. An improved method of raising and lowering electric light pendants. Robert Walter Braham, 60, Red Lion-street, Clerkenwell, London.

21462. Improvements in or relating to street boxes of electricity mains, tramway cables, or analogous road receptacles. Henry Wall Wilkinson, 433, Strand, London. (Complete specification.)

21484. Improvements in electric motors. William Robert Lake, 45, Southampton buildings, Chancery-lane, London. (Riccardo Arno, Italy.)

SPECIFICATIONS PUBLISHED.

1896.

18570. Electric batteries. Dannert.

19148. Electric current transformers. Lake. (Elektrizitäts Aktiengesellschaft vormals Schuckert und Co.)

20805. Devices for protecting electric circuits and apparatus or instruments from injury by excessive electrical potential. Fynn.

21972. Dynamo-electric generators and motors. Brown.

22043. Means applicable for use in working electric railways provided with underground conductors. Hecker.

23778. Electric indicators of water-level. Hutton.

23942a. Electric switch. Belfield. (Wurts.) (Date claimed under Patents Rule 19, October 27, 1896.)

24075. Suspenders for electric lamps. Laurie.

25343. Electric locks for railway points and signal levers. Tyer.

26491. Electric accumulators. Celestre.

29226. Dynamo-electric machines. Lake. (Cie. de l'Industrie Electrique.)

1897.

10056. Rail bonds for electric railways and the method of making the same. Cleveland.

17026. Galvanic element. Abel. (Sedneff.)

17471. Electrical furnaces. Abel. (Siemens and Halske.)

17521. Regulating devices of horizontal shunt arc lamps. Wetter. (Elektrizitäts Aktiengesellschaft vormals Schuckert und Co.)

17606. Means for rectifying alternating electric current. The British Thomson-Houston Company, Limited. (Thomson.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	9¼-9¾
Brush Company, Ordinary	2	¾-1
—— Non. Cum., 6 per cent. Pref.	2	1½-1¾
—— 4½ per cent. Debenture Stock	100	103-107
—— 4½ per cent. 2nd Debenture Stock	100	94-98
Callender's Cable Company, Debentures	100	108-113
—— Ordinary	5	7-8
Central London Railway, Ordinary	10	9¾-10¼
——	6	5¾-6¼
Charing Cross and Strand	5	12¼-13¼
Chelsea Electricity Company	5	10-10¼
—— 4½ per cent. Debentures	100	110-113
City of London, Ordinary	10	25-26
—— 6 per cent. Cumulative Pref.	10	17-18
—— 5 per cent. Debenture Stock	100	130-135
City and South London Railway, Consolidated Ordinary	100	67-69
—— 4 per cent. Debenture Stock	100	138-140
—— 5 per cent. Pref. Shares	10	15½-15¾
County of London and Brush Provincial Co., Ordinary	10	12¾-13¼
—— 6 per cent. Cum. Pref.	10	15½-15¾
—— 4½ per cent. 2nd Debenture Stock	10	15-15½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1½ 2
—— 5 per cent. Debentures	—	89-94
Edison and Swan United Ordinary	2	2¼-2¾
—— 5 per cent. Debentures	5	4-4½
Electric Construction, Limited	2	1¾-2¼
—— 7 per cent. Cumulative Pref.	2	3-3½
Elmore's Copper Depositing	1	⅝-¾
Elmore's Wire Company	2	¾-1
W. T. Henley's Telegraph Works, Ordinary	10	18½-19½
—— 7 per cent. Preference	10	18-19
—— 4½ per cent. Debentures	100	109-114
House-to-House Company, Ordinary	5	9-9½
—— 7 per cent. Preference	5	10¾-11½
India Rubber and Gutta Percha Works	10	21½-22½
—— 4½ per cent. Debentures	100	105-108
Kensington and Knightsbridge Ordinary	5	13½-14½
—— 6 per cent. Pref.	5	8½-8¾
London Electric Supply	5	1¾-2
Metropolitan Electric Supply	10	17½-18½
—— 4½ per cent. First Mortgage Debenture Stock	100	118-122
National Telephone, Ordinary	5	6½-6¾
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	15-17
—— 5 per cent. Non. Cum. Third Pref.	5	6-6½
—— 3½ per cent. Deb. Stock	100	105-110
Notting Hill Company	10	15-16
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8-8½
—— £4½ shares	4½	7¼-7¾
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	104-106
St. James's and Pall Mall, Ordinary	5	16½-17½
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	36-39
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	8	10¾-11¼
Westminster Electric Supply, Ordinary	5	14½-15½
Yorkshire House-to-House	5	8-8½

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NOTES.

The Johannesburg Trams.—The Volksraad have again rejected the electric tramway scheme owing to the influence of the Progressive vote.

Argentine Telegraph Rates.—Nearly all the Argentine railway companies whose lines come to the capital have agreed to reduce their rates for telegrams to the level of those of the National Telegraph Office, but it is said that the Southern Railway have not yet agreed to the reduction. National telegrams are to be transmitted at half rates.

The French Society of Civil Engineers.—We have received a copy of the *Transactions* of the Society of Civil Engineers of France, which contains two interesting articles. The first is "The General Problem of Aerial Navigation," by Mr. Rodolphe Soreau; and the second is "The Phosphate of Lime Beds in the Provinces of Constantine and Algeria," by M. L. Cateau.

Public Enterprise.—There is an amount of enterprise in Blackburn which might well be emulated by many another town. A report has just been issued by the town clerk, showing that the following public works are to be undertaken for the town as necessity arises: tramway purchase and conversion to electricity, £100,000; sewerage, £38,000; recreation ground, £12,000; markets, £28,000; municipal lodging-house, £17,000; wood paving, £11,000; cemetery extension, £12,000; refuse destructor, £15,000.

Carbide of Calcium.—An experiment has been made at Aosta with the electric furnace invented by Mr. Regnolei-Memmo for the production of carbide of calcium. The furnace produced 200 grains of carbide with an average consumption of 735 W. – o., which means one kilogramme of carbon per five horse-power hour. The furnace developed a total force of 50 h.p. The Bold Venture Lime Company, of Chatburn, succeeded last Friday night, says a Blackburn correspondent, in producing the first carbide of calcium made in England for commercial purposes.

An Electric Railway.—The Municipality of Kassel has entered into a contract with the Kassel Electric Street Railway Company to supply them with electricity on certain terms. Provided the company use half a million kilowatt-hours per year the charge is 1¾d. per kilowatt-hour, and for every 100,000 kilowatt-hours or more up to a million the charge is reduced by 3 per cent. This means a minimum payment to the Municipality of £3,500 per year. The company, which was converted from the old street railway company, have decided to construct a new line from Kassel to Wilhelmsoehe.

The Spacing of Poles.—The question of spacing poles seems to have been occupying some attention in Germany, for Messrs. Stark and Schwarz, in the *Elektrotechnishe Zeitschrift*, say that in that country they do not place their poles at the most economical distance for overhead lines. We should think this is a matter easy of remedy, for it cannot require much time or much calculation to know how far apart they can safely put their poles. There are plenty of general principles to work upon, and it hardly seems necessary to adopt the suggestions of these gentlemen, that every line, if not every pole, should be considered on its own merits.

Underground Telegraphs in the City.—The Clerk to the City Commission of Sewers laid before the last meeting of the Court a letter from the Postmaster-General requiring the consent of the Commissioners to the placing and maintaining of a line or lines of underground telegraphs in or under certain streets in the City, and intimating that, failing such consent, a difference would be deemed to have arisen between the Postmaster-General and the Commission within the meaning of Section 3 of the Telegraph Act, 1878, and that the Postmaster-General will apply to the tribunal having jurisdiction in that behalf to hear and determine such difference. The letter was referred to the Streets Committee.

Carbide of Calcium in France.—The carbide of calcium works which have been constructed at Notre Dame de Briançon, in Savoy, are, according to *La Nature*, among the most important and, without doubt, the best yet installed. The town is situated in a valley enclosed by mountains, and torrents and waterfalls abound. There are two torrents which can be utilised, giving a minimum of 7,500 h.p. and a maximum of 15,000. Works have been erected by the carbide company on the banks of the Isère, but at present only one stream of water is being tapped. The electrical energy is supplied by five two-phase alternators of 530 h.p. each, and by two exciters of 25 h.p. The alternators have 600 revolutions per minute.

Traction.—It is pretty well understood that our American competitors have exploited almost every corner of the world in order to introduce electric traction. We commend their business energy, but certainly we can wish that the electrical firms in England had followed a similar course. At the present moment we believe Mr. Gustave Fischer, the engineer for tramway traction in New South Wales, is in America to supervise the construction of the electric apparatus for tramway work which is being made at Milwaukee. We can only trust that in the end the fable of the hare and the tortoise may be followed, and that in the long run the race for traction work will show that English manufacturers at any rate are not behindhand with any other competitors.

Dover in Darkness.—Owing to a slight accident the whole of the arc lamps in Dover along the sea-front and the principal streets of the town went out on Sunday, but the authorities took prompt steps to alleviate the inconvenience as much as possible, and the shopkeepers assisted by drawing up their blinds and turning on the lights in their windows. The incandescent circuits were all right, and the festoons of lamps which had been arranged along the sea-front for use during the summer months, and which are on the incandescent circuits, were lighted by order of the authorities. The festoon lighting has now been stopped for the winter months, as the company say it is too expensive to keep on for occasional use only, but it is fortunate that the festoons had not been removed on Sunday.

Victorian Railways.—Mr. Holmes, the electrical engineer of the Victorian Railways, is, we believe, in this country in order to ascertain the most suitable apparatus which can be employed for the electric lighting of stations—in fact, we may say to investigate into the equipment of central stations generally—for not only is it proposed to light the Metropolitan Railway Station and yards in Melbourne, but also the Parliament House, the Post Office, and other public buildings. Therefore the generating station would be constructed very much after the fashion of our own central stations. We certainly trust that in this instance Mr. Holmes will find the English manufacturers and the English practice capable of providing all that he requires. We are almost afraid, however, that a portion at least of the demands will go to Continental firms.

The Engineering Strike.—We seem as far off as ever from a settlement of the serious disturbance in the engineering trade. All efforts to bring about a reconciliation seem to be fruitless, and each side appears to be deter-

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mined to abate not a jot of their principles, come what may. On Saturday the eleventh distribution of strike pay was made to the 59,000 now out of work throughout the country, necessitating the payment of £36,000, of which sum £24,000 was paid to members of the Amalgamated Society of Engineers alone. The engineers received 15s. per week and an extra allowance of 1s. for each child; the allied workers, 12s.; non-unionists, 8s.; and labourers from 5s. to 6s. The following official figures were issued respecting the number of men now locked out or on strike: "Engineers, 24,500; allied workers, 15,000; non-unionists, 8,500; labourers, 11,000—total, 59,000."

The Electric Cab Accident.—In regard to the death of a little boy through becoming entangled in the machinery of an electric cab, which we published last week, the jury have returned a verdict of "accidental death" without adding any comment. It is curious to note the amount of humour which can find vent even at an inquest. We read that a juror thought there ought to be "a net round these vehicles to catch the boys as they get on." This quaint and original suggestion evoked laughter among the twelve good men and true, as was to be expected, but the prize for downright wit must be given to the juror who made the intensely humorous retort, "This ain't a torpedo catcher." Perhaps this was said with the intention of cheering up the parents, but it may have been that as the father was only a labourer he "didn't count." We are glad to see that the coroner expressed his conviction that something would be done to prevent a recurrence of the accident.

Micanite.—The value of mica to electricity on account of its extreme lightness, high insulation properties, and fireproof character, is well known, but the great difficulty which has stood in the way of its more general use has been the expense of obtaining it in large sheets. Micanite has been very largely used in place of it, with very satisfactory results. Micanite is a composition containing about 92 per cent. of mica and about 8 per cent. of the adhesive matter. The *Elektrotechnische Zeitschrift* publishes the results of some tests, showing that a micanite plate of 1mm. thickness has a resistance of 40,000 volts, the highest tension that can be applied. Micanite plate of ·3mm. thickness resisted up to 18,000 volts; micanite linen of ·3mm. thickness up to 2,500 volts; and of ·4mm. thickness up to 5,700 volts; and micanite paper of 0·1mm. thickness up to 4,300 volts. The insulating resistance is about 65 per cent. after an electrisation of three minutes.

Telephone Statistics.—From an exchange we get some interesting statistics as to the development of the telephone in France, Germany, and Switzerland. There are at present 112 towns in France provided with the telephone system, and the total number of subscribers is 18,191, of which 9,653 are in Paris. The comparison of subscribers to telephones is highest in Cannes, where there is one telephone to every 120 inhabitants; and it is lowest in Toulouse, Tours, and Orleans, where there is one for every 500. In Germany (excluding Bavaria and Wurtemburg) there were, at the date of the latest statistics, 397 towns provided with the telephone. There were 83,409 subscribers, and the number of messages is given at 424,000,000 a year, while for France the latter figure is given at 74,000,000. In Bavaria, and especially in Wurtemburg, telephony is very extensive. In Switzerland the communications per year were only about 15,000,000. Tariff is highest in France compared with most of the Continental towns.

The Mileage of Electric Railways. — Mr. Walcknaer has published statistics concerning electric traction, from which we learn that in Germany there are 400 miles of electric railways, in France 175 miles, in England only 82 miles, in Switzerland 50 miles, and from 10 to 20 miles each in Belgium and Spain. The total mileage of electric traction in Europe comes to 940 miles, on which are employed about 300 carriages. In America the total mileage is about 12,500 miles, but the circumstances are of course different. Progress in America and progress in Europe are two very different things, but there are many indications that Europe is going ahead now very fast, not only in the matter of electric traction, but also as regards lighting and the more general use of electricity. We know what rapid developments are taking place in England, and a perusal of the French and other Continental electric papers reveals the fact that those countries are, if anything, ahead of us in the way they are adopting electricity in small towns as well as large, especially for traction purposes.

The Old Adam.—We have often quoted the saying of Artemus Ward that there's "a deal o' human natur' in man," and it certainly is so, whether those men be in England or Australia. It is curious that the advent of almost any new machinery has been followed by attempts to stop its use. This is even so in tram work in New South Wales. Probably someone connected with horse traction was dissatisfied with the introduction of machinery and tampered with the brakes of several trams, thus causing a collision. We hear that the first car stopped in the ordinary course at the foot of the hill, and before the two following trams could be stopped they collided—the second with the first and the third with the second—badly damaging the second car. Fortunately, no one was very seriously hurt. A reward of £50 has been offered for finding the delinquent. Thus history repeats itself. Many of our readers will recollect, for instance, that wilful attempts were made to injure submarine cables when they were first introduced; and as for the attempts to stop the use of lace machinery and machinery for various manufactures, their name is legion.

Standardising.—We have several times lately called attention to the question of standardising lamps so as to be in accord when speaking or writing upon any question relating to lamps. Our American friends go further than this, and suggest the standardising of dynamos. It seems to us that there may be too much standardising, and that in the case of dynamos it would be carrying the matter a little too far, and would be against progress rather than for it, in that it would tend to reduce all dynamos to one common type, and leave nothing to the initiative of the private manufacturer. At the present time the various modifications introduced by a manufacturer are introduced with a view of making his machine (at any rate in his own estimation) better than the ordinary run of machines that are made by his competitors. If, however, he had to build to a standard size, this would necessitate castings and wire and every other detail being made to a standard size, and as nobody would have anything to gain by it, there would be no attempt to make an improvement. At any rate these are our views on the matter. They may be incorrect, but we are open to conviction.

Swiss Railways.—After a general debate lasting three days, the National Council have adopted, by 112 votes against 21 votes, the preamble of the Bill for the purchase of the railways by the State. This will, of course, include the electric railways. The management will be carried on under the supervision of the Federal Assembly. A "Railway Council" will be instituted, to be appointed by the various cantons in the ratio of one member for every 50,000 inhabitants; and, further, a Council of Administration, for which the Federal Assembly and the Railway Council shall each

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nominate 11 members, and the Federal Council 17 members, for a term of three years each; and, lastly, a General Board, consisting of five to seven members, will be nominated by the Federal Council for a term of seven years. The headquarters of the Board is to be at Berne. Under the purchase clauses of the concessions, State purchase was first possible on May 1, 1883, but was not effected at the time; in 1887-1888 negotiations were carried on for the acquisition by the State of the Swiss North-Eastern Railway, but without success; in 1890 the preference shares of the Jura-Simplon Railway were purchased by the State; and, lastly, in 1891, the negotiations for the purchase of shares of the Swiss Central Railway fell through.

Frankfurt Street Railways.—In regard to the offers submitted to the Municipality from the electric street railways, the experts have reported on the offers of Messrs. Brown, Boverie, and Co., and Messrs. Siemens and Halske, as being the cheapest and best. Messrs. Brown, Boverie, and Co. guaranteed, with a full load over the transformer, an efficiency of 91 per cent. The cost of working this system per kilowatt-hour for current, etc., would be $1\frac{1}{6}$d. The overhead wire will be used, but the 115 cars which will be built will be so constructed that they can readily be used for accumulators. The town is to pay £100,000 to the old company, and the introduction of the electric system is estimated to cost another £175,000. A contract has been made with the two firms named, in which the contractors agree to have the plants ready in six months' time. The town will hand over the whole of the existing lines on January 1, 1898, and the rental will be £15,000 a year. In addition to that, $4\frac{1}{2}$ per cent. has to be set aside for amortisation of capital, and a further 4 per cent. for a renewal fund, for machinery and reserve fund, exclusive of the value of the land on which the station buildings are erected. After these charges have been met the town gets 95 per cent. of the profits, and the contractors get 5 per cent. The town bears the whole cost of initial construction, and has fixed the maximum price to be charged for the current at $1\frac{1}{4}$d. per kilowatt-hour.

What is a Motorcar?—Even now the motorcar is not quite accustomed to its surroundings and the intricacies of the asinine laws which were good enough in the times of equine traction! Is a motorcar a locomotive or a horse and cart? That was the question which Mr. Lushington had to decide the other day at the Bow-street Police Court, and he decided that a motor-van should come under the same laws as any other vehicle used for the conveyance of goods. He did not add, as he should have done, "through the streets," for in that lay the whole point of the case. The driver of a motor-van was summoned for allowing his van to stand in the roadway outside a shop in High Holborn for 20 minutes whilst neither loading nor unloading. Mr. A. Houston, who appeared for the defendant, submitted that this vehicle, being a motor-car, did not come under the provisions of the Police Act, 2 and 3 Vict., under which this summons was taken out, as it was clearly laid down in the Light Locomotives Act, 1896, that such vehicles were to be considered and to be under the same regulations as carriages, and he contended that these vehicles were subject only to the penalties imposed by the latter Act. He also called evidence to show that the delay was caused by the van's waiting for orders, and that it left immediately it was found that there were no orders at present. Mr. Lushington said that he could see no sort of reason why a motor-van should not be under the same regulations as any other vehicle used for the conveyance of goods. The delay had been clearly proved, and he should impose a penalty of 10s. and 2s. costs. In reply to Mr. Houston, he intimated that he should have no objection to stating a case on the point raised if application were made in due form, so that it is just possible we shall hear something more it.

The Electric Clocks of Brussels.—An interesting article is published in *L'Electricien*, from which we gather that the town of Brussels possessed a service for the transmission of the time by electricity as long ago as 1857, when it was in the hands of M. Nolet, of Gand, who installed 100 clocks on his system along the streets and in the municipal buildings. In 1867 the town took up the scheme and considerably augmented it, and there are now 451 of these clocks, of which 158 are in the public roads, 123 in the municipal buildings, and 170 in private houses. The cost of fixing and keeping them in repair in private houses is as follows: The initial cost is £5, varying slightly with the length of the wires. An annual charge of about 8s. 6d. is made for a clock placed in the interior of a building, and half that sum for each additional clock; 12s. for a clock outside a building, and 8s. 6d. for each additional clock. The area is divided into 12 circuits independent of one another. The lines have an average length of about 6,000 yards, the longest being 8,500 yards, and comprising 87 clocks, and the shortest 1,500 yards and 28 clocks. Phosphor-bronze wire 2mm. in diameter is used. In a little box at the back of the face is an electromagnet, the armature of which governs a rack wheel carrying the minute hand. The current is transmitted each minute through the commutator at the central office; it excites the armature, which gives the rack wheel a push of one cog, and the big hand moves on one minute. The current, which is about ·01 ampere, is supplied by a Leclanché battery. It is installed at the central office, which is attached to the town hall.

The Institution of Civil Engineers.—The prize list of the Institution of Civil Engineers for the season 1896-97, now made known, contains awards as follows: The Howard prize of 50 guineas to Mr. Hilary Bauerman, in recognition of his work on the metallurgy of iron. For original papers presented to the institution, Telford medals, with premiums of books and instruments, to Messrs. H. A. Humphrey, for "The Mond Gas-Producer Plant and Its Application"; to Colonel Pennycuick, R.E., for "The Diversion of the Periyár"; to Mr. E. C. Shankland, for "Steel Skeleton Construction in Chicago"; to Mr. Dugald Drummond, for "High Pressure in Locomotives"; and to Mr. Thomas Holgate, for "The Enrichment of Coal-Gas." George Stephenson medals and Telford premiums to Mr. Cruttwell, for "The Tower Bridge Superstructure," and to Prof. Unwin, for "A New Indentation Test for Determining the Hardness of Metals." Watt medals and Telford premiums to Messrs. Hay and Fitzmaurice for their joint paper on "The Blackwall Tunnel." The Telford premium list contains the names of Messrs. Donaldson, Ripper, Ravenshaw, Worth, Santo Crimp, Homfray, Nichols, Ramsay, H. D. Smith, and Major Leach, of the Corps of Engineers, United States Army. Awards to students attached to the institution comprise: the James Forrest medal to Mr. A. H. Jameson, the Joule medal to Mr. H. W. Barker, and Miller prizes to Messrs. Beer, Brand, Berridge, and Kitchin for papers read in London, and to Messrs. Godfrey and Garvie, of Manchester, Mr. Carter, of Newcastle, and Mr. Hurt, of Leeds. This year marks the first award by the institution of the medals named after James Prescott Joule, the discoverer of the mechanical equivalent of heat, and James Forrest, whose long service as secretary and the care devoted by him to fostering the student class have on his retirement been commemorated by the foundation of this medal. The

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presentation will be made at the opening meeting of the new session on November 2.

Salaries versus "Brains."—The *Practical Engineer* has somewhat to say upon the ever-present and ever-pressing question of the proportion between labour and its remuneration, and as our readers will be interested in the opinions of a paper representing the more general opinions of engineering than those of any one branch in particular, we quote the paragraph verbatim: "In a recent issue we deplored the false economy which is exercised in many parts of this country by those responsible for fixing the salaries of science masters, demonstrators, chemists, and so forth in connection with colleges and other public institutions. The evil existing in those directions is very forcibly seen in the electricity supply industry, and particularly where the appointments are made by the municipal authority. There are one or two instances where the corporation electrical engineer is making a very good thing of it, but there are a number of other places where men are appointed to positions of the greatest possible importance in electricity supply stations at from £100 to £150 per annum. Those instances we will not refer to in detail at the moment, but would simply remark that a man to be capable of taking complete charge of a municipal electric lighting plant must not be a mere tyro in electrical matters. He must know his business thoroughly, or the results of operation cannot be conjectured. We should not like to say that anyone of those who has taken a low-salaried appointment was unfitted for the post, but in such instances it is often found that the badly-paid man makes a change to some other station where he is paid better. This continual changing of hands is anything but good for such an undertaking. An instance of low salaries for electrical engineers comes from Taunton, where several new appointments have just been made. Those now in charge are as follow: engineer-in-chief, £130 per annum; second engineer, £1. 5s. per week; assistant engineer, £1 per week. Well might a sarcastic councillor remark that, 'after all that extravagance, they would not bring the Council to bankruptcy and ruin.'"

Electric Traction on American Railways.—Now that electricity has been found to be a practicable and economical motive power for railways, the American companies are pretty generally adopting it. The New York, New Haven, and Hartford Railway Company have extended the system on the Nantasket Beach line. The overhead wire was used on the double-track section about seven miles long, but the three-rail system has been applied on the extension 3½ miles in length. The current is transmitted in the cars by means of "contact shoes," which are pressed by springs against the conductor rail. Such a contact shoe being provided at both ends of the car, which are at a distance of 33ft. from each other, this figure supplies the admissible limit of interruption of the conductor rail. Simultaneously with the opening of the extension for traffic, the haulage of passenger trains by luggage vans serving as locomotives was abandoned, and all passenger cars were fitted with two electromotors, each of 100 h.p. According to the latest reports, the administration of the New York, New Haven, and Hartford Railway are so highly satisfied with the result obtained that they are about to extend electric working to the lines in the neighbourhood of Hartford, Connecticut. The Baltimore and Ohio Railway have likewise extended electric working on their system. At first, goods trains only were hauled, up hill, through a tunnel section about three miles in length, by electric locomotives. Lately, after the completion of the requisite works of extension as far as Camden Station, they have proceeded to having passenger trains, too, hauled by electric locomotives, so that now the whole traffic on the Baltimore Junction Railway is worked by electric locomotives. A smaller-sized locomotive has also been lately ordered, for the purpose of performing the shunting service on the junction tracks in the Aliceanna and Wolfe streets, which was hitherto effected by animal traction. An overhead trolley wire, supported on poles, similar to those customary for street trams, has been projected for this extension. As a further instance of the progress made during the last year, we may quote the Ailmer Hull Junction Railway in Canada, which connects the Canadian Pacific with the Pontiac Pacific Railway. For expediting the transit of through traffic between the two railways, a junction line, about 6½ miles long, has been built from Hull to Aylmer, for working which by electricity the Hull Electric Company has lately been given a contract for 35 years. Besides the goods traffic, which amounts to about 50 to 75 truck loads per day, and which is chiefly dealt with during the night, a very brisk passenger traffic has to be coped with.

The Utilisation of Aluminium.—A long and interesting paper has been read before the Franklin Institute by Mr. Alfred E. Hunt, president of the Pittsburgh Reduction Company, on "The Utilisation of Aluminium in the Arts." The author states that aluminium has received considerable use as a conductor of electricity, and is destined to have much larger future applications. He gives the results of several tests, showing that the conductivity of pure aluminium is from 63 to 64 per cent. It is practically non-magnetic, and may therefore be used for many purposes in electrical work where a magnetic metal would be useless; at the same time its electrical conductivity is excellent. He quotes Roberts-Austen's figures of the relative electric conductivity of metals, which put aluminium fifth on the list. First comes silver (pure) 100·00, then copper (pure) 97·61, copper (refined) 97·50, gold (pure) 76·61, and aluminium (pure) 63·00. The next highest figure we get is magnesium (pure) 39·44, and the remaining 24 metals dwindle down till we get tellurium with a conductivity of ·0007. Having such a good electrical conductivity, Mr. Hunt says aluminium may, therefore, in the future be largely used in the winding of field magnets on dynamos where saving of weight is an object, and in general for switches, brushes, brush-holders, and apparatus where its non-tarnishing and non-corrosive qualities should render it specially valuable. Its conducting power is greatly decreased as the result of the presence of alloying metals, and it was ignorance of this fact which in the earlier determinations and books gave it such a falsely low conductivity compared to pure copper. Already the Pittsburgh Reduction Company has furnished several hundred miles of aluminium wire for movable telephone and telegraphic work. The facts that the weight of copper wire is 3·3 times greater, and that the tensile strength of the two materials is not very different, have made the use of aluminium wire for field military telephones and telegraph lines especially advantageous. In castings, aluminium alloyed with about 5 per cent. of copper to harden it is just beginning to be used to replace brass castings in electrical apparatus. The aluminium alloys used are as easily tooled and take as good threads as brass castings, and the electrical conductivity of the alloys used has been fully up to that of ordinary brass, and better even than that of ordinary copper castings, for the reason that copper, as it is ordinarily treated in making castings, absorbs a great deal of oxygen, which causes it to have markedly lower electrical conductivity than rolled copper, which, although reckoned at 100 per cent., is often lowered to 30 per cent. in copper castings. Nickel-

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aluminium castings have been made with a conductivity of 50 per cent. in the same scale, and they can readily be supplied of a tensile strength of 25,000lb. to the square inch, as compared with 19,000lb. in ordinary copper castings.

The Electrolytic Manufacture of Alkalies and Alkaline Chlorates.—Mr. Bayet has published on this subject an important work in the last official report of the French Association of Electrical Engineers. We have translated the following summary from the French, which appeared in the last issue of *L'Electricien*. The solutions to be electrolysed for the purpose of obtaining alkalies and alkaline chlorates are chlorides of sodium and potassium in aqueous solution; the chlorine proceeds to the positive pole, and the sodium or the potassium to the negative pole. If the latter is composed of mercury, the alkaline metals are dissolved by it in forming an amalgam. If the negative pole consists of an iron or charcoal plate, the sodium or the potassium which are formed at the negative pole react with the water to form soda or potash with the releasing of the chlorine and the hydrogen. To obtain one kilogramme of sodium it takes, theoretically, 1,160 ampere-hours; to obtain one kilogramme of soda it only requires 668, and that formation at the time of the electrolisation of the chloride of sodium supplies at the same time ·885 kilogramme of chlorine and ·025 kilogramme of hydrogen. The voltage necessary for the electrolisation is 2·29 volts, which works out at 1,530 watts of energy necessary to obtain one kilogramme of soda. In practice a result in ampere-hours of 80 per cent., and a voltage of 3·5 volts to the limits of the electrolyser, is generally allowed of. The industrial produce in watts does not therefore reach a higher average than 52·3 per cent. The increase in the necessary voltage is due to the resistance of the bath, and of the diaphragms, and to the polarisation of the electrodes. The minimum voltage of the electrolysis was higher than that which was required for the decomposition of the water. In addition to this, the oxygen being taken up at the positive pole at the same time as the chloride forms hypochlorous anhydride, which, meeting with the soda at the negative pole, gives hypochlorites, and afterwards, by subsequent oxidation, chlorates. As a general rule an electrolyser (Mr. Bayet describes those of Roberts, Caldwell, Gall, and Montlaur, Greenwood, etc.) will be found satisfactory under the following conditions: (1) the receiver shall be supplied with a hermetically closing cover, and divided into two compartments by a diaphragm more or less perfect, designed to prevent the mixing of the solution and the gas; (2) the released gas at the electrodes, hydrogen at the negative pole, and chlorine and oxygen at the positive pole, should be ejected through the orifices made for that purpose, the chlorine being turned into the lime washings to form chloride of lime, or into the concentrated solutions of potash or soda, there to form chlorates—as for the hydrogen, some employment can be found for it; (3) the diaphragm should be sufficiently porous so as not to offer a considerable resistance to the current, but it should not be allowed to pass the solutions from one compartment to the other, and it should also be impervious to the action of the chlorine and the soda, it should not be allowed to become dirty, and it should be easily taken out and replaced; (4) the electrode should, for the greater part, be of charcoal at the positive, and iron at the negative, and some means should be found to reduce the wear of the positives. Moreover, as the gas releases itself at the electrodes, these, as a rule, should be vertically placed to facilitate the releasing. To avoid the tedium inherent in the formation of the soda in the interior of the electrolyser a process of mercury is employed. The negative is then placed through a bath of that metal in which sodium is dissolved to make an amalgam. This, placed in contact with water in a bath, is decomposed, the soda is produced with the releasing of the hydrogen, whilst the regenerated mercury can return to the electrolyser. That is the principle of the mercury method which is used in a certain number of the processes. Finally, if in the electrolisation of a saline solution, neither a negative of mercury nor a diaphragm is employed, the soda formed meeting with the chlorine creates the hypochlorite NaOCl, and then if the temperature is favourable the hypochlorite will give chlorate according to the following equation: $3NaOCl = NaClO^3 + 2NaCl$.

A Cable to Iceland.—An important step has been taken by the Icelandic Parliament in the acceptance of the offer of the Great Northern Telegraph Company in Iceland to lay a submarine cable to Iceland from the North of Scotland *viâ* the Faröe Isles, provided the Althing, or Icelandic Parliament, grants an annual subsidy of 35,000 kroner for 20 years to the said company. Many years ago the question of the North Atlantic cable was widely discussed, and although some 40 summers have passed since then without anything being done, it now looks as if that much-talked-of scheme will soon be realised. At any rate, Iceland will be a valuable link in our cable communication with British North America. The Althing has granted the conditions required by the Great Northern Company, and it is estimated that the cable can be laid early next summer in six weeks from Scotland to Iceland. The Danish Government has promised ample financial help and active co-operation in the scheme. A correspondent, writing to the *Times* on the subject, says that Lord Palmerston, in 1860, sent Captain (now Admiral Sir F. L.) M'Clintock, in her Majesty's ship "Bulldog," to survey and sound the depths of the seas intervening between Scotland, the Faröes, Iceland, Greenland, and Hamilton Inlet in Labrador with a view to laying this cable. After five months' absence Captain M'Clintock came back and reported in favour of the scheme. At the same time the steamer "Fox" was sent by Mr. Croskey, of London, to examine the landing places for the cable. One may judge of the interest taken in the expedition by the fact that the Queen and the Prince Consort came on board the "Fox" at Southampton before she left. Some of the results of these two expeditions may now be said to have actual interest. The distance from the nearest point of Scotland to Thorshavn, in the Faröes, is about 250 miles, the greatest depth 254 fathoms, while the bottom is composed of *débris* of shells and mud. From Thorshavn the cable goes first either to Haldervig or Westmanshavn. The distance from the Faröes to Iceland is—according to the landing place selected in the last-named country—to Ingolfshöldi 280 miles, to Portland 350 miles, to Bernfjord 240 miles. The last-named is the best landing place. The depth in this part averages a little under 300 fathoms. In one place only it is 680 fathoms. The bottom is composed of sand, *débris* of shells, and mud. Pumice was found in two places only. The temperature is 46deg. F. at a depth of 100 fathoms. When the cable is landed at Bernfjord, where the conditions are most favourable, it must be continued overland to Reykjavik. It must be laid north of the glacier plateau of Vatna Jökul. The following routes may be chosen: (1) *viâ* the Sprengisand, a distance of 250 miles; (2) close to the north of Vatna Jökul, 210 miles; (3) across North Iceland, 310 miles. Lastly, the cable may be laid on sea bottom round the south coast of Iceland and round Cape Reykjanœs, a distance of 260 miles.

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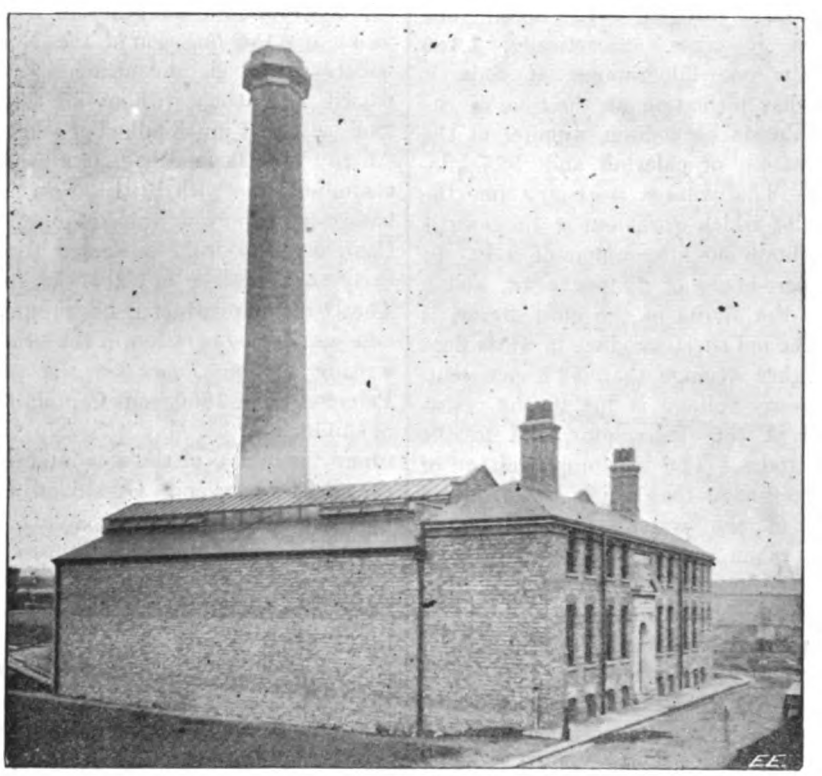
HAMMERSMITH.

In the years of long ago there lived one of those men who can see no further than the length of their arm, who watched a forester planting acorns. "What are you planting those acorns for?" said the short-sighted one. "That they may take root and grow into oaks, from which to get good sound timber for ships and acorns for the pigs." A year after the short-sighted man met the forester again, and began complaining. "What is the use of planting acorns; your trees are not grown yet, and you have neither timber nor acorns." "Don't worry, old man," said the forester. "Everything is going on nicely. Time is young yet; the trees will come along all right." And so they did, for in after years the trees formed a forest, and the forest provided both timber and acorns. We always imagine that that short-sighted old man had a large family, for his progeny are to be met with everywhere. "Don't!" "Why should you?" "What's the use?" "Nothing of the kind pays," and many more ejaculations of the kind are heard when local authorities suggest the provision of electric light stations among other things. Yet as time moves onward the pessimists are confronted and confounded with successful stations. These successes induce other local authorities to come forward and proceed with the work. The latest authority to enter upon actual work is the Vestry of Hammersmith, the central station for this district being opened yesterday. The history of this undertaking is spread over a period of 15 years, for shortly before the 1882 Act was passed the Fulham District Board of Works entered into a preliminary agreement with a company which proposed to obtain a license to supply electricity in Fulham and Hammersmith. The District Board was dissolved in 1886, the Vestry succeeding, and consented to the company being granted a license provided the necessary capital—£60,000—was raised before commencing the work. The negotiations fell through, and the license was lost through lapse of time, and the nibbles of other companies desirous of obtaining a provisional order came to nought. Little was done till 1891, when the Putney and Hammersmith Company commenced negotiations, and the Vestry had an able report from its surveyor (Mr. H. Mair) recommending the Vestry to apply for a provisional order, but it was decided to leave the work to private enterprise. A year later better counsels prevailed, and an order was applied for and granted in 1893. Even then delay arose, further reports were obtained and shelved, till January, 1895, when a standing Electric Lighting Committee was appointed, consisting of 27 members. We shall now quote from the historic sketch prepared by Mr. W. J. Searle, the chairman of the committee:

"The committee at its first meeting elected Mr. W. J. Searle chairman, and Mr. A. Ebbs vice-chairman, both of whom still remain in office. The new committee immediately took the whole subject into consideration, and, after carefully reviewing the work of their predecessors, recommended the Vestry to forthwith carry into effect the provisions of the electric lighting provisional order, which recommendation was adopted. The question as to the best position for the generating station was then considered, and after viewing several sites, negotiations were opened for the purchase of two pieces of land in Fulham Palace-road, one belonging to Miss Yeldham, the area being 2a. 2r. 7p., and the other to the Latymer Foundation, 1a. 0r. 2½p., making a total of 3a. 2r. 9½p., which were ultimately purchased for the sum of £7,200, the electricity undertaking to be debited with the cost of so much of the land as might from time to time be required for its purposes. In order that the committee should be in possession of the fullest information on the subject, a sub-committee was appointed to visit the installations in operation at Chelsea, Ealing, St. Pancras, and Portsmouth, each of them illustrating a distinct system either of generation or distribution of electricity. The valuable information freely given by the engineers and others connected with these installations was a great assistance to the committee in their future deliberations, which resulted in a report being presented to the Vestry recommending that advertisements be issued for complete schemes and tenders for the whole plant necessary to carry out the same in the compulsory area, subject to the following amongst other conditions: That in drafting the scheme and tendering thereon, the chief points to be considered should be (1) efficiency of the light and reliability of the supply; (2) adaptability to economical extensions over the whole parish, combined with moderate first cost; (3) low working and maintenance costs; (4) durability of the plant; (5) economy of ground space. In due time advertisements were issued, and 13 tenders were received and opened on December 4, 1895. These were referred to the committee, and by them to a sub-committee (consisting of the chairman, vice-chairman, Messrs. Russell and Cramp, and the surveyor) to examine and report. After carefully preparing a summary of the



Hammersmith Central Station.

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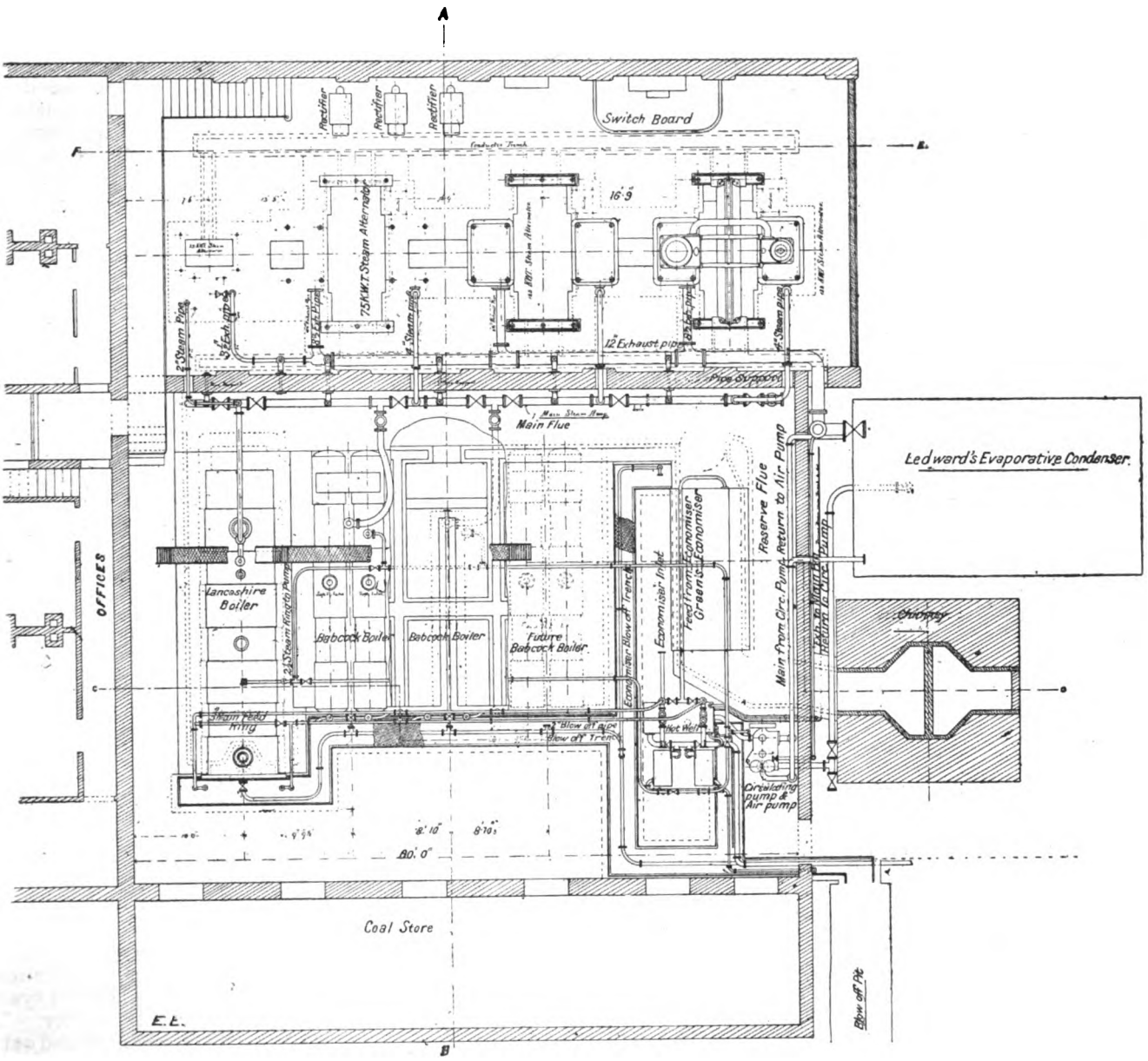
tenders and epitome of each one, they stated that they varied so considerably as to details, more especially as to the amount of plant in the generating station and the system of distribution, that they considered the advice of a consulting electrical engineer should be taken before coming to any definite conclusion. Instructions were accordingly given by the Vestry for the committee to make a selection, and Mr. A. H. Preece, of Victoria-street, S.W., was asked to prepare a full and complete report upon the tenders, and to advise as to the system best adapted to the requirements of the parish. He reported in favour of the alternating-current transformer system, and that the tenders of Messrs. Siemens and Messrs. Ferranti were the lowest respectively for high and low speed plants, but that for several reasons it would be better to invite both firms to submit revised tenders for complete station plant in accordance with a specification which he would be pleased to prepare, leaving the whole of the mains and other outside work to be dealt with later on. This advice and offer was accepted, and the two tenders were in due course received and opened, and submitted to the engineer, who reported that in consideration of the higher efficiency of the generating plant guaranteed it would be more economical to accept Messrs. Ferranti's tender, including rectifiers, subject to their guaranteeing the efficiency of their plant, under a penalty of £200 for every 1 per cent. less than the efficiency guaranteed.

"This report was adopted, and Mr. A. H. Preece appointed consulting engineer to prepare the necessary plans for the completion of the installation and to superintend the carrying out of the same. In the meantime the surveyor had been instructed to prepare plans and specifications for the necessary buildings and chimney shaft; he had also been instructed to have the site excavated and the sand removed preparatory to the concrete foundations for the buildings and plant being put down, this work being carried out by men directly in the employ of the Vestry. The plans were submitted to the Vestry on April 29, 1896, and advertisements were ordered to be issued inviting tenders for the erection of the same. These were received in due course; the one sent in by Messrs. Leslie and Co., of Kensington, being accepted. This portion of the work is now complete, and it is very much to the credit of Mr. Mair, who has taken great interest in the whole scheme, that it has been carried out well within the estimated cost; and it is confidently anticipated that equally satisfactory results will be found upon the completion of the other portions of the installation under the superintendence of Mr. A. H. Preece. It will be seen from the foregoing that there has not been any opposition to the introduction of the electric light into Hammersmith; the chief work of the committees dealing with the subject in its earlier stages being directed simply to the protection of the ratepayers' and consumers' interests. The only point at any time in dispute has been whether it should be a public or private undertaking. That point having been finally settled in the early part of 1895, in favour of the Vestry retaining the powers granted by its Act of 1893, the committee has since received the cordial support of a united Vestry, and the work is now practically complete."

Mr. H. Mair, the surveyor to the Vestry, and Mr. A. H. Preece, the consulting engineer, have prepared a pamphlet



Plan showing Machinery at Hammersmith Central Station.

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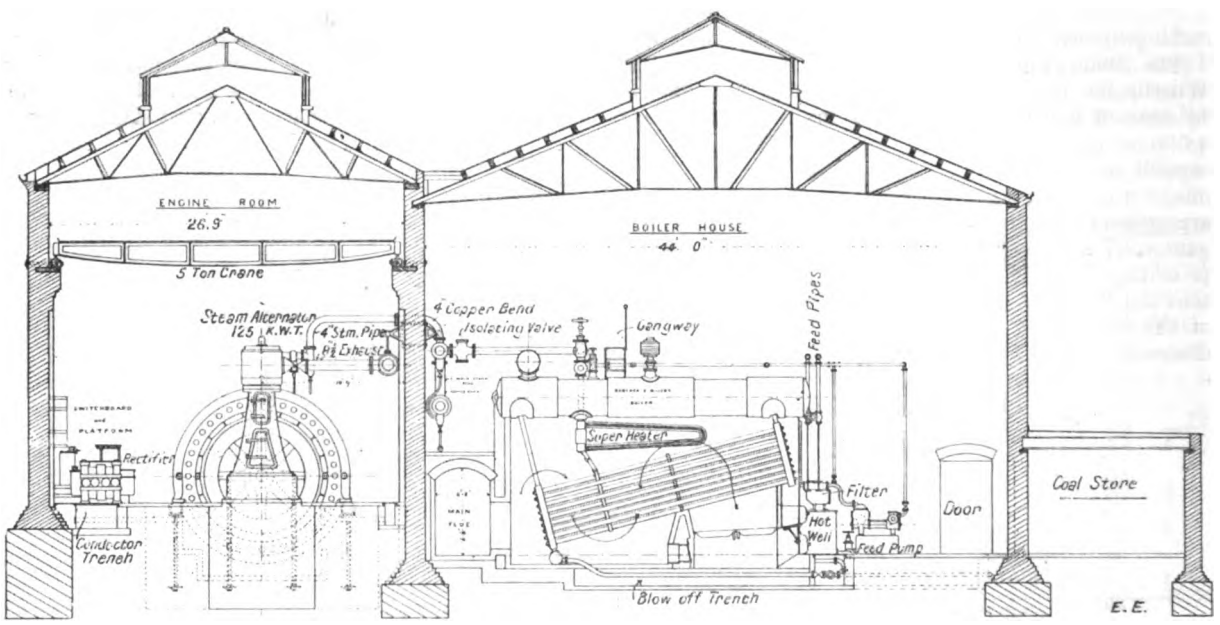
describing the installation, from which most of the following information is taken.

Buildings.

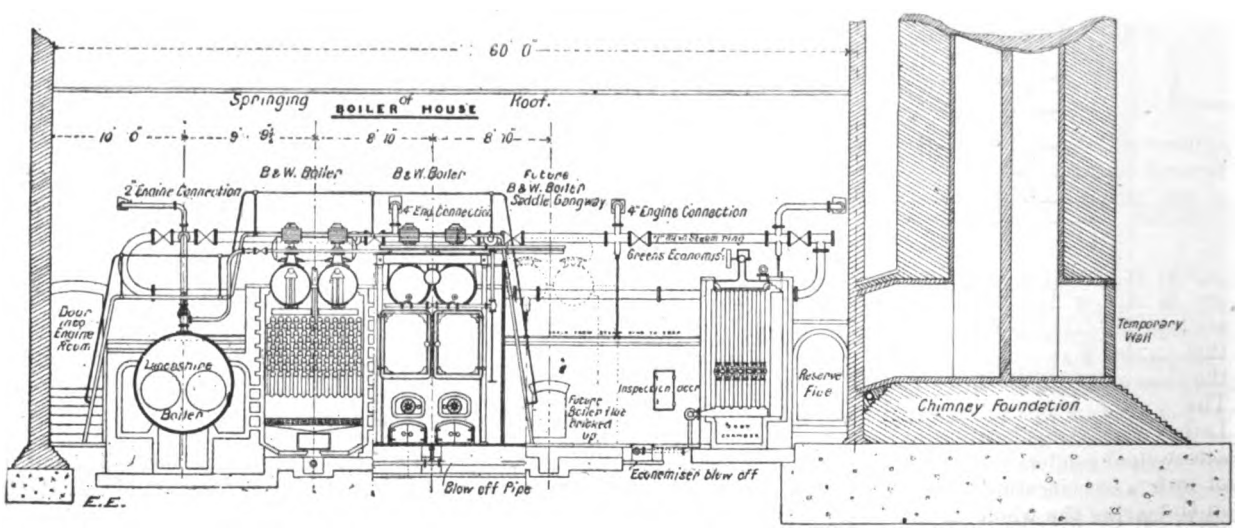
In preparing the plans it was decided to erect the buildings at right angles to the roadway from Fulham Palace-road leading to the main entrance, as this would allow of future extensions northward and also of the chimney being built in a position to admit of additional boilers being added as it became necessary. The front block consists of engineer's and clerk's offices, with store clerk's office and a number of rooms that can be used for storing lamps and other small articles in connection with the works. There are also workshops on the same level as the engine and boiler houses for the execution of small repairs to the plant. The engine-house floor is 4ft. above the level of the boiler-house to admit of the steam-piping being more easily arranged. The engine-house is 65ft. long, 26ft. wide, and 24ft. high to the springing of the roof, and is faced on the inside with white glazed bricks, having a dado 5ft. 9in. in height of salt-glazed bricks all the way round, except the northern end, which has been temporarily framed and lined with matchboarding, so that when the building is extended the engine-room will be in one open length under one roof. The boiler-house is 60ft. 6in. by 44ft. by 26ft. 6in., and has a similar dado in salt-glazed bricks carried round, the wall above being limewashed. The chimney is 140ft. high from the top course of footings. The foundation was excavated to the water-level, and is on a bed of hard gravel. The concrete foundation is about 7ft. deep by 23ft. square. In depositing the concrete a quantity of old tramrails and hoop iron was laid irregularly in layers to assist in binding the mass. There has not been the slightest appearance of cracks or defects of any kind. The chimney is built octagonal in shape, 8ft. internal diameter, and large enough to take another set of four boilers; there is a plinth course of Bramley Fall stone 30ft. from the base, the top 9ft. of the shaft being finished with fireclay blocks specially moulded; the inside is also lined for a height of 40ft., and a middle wall of fireclay divides the chimney to the same height, so that by shutting a damper one flue may be used and the other cleaned out without any difficulty, and when the extension of the works takes place it will only be necessary to remove a 9in. wall under an arch on the west side, which has been left for the purpose.



Plan showing Machinery at Hammersmith Central Station. Section on A B.

System.

The system of electricity adopted is that known as the high-pressure alternating-current system, in which electricity is generated at a pressure of 2,000 volts, and is distributed to underground sub-stations where it is transformed to a low-pressure current of 110 volts for use in houses of consumers.



Plan showing Machinery at Hammersmith Central Station. Section on C D.

Generating Plant—Boiler-House.

The boiler-house plant consists of two Babcock and Wilcox water-tube boilers fitted with their patent superheaters, one Lancashire boiler and economiser, and the necessary feed pumps, pipes, etc. The Babcock boilers are each capable of producing steam for 250 h.p. They have each a heating surface of 2,437 square feet and a grate area of 44 square feet. The Lancashire boiler, which has

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been constructed by Messrs. Tetlow, is of mild steel, and it is 28ft. long by 7ft. 6in. in diameter, and the two flue tubes are each 3ft. in diameter. This boiler is sufficient for 200 h.p., and it is intended to be used during the daytime. The economiser is of Green's patent type, and it is used for heating the feed water required for the boilers by means of the waste gases in the flues. It consists of 144 tubes 9ft. long and $4\frac{9}{16}$in. in diameter. It is constructed on the latest principle with improved soot-cleaning apparatus, which is driven by means of an electric motor.

Pumps, Feed Pipes, etc.

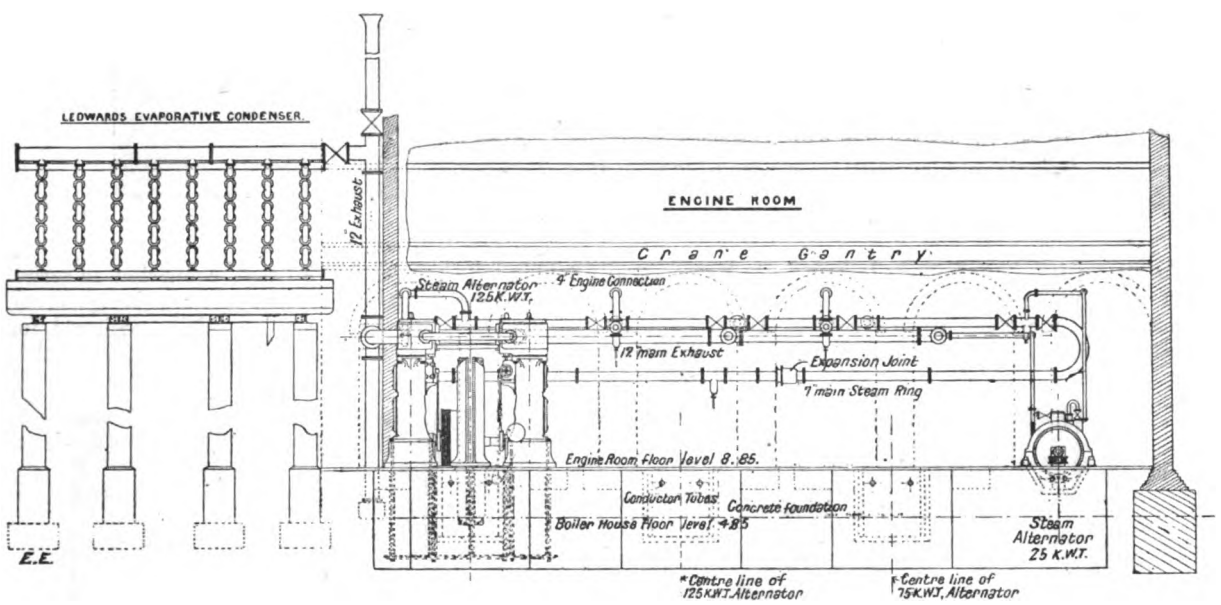
The feed pumps are in duplicate, and they are of the Worthington patent type. Each pump is $7\frac{1}{2}$in. by 5in. by 6in. They are each capable of delivering not less than 4,000 gallons of water per hour, and thus either pump is capable of supplying all the boilers, including the future one, with the requisite quantity of feed water. The arrangement of the steam-pipes for conducting the steam generated by the boilers to the engines is on the ring principle, and it is so divided up by valves into sections that the failure of any section will only affect the running of the engine or boiler connected to that section. The diameter of the main steam-pipe is 7in., and there is also an auxiliary steam-ring $2\frac{1}{2}$in. in diameter which provides steam for the feed pumps and other auxiliary apparatus. Each boiler is connected to this steam-ring through an isolating valve, which prevents the possibility of any steam leaking back into a boiler which is not in use.

Condensing Plant.

The exhaust-pipe is carried overhead in the engine-room, and is 12in. in diameter. It is connected to the condenser and also to the atmosphere, and arrangements are made so that in the event of the failure of the condensing plant, the connection to the atmosphere is automatically opened. The condenser, which is placed out of doors, is of the Ledward patent evaporative type, and it depends for its action upon the cooling effect produced by the evaporation of water, and the effect is increased by placing the apparatus in the open air. The exhaust steam is taken into a series of cast-iron pipes of corrugated pattern, and cooling water is pumped over the outside of the pipes, thus cooling the pipes and condensing the steam inside them. There are altogether 160 of these pipes, each pipe being 5ft. long, and the condenser is sufficient to deal with the steam required by 400 h.p. A large storage tank is fixed beneath the condenser, and arranged so that it can catch the cooling water of the condenser. This tank, which has a capacity of 4,000 gallons, forms the main storage supply to the building, and is connected to the main water supply of the parish. Arrangements have been made with the water company so that a duplicate supply is provided to the station, taken from two different points of their system; thus, if there should be a failure in connection with one portion of the public water-mains, the station can still be supplied from another section. The feed pumps in the boiler-house can also, if necessary, draw water direct from the company's mains instead of from the above-mentioned tank. The condensed steam from the condenser is drawn by one of Allen's air-pumps fixed in the boiler-house, and delivered into a hot-well, which is a cast-iron tank of 500 gallons capacity. The hot-well is connected to the feed pumps above described. Filters are also provided in a convenient position of the system, which will extract all the oil and other dirt from the water before it is pumped into the boilers.

Engines.

The engine-house plant consists of three main engines and dynamos, one small engine and dynamo for working during the daytime, the arc lighting apparatus, and the switchboard. The three main engines and dynamos are of Messrs. Ferranti's special design. Each set is capable of lighting about 4,000 8-c.p. lamps at one time. The engines were made for Messrs. Ferranti by Messrs. McLaren, of Leeds. They are vertical compound, with most of the working parts enclosed, arranged to work condensing or non-condensing. The cylinders are mounted on cast-iron columns, which with the crank pits form enclosed chambers, in which the cranks and driving parts work. The valve gear is outside the columns, and with the exception of the rods and low-pressure expansion gear is cased in, thus securing the advantages of an open-type engine with the absence of oil and water where it is not wanted—*i.e.*, splashed over the alternator and exciter. The high-pressure and low-pressure engines are placed on either side of the alternator, and the cranks being overhung only two main bearings are necessary. These are of exceptionally large bearing surface, to minimise wear and do away with the frequent letting together. The cylinders are high-pressure $15\frac{1}{2}$in., and low-pressure $25\frac{1}{2}$in. diameter, with a stroke of 18in., the engines running at 150 revolutions a minute. The high-pressure slide-valve is driven from a McLaren patent automatic expansion governor, which gives a maximum variation of 3 per cent. revolutions from no load to full load. The low-pressure valve is driven through a link, which by hand regulation gives a variable expansion on this engine. Inside each crank pit is an oil-pump, driven by a dray-link from the crank pin, which keeps all working parts lubricated under pressure; this is usually kept at 20lb. per square inch. The stop valve, starting valve, by-pass valve, and drain cocks are, by means of extended spindles, all brought within control from the engine-room floor level.



Steam Pipe Ring, Hammersmith Central Station.

Dynamos.

There are in all four dynamos: three of 125 kw. and one of 25 kw. capacity, making the present total capacity 400 kw. The larger machines are of the well-known

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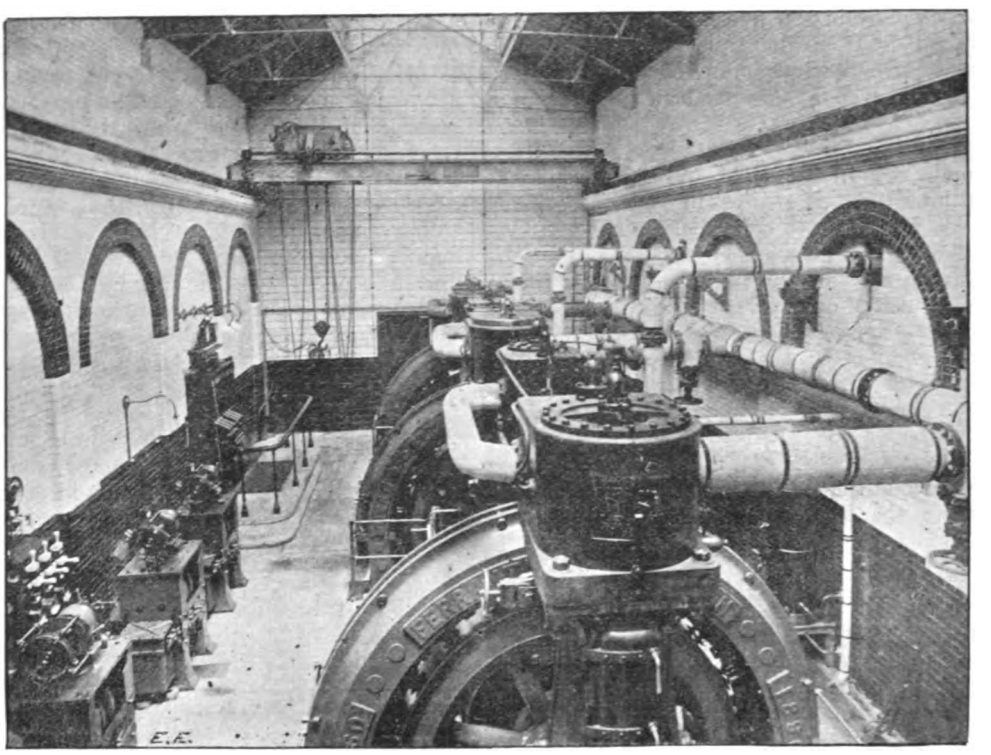
Ferranti disc type, in which the armature coils are carried by holders securely bolted to and insulated from the flywheel. The coils are wound with copper tape over cores built up of hard brass strip carefully insulated. They

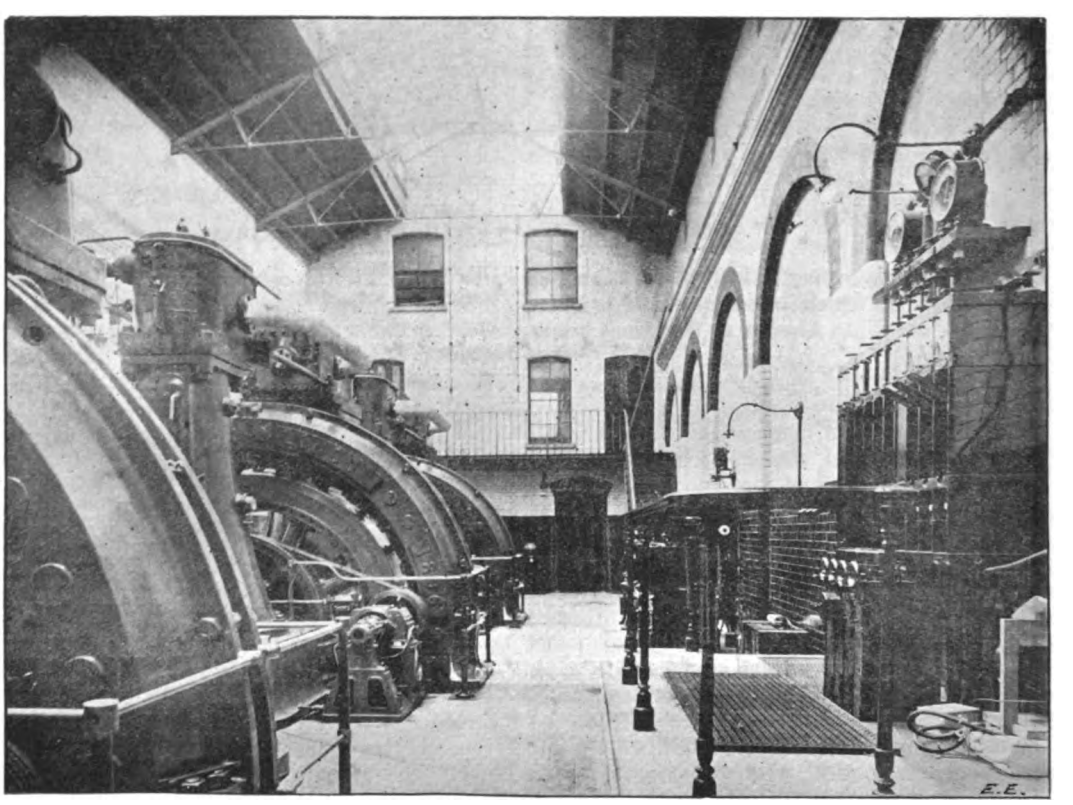
from tip to tip of the armature coils is 12ft. 6in., and the total revolving weight nine tons. The field coils are of copper strip wound on edge, thus securing one layer only of winding with the best possible ventilation. The whole



View of Dynamo Room at Hammersmith.

are built in pairs, the holder forming the connection between the two coils. There are 20 such pairs to each machine, connected in two sets of 10 in parallel. The earth connection is made directly to the flywheel.

field winding consists of 80 coils connected in series. The exciters are shunt wound, driven from the governor drum by ropes. They have been specially designed for rapid excitation, which is regulated by a resistance in the shunt.



View of Dynamo Room at Hammersmith.

The insulated pole is connected to a gunmetal collector ring, mounted on porcelain insulators. The flywheel is built in two halves, bolted together at the rim, and further secured by steel rings shrunk in recesses at the joints; the wheel is fastened to the shaft by massive steel tyres, which are shrunk on in position, no keys being used. The diameter

The frames can be easily opened out without disturbing any other part of the machine.

Day-Load Engine and Dynamo.

The day-load set is capable of lighting 750 8-c.p. lamps at one time. The engine has been made by Messrs. Belliss.

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It is their patent closed-in high-speed type, provided with forced lubrication. The speed of the plant is 450 revolutions per minute. The engine is compounded, and the high-pressure cylinder is 7in. in diameter, while the low-pressure cylinder is 11in. in diameter and the stroke is 5in. The governor is Messrs. Belliss's patent design, and it controls the engine by means of a throttle valve. The dynamo is Messrs. Ferranti's revolving field-magnet type, with the armature fixed. The field magnet, which forms a flywheel, is provided with one large exciting coil. The armature is made up of a number of flat coils bolted to a ring surrounding the field magnets. The exciting current is supplied from a small continuous-current dynamo attached to an extension of the dynamo shaft.

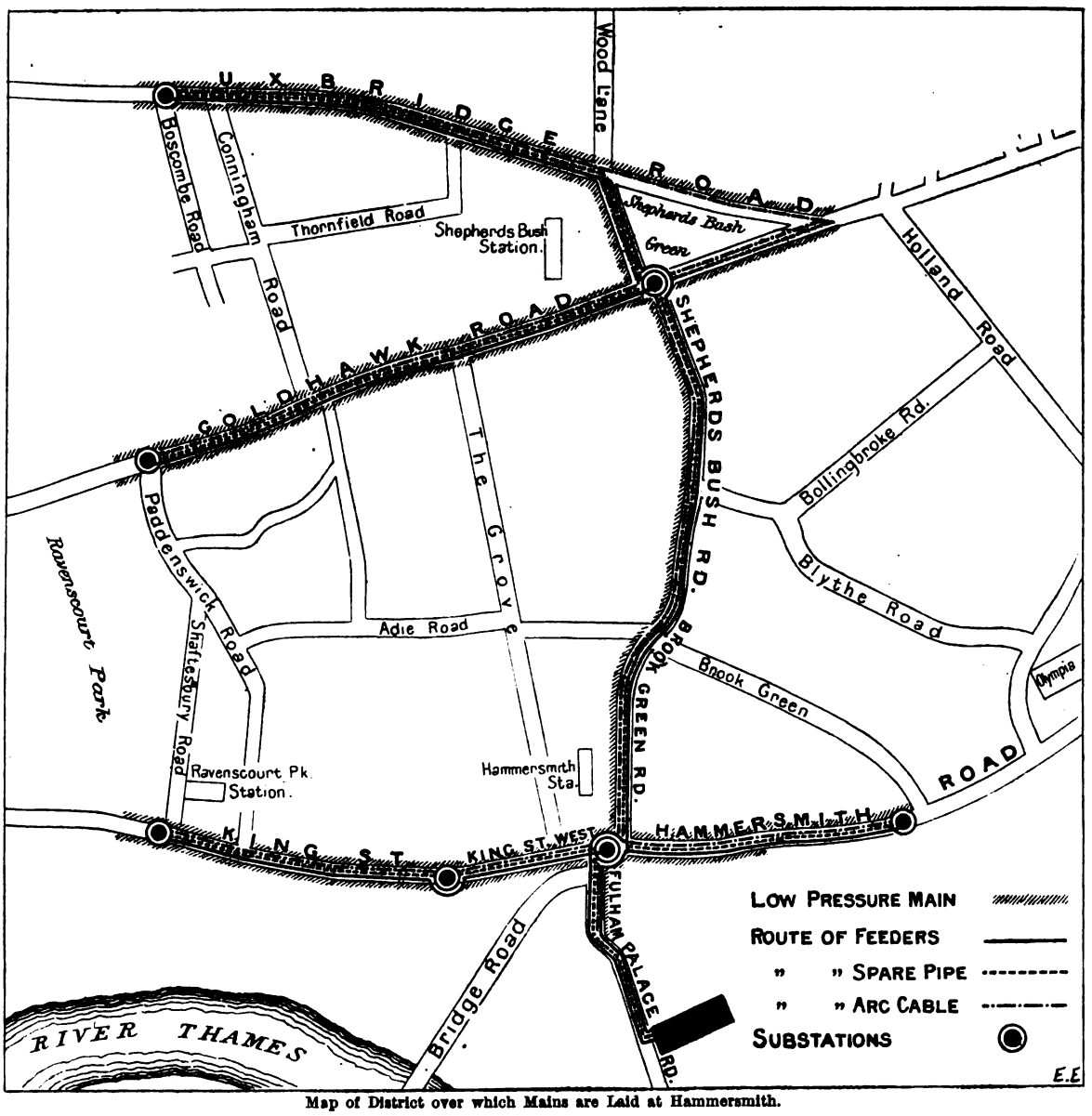
Arc Lighting Apparatus.

The arc lighting apparatus consists of three of Messrs. Ferranti's patent rectifiers, which change the alternating current produced by the main dynamos into a continuous current. By this arrangement the arc lamps are able to work most satisfactorily in series. Each rectifier is designed to light 50 12-ampere arc lamps. At present not quite 100 lamps are installed, so that one rectifier is used as spare. The rectifiers are driven by alternating-current motors, and the current required by the arc lamps is kept constant by means of a special automatic regulating transformer. The motor is run up to speed as an ordinary shunt motor with a resistance in the fields, and when up to speed the fields are switched across a few turns of the armature which supply current through a commutator, giving a direct current for excitation. The motors in use are two-pole, and run at a speed of 1,500 revolutions a minute when synchronised.

Switchboards.

There are two switchboards, one for the main dynamos and the other for the arc lighting circuits. The board is divided up into two panels, each dynamo and each circuit being provided with a separate panel. The board is entirely of slate, and is built into the wall of the engine-room. Each panel is divided from its neighbour by a slate partition, and the whole board is arranged so that it is practically impossible to touch any terminal or other metal which is in use and therefore dangerous. It is single-pole, and each dynamo and each circuit is provided with a single-pole switch, a fuse, and an ammeter. The switches are specially designed with a very long break, and arrangements are made in the dynamo circuits, so that when each dynamo is being brought into parallel, connection is first made through a synchronising apparatus. The fuses are Messrs. Ferranti's patent oil spring type, and duplicate fuses are provided to every panel. Above the main switchboard the two main voltmeters of the Kelvin type are fixed together with the synchronising lamps. The circuits (at present there are four) are brought from underground up to their respective panels through special concentric fittings, and the outer, which is earthed, is connected direct to the earth bar at the top of the board. The arc lighting board is of simple design. Arrangements are made for either of the three rectifiers to be connected to either of the two arc lighting circuits. Each circuit is provided with oil fuse and an ammeter and current-direction indicator. The outer conductor of the arc lighting circuit is not earthed, and is carefully insulated throughout.

Arrangements are provided in one of the rooms on the level with engine-room for testing all the mains and



Map of District over which Mains are Laid at Hammersmith.

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other apparatus, and testing plugs are also provided on the switchboard for each dynamo.

Distributing System.

The current generated in the works is conducted to the various portions of the parish included in the provisional order as the compulsory area by means of concentric cables laid throughout in cast-iron pipes. All draw-in boxes are, where possible, of cast iron. The pipes in every box are plugged, and it is therefore hoped that gas will be effectually kept out of the pipes. The whole of the contract for trenching, supplying and laying pipes, providing cables, etc., has been carried out by Messrs. Callender. The high-pressure cables, which are concentric and protected by lead sheathing, are of Messrs. Callender's patent jute-impregnated type. The high-pressure cables are connected to certain districts where sub-stations are placed, and in these sub-stations the high pressure is transformed, and the low-pressure current produced is conducted by a network of low-pressure mains along the various streets in the district. There are altogether four main circuits, and these are arranged to supply the following districts: (1) Broadway district, (2) King-street district, (3) Goldhawk-road district, (4) Uxbridge-road district. These main circuits are interconnected, so that the failure of any one circuit will not interfere with the supply to the particular district. Branch circuits are provided at the distributing points to feed the ends of the various districts. The low-pressure cables are laid on both sides of all the streets included in the compulsory area, except Shepherd's Bush-road. These cables are also of Messrs. Callender's patent jute type, and they are protected by a lead sheathing, and also a double armouring of steel tape. They are laid direct in the ground beneath the pavement, and also protected from picks, etc., by means of bricks. The arc lighting cables are laid in a separate system of pipes throughout the area served, and in order to provide for the 85 lamps at present fixed, it has been necessary to lay two circuits. They are on opposite sides of the streets, thus in the event of the failure of either circuit the streets will not be placed in darkness. The whole of the high-pressure and low-pressure cables were tested after laying and jointing up to over three times the working pressure, and they all withstood this severe test satisfactorily.

Sub-Stations.

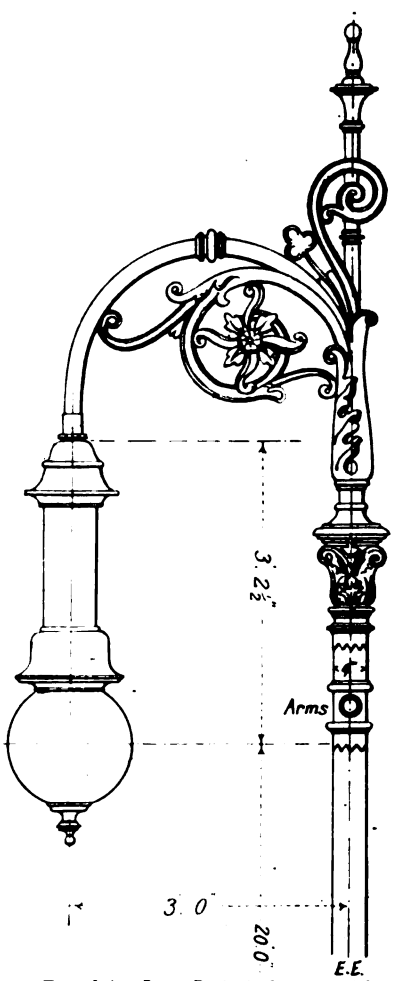
There are at present six sub-stations provided for transforming the high-pressure current to the low-pressure current. Except in the case of the town hall sub-station, which is placed in the basement of that building, all the sub-stations have been constructed in convenient positions under the pavement and roadway. Each sub-station is about 8ft. by 9ft. by 7ft. high, and access is provided by means of a manhole about 3ft. square. The sub-stations which were erected by the Vestry's own workmen are all large enough to provide for at least double the present requirements. The apparatus in each sub-station consists of one or more transformers made by Messrs. Siemens Bros. Complete switching arrangements of special design, also made by Messrs. Siemens, are provided so as to enable any high or low pressure circuit to be disconnected at will for testing, repairs, or additions. All connections and switches are placed in watertight cases. The arrangement is so designed that any sub-station may be flooded without incurring any stoppage in the supply of electricity.

Public Lighting.

The street lighting at present is by arc lamps, which are lighted from sunset to midnight, and after that hour incandescent lamps are used. The arc lamps, posts, etc., for whom Messrs. Siemens were the contractors, are placed between 70 and 110 yards apart along the streets comprising the compulsory area. The posts are of ornamental character, those placed in the centre of the streets having the lamps placed in central carriers, and those at the side of the streets having projecting brackets. The arc lamps are of the well-known Brockie-Pell type, as made by Messrs. Johnson and Phillips, each giving about 1,200 c.p., and fixed 20ft. above the ground. On each post there are two incandescent lamps of 32 c.p. each, placed about 14ft. above the ground, and connected to the low-pressure mains. A special automatic switch of Mr. Edmund's patent design is placed in each of the posts, and it is arranged that if, by design or by accident, any of the arc lamps go out, the incandescent lamps are automatically lighted by means of this switch.

Private Lighting.

All private consumers will be connected to the low-pressure mains by means of a joint-box. The Vestry will lay a short connecting cable into each house and end at a safety fuse, which will be sealed and only used by the Vestry. The meter and demand indicator will also be supplied and fixed by the Vestry. Two scales of charging have been adopted, both of which are based on the maximum demand system. This system of charging was first adopted by Mr. Wright at Brighton. The scales adopted in Hammersmith are (*a*) 6d. per unit for two hours' maximum demand, and 4d. per unit for all units in excess; (*b*) 2½d. per unit, and in addition a fixed charge of 1s. 3d. per quarter per lamp demanded.



Top of Arc Lamp-Post at Hammersmith.

All ordinary and irregular consumers will find that scale (*a*) is best for them to adopt, while all large or constant consumers will find that scale (*b*) is best. It is estimated that if the Vestry can be assured of obtaining 1s. 3d. per lamp used per quarter, there will be no difficulty in paying all standing charges, while 2½d. per unit will cover the cost of producing electricity.

As we have said, the buildings have been designed and superintended by Mr. H. Mair, A.M.I.C.E., the surveyor to the Vestry, while Mr. A. H. Preece, A.M.I.C.E., has designed and superintended all the machinery and other electrical work. Mr. Bell has acted as resident engineer, and now takes charge of the running of the station. The total cost of the scheme has been about £40,000; and the following is a list of the principal contractors, with the work done and amounts of contracts:

Excavation of site and carting away surplus earth—the Vestry	£227	8	6
Foundations of buildings and condenser—the Vestry	623	1	11
Buildings and chimney—Messrs. Leslie and Co.	6,730	17	5
Boilers, engines, dynamos, and other machinery—Messrs. Ferranti	13,617	7	0

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Travelling crane—Messrs. Marshall, Fleming, and Jack	157	0	0
High-pressure and low-pressure cables and pipes—Messrs. Callender	10,170	2	11
Arc lamp-posts—Messrs. Siemens	2 702	0	0
Making good trenches in street—the Vestry	1.625	0	0
Sub-stations—the Vestry	335	8	11
Sub-station equipment and transformers—Messrs. Siemens	935	0	0
Consulting engineer, clerk of works, quantity surveyor, and sundry expenses	1,400	0	0
Total	£38,523	6	8

The Opening Ceremony.

Yesterday (Thursday) afternoon there was a large gathering of the members of the Vestry, guests, and visitors at the works in Fulham Palace-road. They were received at 4 o'clock by the Rev. Prebendary J. H. Snowden, M.A., chairman of the Vestry, and conducted over the works by him, accompanied by Mr. A. H. Preece, consulting engineer, Mr. Mair, surveyor, Mr. G. G. Bell, resident engineer, and Mr. W. P. Cockburn, vestry clerk. Steam was up, and the machinery was set in motion, and everything appeared to be ship-shape and in first-class working order. The visitors appeared to be, and had every reason to be, satisfied with what they saw, and the inspection occupied fully half an hour, but there were no formal speeches.

An adjournment was then made to the town hall, where the final arrangements of the electrical exhibition were just being completed, and the finishing touches given. Space forbids our entering upon a long description of the exhibition, but we cannot let the opportunity pass of saying how much we were struck by the business energy in evidence on all sides. We recognised a few of the names of some of the better-known firms who have established branches in Hammersmith, and we were pleased to see such a very large proportion of the stalls occupied by local electrical engineers.

At 5 o'clock the Vicar, as chairman of the Vestry, asked Dr. Collins, the chairman of the London County Council, to declare the exhibition open.

Dr. Collins first of all alluded to his last visit to Hammersmith at the opening of the town hall by the Duke and Duchess of Fife, a few months previously, and again congratulated Hammersmith on its civic energy and enthusiasm, which he said, so far from giving rise to a feeling of jealousy on the part of the body he represented, only filled them with a feeling of profound admiration. He was pleased to notice that the various authorities were rivalling each other in regard to such matters as electric lighting. He claimed that it was the policy of St. Pancras which did the pioneer work in the matter of electric lighting, and their example had been followed by Islington, Hampstead, Shoreditch, and now Hammersmith. They were adopting the light of the future, and abandoning the light of the past. He must say that the London County Council had done what they could in lending the Vestry £40,000 on very liberal terms, with a repayment period of 42 years. He congratulated all concerned in this new venture; everything seemed to have been done on the best lines possible. He was glad to find that the question of lighting had been solved as it had been done by the Vestry doing the work instead of its being handed over to a speculative company. In conclusion, he formally declared the exhibition open.

Mr. W. H. Preece, C.B., then delivered a short address, in which he dealt chiefly with the domestic advantages pertaining to electricity. Considering that he was addressing an audience composed chiefly of ratepayers and their wives, his address was eminently practical and to the point. He remarked that he had always advocated the municipalisation of electricity undertakings because he felt that such an important matter as pure light should, in conjunction with the equally important matters of pure air and pure water, not be controlled by speculation. It had been urged that municipalisation interfered with private enterprise, but he asked them to look around them and see how flourishing private enterprise was when so staunchly backed up by the Vestry. In conclusion, he referred with pride to the fact that this was the first undertaking of magnitude which his son had carried out, and said he had been round the works and found that everything was good.

Major-General Goldsworthy, M.P., proposed a vote of thanks to Dr. Collins, Mr. Preece, and the other visitors, which was carried by acclamation, and responded to by Dr. Collins and Mr. Preece.

The Chairman of the Electric Lighting Committee (Mr. W. J. Searle) then performed the ceremony of turning on the street-lighting. He first delivered a short address, giving briefly the position of affairs and the prospects, and then touched an electric bell communicating with the electricity works. A moment afterwards the streets of Hammersmith were illuminated with electric light for the first time.

A vote of thanks was then passed to the Chairman, and a tour was then made round the exhibition. At 7 o'clock the committee proceeded to inspect the street-lighting, the journey being made in electric cabs (10 in number) and hansoms.

The light was a great success, and large numbers of people were gathered in the streets for some hours surveying their district under its new aspect.

The exhibition at the town hall remains open until Tuesday evening next.

NOTES ON ACCUMULATOR CONSTRUCTION.

BY DESMOND G. FITZ-GERALD.

I.

To find the number of plates that a given cell or vessel will contain.

The length of the containing vessel—*i.e.*, the dimensions (L) transverse to the plane of the plates—being given; also the thicknesses, t and t_1, of the positive and negative plates; and the distance (l) between the plates. Find the number (n) of plates that can be contained in the given vessel.

N.B.—The number (n) should be an odd one. In an accumulator the terminal plates are ordinarily those with spongy-lead active material, which in accordance with usage we will term – elements. (They are negative electrodes or cathodes in charging.)

$$\text{Then the number of + elements} = \frac{n-1}{2}$$

$$\text{,, ,, ,, – ,,} = \frac{n+1}{2}$$

$$\text{,, ,, ,, spaces } (l) = n-1$$

The total space occupied should (as nearly as possible) be (L), or

$$\frac{n-1}{2}\,t + \frac{n+1}{2}\,t_1 + (n-1)\,l = \mathrm{L} \quad . \quad . \quad \text{(I.)}$$

$$n\,t - t + n\,t_1 + t_1 + n\,2\,l - 2\,l = 2\,\mathrm{L}$$

$$n\,t + n\,t_1 + n\,2\,l = 2\,\mathrm{L} + t - t_1 + 2\,l$$

$$n\,(t + t_1 + 2\,l) = \text{idem.}$$

Whence the formula:

$$n = \frac{2\,\mathrm{L} + t - t_1 + 2\,l}{t + t_1 + 2\,l} \quad . \quad . \quad . \quad \text{(II.)}$$

Example.—The thickness of the peroxide elements being 75 mils,* and that of the spongy-lead elements 50 mils, how many plates can I get into an ebonite case of which the length (L)—*i.e.*, the dimension normal to the plane of the plates—is 2in. = 2,000 mils, if the distance (l) between the plates is to be as nearly as possible 125 mils?

$$\text{Here} \qquad n = \frac{4{,}000 + 75 - 50 + 250}{75 + 50 + 250} = 11{\cdot}4.$$

But this does not mean that there would be room in the vessel for 11 plates and a fraction of a plate; the figures signify that there will be room for 11 plates and *a little space to spare.* Eleven, being an odd number, will suit us very well; but, for the sake of symmetry—if we cannot increase the thickness of our plates—we must slightly increase the value of l.

Taking, therefore, the number (n) of plates as 11, what will be the exact value for (l) the distance between them?

* The *mil* is one-thousandth of an inch.

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We can derive an equation for l from formula (II.).

$$n(t+t_1)+n\,2\,l=2\,\mathrm{L}+t-t_1+2\,l$$

$$(n-1)\,2\,l=2\,\mathrm{L}+t-t_1-n(t+t_1)$$

and

$$l=\frac{2\,\mathrm{L}+t-t_1-n(t+t_1)}{2(n-1)} \quad . \quad \text{(III.)}$$

In the present case, therefore,

$$l=\frac{4{,}025-11\times125}{20}=132{\cdot}5,$$

(instead of 125 mils). The latter may be a carefully calculated value, providing for a certain definite weight of acid of given initial and final density; but the excess of 6 per cent. may be regarded as being practically a negligible quantity.

II.

To find the dimensions of a cell or vessel to contain a given number of plates.

The number (n) of plates, their thicknesses (t and t_1), and the distance (l) between any two plates being given, the "length" (L) of the containing vessel is calculated from formula (I.).

The interior depth of the vessel is ordinarily much in excess of the height of the plates, when these are disposed perpendicularly; some space, to be occupied by the electrolyte, being allowed both below and above the plate, as well as a considerable margin above the electrolyte.

The interior width of the vessel may advantageously be but little in excess of the width of the plates.

Example.—What must be the length of a trough or cell to contain 21 plates; the positives being $\frac{1}{6}$in. and the negatives $\frac{1}{8}$in. respectively in thickness, and the distance between them being $\frac{1}{4}$in.?

Converting into decimal values,

$$t=\cdot16\dot{6},\quad t_1=\cdot125,\quad l=\cdot25,$$

and $\mathrm{L}=10\times\cdot16\dot{6}+11\times\cdot125+20\times\cdot25=8{\cdot}042$in.

The fraction in excess of the 8in. may be avoided by slightly decreasing l, which, by formula (III.), now becomes

$$l=\frac{16+\cdot041-6{\cdot}132}{40}=\cdot247\text{in.};$$

the diminution, though essential, being practically inappreciable.

THE CONSTRUCTION AND WORKING OF A TYPICAL TELEPHONE EXCHANGE.

BY J. WRIGHT.

My object in the following paragraphs is to put before the reader as simply and explicitly as possible the construction and mode of working of a small exchange on the National Telephone Company's system as equipped at the present time. In order to achieve as systematic a result as possible I shall start with the subscribers' lines from the point where they enter the building and trace them through to the switchboard where they terminate, and shall in addition describe the construction and mode of working of the various accessory apparatus employed in the system.

The reader has no doubt noticed the large frameworks, technically known as "derricks," which are erected at various points of the Metropolis on the roofs of buildings. These are the centres of convergence of the telephone subscribers' lines, which find their final attachment here before entering the exchange. The lines usually terminate on ordinary "shed" insulators, whence they are connected by multiple indiarubber-covered cables with the testboard.

The latter consists of a framework or cabinet fitted for the primary reception of the lines. The cables from the derrick are brought on to the top of this case and are there passed through circular openings on either side. The separate wires composing the cable are then brought out in pairs in their proper order at a distance of about $\frac{1}{2}$in. apart ready for attachment to the lightning arresters. To effect this in as workmanlike a manner as possible the cable is first stripped of its outer covering of braided flax for a distance of about 2ft., and the ends of the various wires are threaded in order of priority through a perforated strip of wood, the perforations in which are the exact distance apart of the terminal tabs on the lightning-arrester bar. The whole of the cable end having been disposed of in this way, it is next bound round with tarred tape, which is lapped round, passing between the various pairs of wires and holding them together in a compact form. The cable thus finished off is ready to be soldered on the terminals of the lightning arresters.

These lightning-arrester strips consist of a bar of ebonite having a square sectional area of about an inch. To one face of this are attached the terminals or tabs of the form shown in Fig. 1, where A is a slotted tab with a serrated edge which forms part of the lightning arrester. B, on the other hand, is a simple attachment to receive the wires of our cable. It has a fork by means of which it is supported by a screw passing through into the ebonite base of the bar. The object of having the two tabs separate is to allow of any necessary detachment for testing purposes. On a neighbouring surface of the ebonite to that occupied by the tabs is a thin strip of brass which forms the remaining portion of the lightning arrester. The serrated edge of the tab, A, is in close proximity to this strip, which is earthed. The arrestive action of this device on lightning will be clearly seen. On a line becoming charged with the electric fluid it discharges itself by means of a spark across the small air-space, and thus flows to earth before reaching the switchboard.

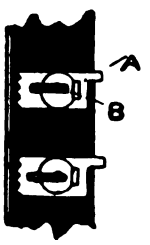

Fig. 1.

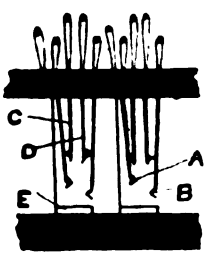

Fig. 2.

The lightning-arrester bars are fixed to the edges of the shelves in the test case, in a vertical position, opposite their respective cable ends. They are usually arranged in rows of 25 pairs, or 50 terminals in all. The wires of the cable having been brought out as previously described are easily stripped and soldered to that movable portion of the terminal shown at B in Fig. 1. I may here mention that for all interior soldering work, the company use a special kind of solder drawn out in the form of thick wire with a core of powdered resin running down the centre, thus combining solder and flux in one, which for small and intricate work is a great convenience.

In cases where the line is of the underground variety it reaches the test-room as a dry-core lead-covered cable, which terminates in what is known as a "head." The latter is an airtight cast-iron box, fitted with a series of brass terminals, into which the end of the cable is sweated. The connections to the lightning-arrester bars are made by multiple cables cotton covered and paraffined from the outer portion of the brass terminal bolts on the cable head.

To proceed, the next piece of apparatus is the spring test "jack." It consists of an iron plate foundation, on which are mounted two parallel ebonite strips in a position parallel to its length. They carry two pairs of stiff brass springs—four in all—for each subscriber. The inner pair are screwed direct on to the ebonite strips, and are curved over at their front ends to form a tab for the attachment of the exchange wire. The outer pair, on the other hand, are fixed directly over the former, and make spring contact with them in front, but are insulated from them at the back by a third ebonite strip.

These sets of springs are mounted 20 at a time, and are slid bodily in a vertical position into slots provided in the shelves of the test case, just below the lightning-arrester bars. The utility of the device will be explained presently. The tabs, A (Fig. 1), are connected to the outer pair of springs by a taut length of twin wire, covered with one coat of pure Para rubber, surmounted by two layers of cotton saturated in paraffin wax. The denomination of the

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various lines is represented by a variation in the colours of the connecting twins, such as black and green for subscribers, pink and green for "junction" wires, etc. They are run as directly as possible through a series of thick wire or wooden grids fixed in a perpendicular position in various parts of the test case.

A testing set is fitted in a convenient position, and consists of an ordinary magneto pattern wall instrument as issued by the National Telephone Company, a trigger switching device, a detector galvanometer, a local battery switch, an eight-point switch, and a battery of some half-dozen cells.

The switching device consists of a set of four trigger switches, each having a special office. By depressing the first a current is sent through the whole circuit, including the subscriber's instrument and the galvanometer. A disconnection or short-circuit can thus be at once detected. The second and third triggers put the battery to each side of the line and earth respectively through the galvanometer, thus providing an earth test. The fourth and last trigger detects an earth on the lightning-arrester bars.

By means of the eight-point switch this testing set can be respectively connected with "line" and "exchange," so that each side can be tested in turn to localise a fault irrespective of the other.

The connections to the testing set are made by means of a four-way cord and plug. The latter consists of a hollow cylinder of ebonite cut down to the shape of a wedge at its extremity. On each of the two faces of the wedge is fixed a pair of brass contact plates, one pair being connected with the line side of the apparatus, the other with the exchange. The connection with any line is made by inserting this composite plug or wedge in between the test springs corresponding to that particular line.

From the test jacks, the lines go to what is known as a "distributing board." This is usually fitted at the back of the switchboard, and consists of a series of ordinary metallic tabs for the reception of the various wires. The connection is made by means of a 42-wire cable. This cable consists of 42 tinned wires of No. 20 S.W.G., having one coat of pure Para rubber and two layers of paraffined cotton. They are laid up in pairs, and are distinguished by the different colours of their cotton covering. The cable is run in troughing, and the ends are finished off in a similar manner to those of the derrick cables, in that they are tapered off on a "lacing table," which consists of a row of pegs fixed upright in a board at distances corresponding to those of the tabs to which they are to be attached. Instead, however, of their being, as in the previous case, lapped with tape, they are laced with mattrass twine. The test spring end of the cable is laid in a channel formed by the bent-over ends of the lower springs, to the tabs of which the wires are soldered in the usual manner. The other end is treated in a similar manner, but in lieu of a channel, it is cleated to the distributing board by pig-skin loops.

From the distributing board a similar multiple cable leads off to the "home section" or "local jack." The latter is made up in rows of 25, and the construction is shown in Fig. 2, which represents two of these jacks.

A and B are the incoming springs, and make contact with the "tip" and "base" of the plug, to be described presently. C and D are the outgoing or indicator springs. As will be seen in the figure, they are provided with platinum contact points on the sides nearest A and B, with which they respectively make contact, when no plug is inserted; they are connected to the subscriber's indicator. E is a metal-lined bush, which forms the connection for the engaged test.

From the distributing board another cable goes to the first of the so-called "multiple" jacks, which are precisely similar to the local, with the exception of being mounted in sets of 20 instead of 25. The outgoing springs, C D (Fig. 2), are not, however, connected with the indicator, as in the previous case, but are connected with the A and B of the next multiple jack in the board, which is usually some five panels down, and so on throughout the whole length of the board. It will thus be seen that an operator, by plugging in the first multiple of a particular number in the board, cuts out all the other multiple jacks of that particular number by breaking the contact between A B and C D. These multiple jacks are arranged in panels in the upper part of the switchboard in sets of 100, corresponding to that number of subscribers.

I spoke just now of the subscribers' indicators. These are fitted in rows in a section of the switchboard just below the local jacks. They consist of a small horseshoe electromagnet, A (Fig. 3), with a pivoted armature, B, at one extremity carrying a light arm, C, which extends back over the magnet and ends in a small hook, which serves to support the indicator shutter, D, until rung down. When the subscriber turns the handle of his magneto, he sends a pulsating current over the line to the indicator. This gives rise to a vibration of the armature, and consequent release of the shutter, D, which falls by its own weight and exposes the subscriber's number to the operator at the board, thus signifying that he requires attention.

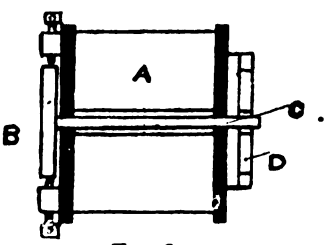

FIG. 3.

Now as to the apparatus employed in operating. Each telephone operator is provided with a head-gear receiver and breast-plate transmitter, as shown in Fig 4.

The transmitter, A, consists of a thin ferro-type diaphragm, on to which the collector, B, opens. At the back of this diaphragm is a small quantity of granulated carbon, held in position by a circular carbon cup surmounted by a soft felt sleeve. The local battery can be put out of circuit at will by turning down the transmitter, A, which is pivoted for that purpose, and is provided with a sliding contact on its circumference which is traversed by the fixed spring, C. The receiver, D, which is of the ordinary double-pole pattern, is mounted on two light metal bands, E, which fit over the curve of the head and support it in position at the ear. F is a small stuffed washleather pad to soften the pressure at the opposite extremity of the bands. The receiver is connected to the breastplate by a

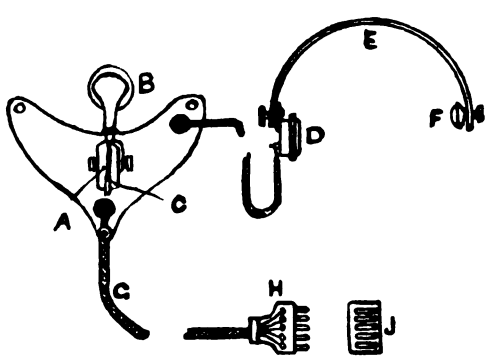

FIG. 4.

green flexible cord. The connections to the switchboard are also made by a green flexible cord, G, ending in a five-point plug, H, which fits into a corresponding Ericcsson jack, J, on the switchboard. The object of the fifth point is to connect the middle point of the receiver winding to earth for the "engaged" test, which will be explained presently.

(To be continued.)

The Utilisation of Water Power in Canada.—A short time ago a company of Ottawa capitalists was formed for the purpose of utilising the water power of the Lachine Rapids, near Montreal, and the new works have just been formally opened. From 20,000 h.p. to 25,000 h.p. is procured at a cost of nearly £400,000, and furnishes electricity for lighting and motive purposes to Montreal and the adjacent municipalities.

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E C Anonymous communications will not be noticed.*

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Vol. XIX. of new series of "The Electrical Engineer" can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.

THE HASTE TO BE RICH.

Every man, however good he may be, appears to have a little of the gambling instinct in him, perhaps largely because in life itself and the struggles of one form and another that enter into it there is a considerable element of what seems like chance—however we ultimately regard it. Some are led to the racecourse, some to the search for gold, others to the more speculative forms of business life: but all seem actuated by a desire to get as much as they can with as little trouble as possible. There is, perhaps, no great harm in following out such a rule, provided always that it does not entail injustice to others.

Too often, however, it becomes a matter of gaining wealth and advancement in questionable ways—get it honestly, one is told, "Si possis, sinminus quocunque modo"—honestly if you can, but if not, then by any other way. The haste to be rich overrides all the elements of honest, straightforward work, and although the crash comes sooner or later with everything not founded upon true natural principles of only the best surviving, yet there is a terrible waste of time and energy in doing the work all over again in proper fashion.

We have had in past years a full proportion of this hurry for personal advantage in electrical work; indeed, almost too many instances of "watered" companies and enterprises started by financiers or promoting interests, careful of nothing but their own immediate profits, and at brief intervals there are recrudescences of the same tendency to promote companies for the sake of promotion, and not for *bonâ fide* working objects. So far as electric lighting is concerned, the great spread of municipal management during the past few years has put an end to any large development of promoters in the worst sense of the word, in regard to the big towns where the amounts to be dealt with are of necessity considerable: but even at the present time we notice occasionally efforts made by certain interests to act in a similar fashion with reference to a number of small places, where the amounts at stake, though small in themselves and individually, become important (and profitable, from the promoter's point of view) when added together.

If those who thus offer the advantages of electric supply to places and districts where the local authority itself may not be able to undertake the task are substantially backed up, and enter upon the work with a view to securing good investments as well as an opportunity to employ staff and men with reasonable profit, then we have nothing more to say than to wish them all possible success in their endeavour; but if, as we fear, these enterprises are taken up largely as a matter of speculation, with the idea of selling out at a big profit to the local authority or to a mammoth public company at no distant date, then we can only characterise such efforts as savouring of the smart, and also of the "quocunque modo"—of the "any other way"—above referred to.

Much the same expressions of opinion may be offered in regard to the great mass of work and

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development now in view for the early future in electric traction.

As a matter of fact, there will be even greater scope for the continuance and promotion of electric tramway companies than of electric supply companies, for the majority of electric supply enterprises concerned with lighting are contained in one district only, and may, therefore, well be worked and owned by the local authority. But tramways in many cases will each not only pass through several different districts, but will even connect several towns together, so that there is much more reason for the existence of electric tramway companies, unless the lines are worked by joint committees—by no means an easily arranged method.

It is sincerely to be hoped, not merely for the credit of the electrical industry, but also for the sake of permanent and lasting success for the enterprises themselves (which can only be obtained by straightforward and reasonable action), that the progress which undoubtedly will take place during the next few years in electric traction will not be marred by the same spirit of grab too often shown of old in the development of electric lighting, but that existing lines will be converted and new lines built in accordance with a policy as sound and substantial as the solid permanent way of which English engineers are justly proud.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ELECTRIC TRACTION ON COMMON ROADS, 1895.

SIR,—Mr. Desmond G. Fitz-Gerald, in an article bearing the above title, which appeared in your issue of the 24th inst., makes the following statement: "For short periods of time the discharge was 200 amperes, giving the ratio $\frac{\text{amperes}}{\text{lb.}} = 6$. Barring the Tudor cell, it would, I think, be difficult, outside the laboratory, to find another accumulator that could without damage give this rate of discharge for a minute."

We wish to call your attention to the fact that we have discharged one of our latest type of motorcar cells weighing 26lb. at the rate of 250 amperes for two minutes, which gives the ratio $\frac{\text{amperes}}{\text{lb.}} = 9{\cdot}5$. This was no special cell, but was taken at random from a number of cells, and had the previous day been discharged at 190 amperes for 10 minutes. We may add that this type of cell has for some time past been running our motorcars with the utmost satisfaction.—Yours, etc.,

ELIESON LAMINA ACCUMULATOR COMPANY, LIMITED,
(W. S. Naylor, Secretary).

CORRECTION.

SIR,—I observe a paragraph in last week's electrical papers to the effect that a new company under the title of "Sax, Slatter, and Co., Limited," has been formed to take over the business formerly carried on under the style of "Julius Sax and Co., Limited," at Forester's Hall, Clerkenwell-road, E.C.

As this notification may possibly lead persons to assume that "Julius Sax and Co., Limited" (which was established in 1855) have parted with their business, I write to inform you that this is not the case, and that "Sax, Slatter, and Co., Limited," have no connection with "Julius Sax and Co., Limited." The business formerly carried on at Forester's Hall by "Julius Sax and Co., Limited," being of an entirely different nature to their ordinary business, was recently discontinued. "Julius Sax and Co., Limited," still continue to carry on the business of electrical engineers and electric light contractors, in which they have gained some eminence, at their works, 119, Coldharbour-lane, Camberwell, S.E., where they continue to manufacture, in addition to all ordinary electrical appliances, their well-known telegraphic and telephonic instruments, patent fire and burglar alarms, etc.

The business has recently been placed under new management, and the company is at present actively engaged in executing contracts of considerable importance.

Will you kindly insert this letter, or a notification to its effect, in your next issue?—Yours, etc.,

JULIUS SAX AND CO., LIMITED,
(E. M. Winter, Manager).

REVIEWS.

Dynamos and Electric Motors: How to Make and Run Them. Edited by PAUL N. HASLUCK. Cassell and Co. Price 1s.

The author's name is not given to this book, therefore it may be assumed the editor makes himself responsible for its contents. It is purely an amateur's book for amateurs—good of its kind, but it is difficult to explain exactly "its kind." In the first place, it is not electrical—most emphatically not, but purely mechanical. By this we mean to indicate that while the amateur might from the directions, illustrations, and dimensional details given manage to construct a machine, he really is told nothing of the electrical why and wherefore. The book, in fact, has for its text how to construct and put together each part, rather than to enable one to calculate how to design. When this is understood, we have little but praise to say for the work. It has evidently been written with a view to serve the amateur, and should succeed admirably in its purpose. Few people realise the enormous number of amateur workers, and were it not for such books as these, they (the amateurs) would often be badly off. The mere following blindly the dimensions given, and constructing a machine upon the lines indicated, gives an enormous amount of useful knowledge to the worker, and he often learns more from his failures than from his successes. Happy the man whose sons have a hobby for constructing pieces of machinery; and happy the sons, for they thereby lay a good foundation upon which to build in the future if they intend to follow any branch of mechanical engineering during their working life.

The Elements of Electro-Chemistry Treated Experimentally. By Dr. ROBERT LUPKE. Translated by M. M. Pattison Muir, M.A. London: H. Grevel and Co.

There is no good elementary book upon the subject of electro-chemistry in the English language written by an English author. The best works we have are translations from the German, and the translators, in their desire to closely follow the original text, have fallen into errors of notation that ought to have been avoided. It is contrary to the interests of the student, for example, to symbolise pressure by π. That symbol has been reserved for the well-known ratio between the diameter and the circumference of a circle. It is the common symbol for that purpose, and every author or translator who uses it for any other purpose cannot have the due appreciation of the value of a common notation. There are other faults of a similar kind. Another weak point is tabulating resistances in terms of the old Siemens unit. If we are to have an international system, why use a unit of resistance that is 0·94 of the accepted unit? Such use entails more work upon the student. He has to translate the tabulated figures into the correct figures before he can begin his comparisons. It is no excuse to say that chemists still use the Siemens unit. They ought to fall into line with common practice, and not endeavour to stand upon a pedestal apart.

The present-day theories relating to electro-chemistry

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are new, and have not permeated into the ordinary schools, though accepted by the up-to-date professors. The consolidation of the views of Hittorf, Kohlrausch, Van t'Hoff, Arrhenius, and others by Ostwald, and their acceptance by the leaders of scientific thought, has not yet been followed by these views being understanded by the multitude. We are well aware that great attention has been given to the "migration of the ions" by Lodge and others, that a committee of the British Association has reported at great length upon electrolysis, but no English author, so far as we are aware, has attempted to write a book for students based upon these theories. Some of the theories advanced are no doubt as yet unproved. Indeed, we should always hesitate to accept any theory which gave a law requiring a "constant" in the symbolic formula. Any formula with a constant will agree with any experimental result.

This little work of Dr. Lüpke, as others from German sources, expounds the subject from the standpoint of these modern theories. The subject is not always made so clear as it might be, but this probably ought to be expected, and at the present stage is unavoidable. The wonder is that the author has succeeded so well. Perhaps it is condensing a little too much to say that the present-day theories explain electro-chemical phenomena by the migration of ions with different velocities in directions controlled by the direction of the current. The plan adopted by Dr. Lüpke is exceedingly good. He experimentally shows the phenomena of electrolysis by using fused salts, where the ions "separate directly on the electrodes." Then we have discussed, in successive chapters, Faraday's law, the theories of Hittorf, Kohlrausch, Arrhenius, etc., with a chapter summarising the laws discovered, which concludes the second part of the book. The third part deals with the osmotic theory to explain the action in galvanic cells. It would be impossible for us to adequately deal with this theory, which has been fully accepted, and must refer readers to the book, wherein the subject is fairly treated. Students who desire to make themselves acquainted with these modern theories will find Dr. Lüpke's book of great service, and apart from the difference in notation and minor blemishes, the matter and method are to be commended.

SOME TESTS ON THE VARIATION OF THE CONSTANTS OF ELECTRICITY SUPPLY METERS, WITH TEMPERATURE AND WITH CURRENT.*

BY G. W. DONALD RICKS.

(Concluded from page 406.)

Perry Meter.

The general principle upon which the action of this meter depends differs from that employed in the Chamberlain and Hookham meter in several respects. Instead of the current passing radially through a permanent magnetic field, the field is radial and the current traverses it perpendicularly, the chief retarding force being due to Foucault currents. It was in this meter that complete immersion of the armature was first used.

In the sectional drawings (Figs. 6 and 7), M M are a number of permanent magnets, their pole-pieces being so shaped that they form the boundaries of an annular chamber, S, containing mercury. In this chamber an inverted copper cup rotates on a vertical spindle. The pivot is placed in a small mercury-cup, thus ensuring good electrical contact between the fixed and moving parts of the circuit. The whole surface of the spindle and copper cup, except the rim at the bottom, is insulated from the mercury by a coating of enamel. The current on entering at the terminal passes to the bottom of the mercury-chamber; then up through the cylinder and spindle to the small mercury-cup, C, into which projects a nickelled rod, insulated from the case but connected to the other terminal, by which the current leaves the meter.

Solid friction is not compensated for in this meter, but is made very small compared with the other forces, by so adjusting the weight of the copper cylinder that it just floats in the mercury. There is also very little skin friction, because of the very small diameter of the spindle at the part where it passes out of the mercury. In order to make the Foucault friction as large as possible, discontinuities (Fig. 7) are made in the pole-pieces; but the cylindrical form of the mercury-chamber is preserved by filling these up with plaster of Paris, the aim being to make the retarding force due to Foucault currents large compared with the other retarding forces—viz., that due to the friction of

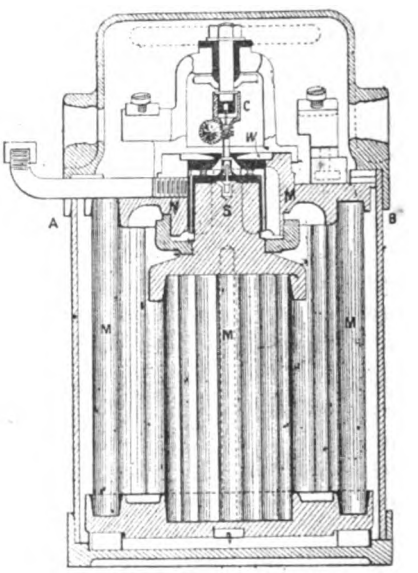

FIG. 6.—The Perry Meter.

the mercury against the sides of the chamber, and the solid and skin friction of the spindle.

In considering the law of this meter, let

A = the current;
F = strength of permanent magnet field;
T = the driving torque;
w = the angular speed of spindle;

Then $T = c\,A\,F$ where c is some constant.

Now the frictional resistance is made up of three parts:

1. Solid friction at the bearings and skin friction where the spindle passes out of the mercury. Let r equal their combined retarding force; the law connecting r with the speed, w, is not at all definite.

2. Fluid friction of the mercury on the copper cylinder and on the walls of its chamber. This is an exponential function of the speed, the exponent increasing with the speed. Let $\phi(w)$ be the retarding force due to this cause.

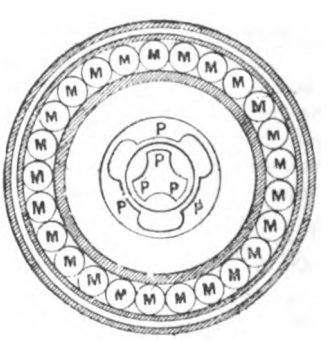

FIG. 7.—The Perry Meter—Section through A B (Fig. 6).

3. Foucault current friction. This is very nearly proportional to the speed and to the square of the strength of the magnetic field, and may therefore be represented by $b\,F^2\,w$, where b is some constant.

Hence for steady motion we have:

$$T = c\,F\,A = r + \phi(w) + b\,F^2\,w.$$

Now the construction of the meter is such that the term $b\,F^2\,w$ is very much greater than the sum, $r + \phi(w)$. As already mentioned, this is effected by using a strong permanent magnetic field and by reducing solid and fluid friction to a minimum.

* Paper presented by Prof. W. E. Ayrton to the British Association meeting at Toronto.

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Hence we have that very approximately $c\,F\,A = b\,F^2\,w$,

$$A = \frac{b\,F}{c}\,w = k\,w, \text{ where } k \text{ is some constant.}$$

The experimental results obtained from this meter are given in tabulated form in Table 4, and shown graphically on Diagram IV.

TABLE 4.—Perry Meter.

Maximum current, 20 amperes. Current varied. $a = 660$. $K^1 = 2$.

Current A.	At −1deg. C.		At 19deg. C.		At 32deg. C.	
	w	K	w	K	w	K
1	0·0607	3·022	0·0685	2·677	0·0724	2·534
2	0·1493	2·456	0·1613	2·271	0·1700	2·152
5	0·3950	2·320	0·4210	2·180	0·4432	2·069
7	0·5490	2·341	0·596	2·155	0 620	2·070
10	0·779	2·356	0 847	2·166	0·875	2·096
15	1·126	2·442	1·241	2 215	1·296	2·121
20	1·490	2·460	1·640	2·256	1 690	2·170

The high value of the constant at low currents is undoubtedly due to relative importance of solid and fluid friction as compared with Foucault current friction, for, as already mentioned, the former are not compensated for, and in the equation of motion are assumed to be negligible compared with Foucault friction.

Above about 30 per cent. of maximum current the constant begins gradually to rise, owing possibly to the increased effect of fluid friction, which increases very rapidly with the speed.

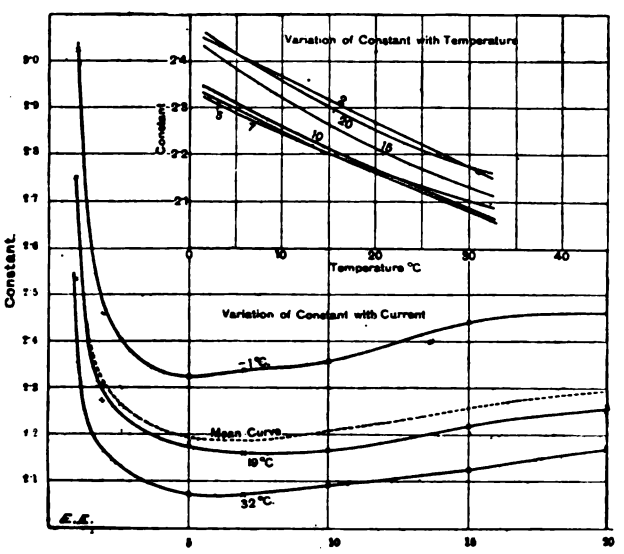

DIAGRAM IV.—Perry Meter. Maximum Current, 25 Amperes.

The effect of temperature, as shown also on Diagram IV., seems to be considerable. The contant decreases in value with rise of temperature, the mean coefficient being 0·47 per cent. per 1deg. C. change of temperature. It may be accounted for by the decrease in retarding forces, due partly to the increased resistance of the copper cup, and consequently smaller Foucault current friction, but probably also to the decreased viscosity of the mercury reducing the fluid friction. The weakening of the permanent magnets with rise of temperature would scarcely have any effect on the constant, because it would, except perhaps at very low currents, alter the driving and retarding forces in almost the same ratio. The inaccuracies of this meter with variable temperature are rather large. An alteration of 10deg. C., for instance, causes an error of 4·7 per cent., which is rather serious when it is remembered that the Board of Trade has fixed the maximum permissible error at 2½ per cent.

Although possessing such a high temperature coefficient, this meter has several very desirable properties, among which may be mentioned extremely low resistance. Delicate counting mechanism is avoided by having a large brake force; extremely delicate registering gears are very troublesome to keep in order, and will stand only the most careful usage. The use of exceedingly pure mercury is not so essential in this meter as it is in those which rely on mercury for fluid friction. Fairly pure mercury is used to reduce the fluid friction to a minimum.

The permanency of strength of the magnetic field is secured by energising the magnets after they are in position, and then slightly weakening them. The strength of field is adjusted by replacing one or more by pieces of wood until reduced to the required strength. The construction is throughout very compact and durable, and the manner of making connections very convenient.

Chamberlain and Hookham Meter.

In this meter two metal discs are employed rotating upon a vertical spindle in a permanent magnetic field the direction of which is parallel to the spindle. The current in passing radially through one of the discs gives rise to a driving torque which, since the field is constant, is directly proportional to itself. A retarding torque proportional to the speed is supplied by Foucault currents in the other disc.

In the sectional drawing (Fig. 8) M M are permanent magnets enclosed in a brass tube, T. The pieces, E E_1, and the wrought-iron pillars, W W_1, continue the magnetic circuit to the pole-pieces, P P_1, between which there is a wrought-iron piece, L. This is held down upon a copper ring, R, which lies upon the flat surface of the lower pole-piece, P, and forms with it a mercury-chamber in which the driving disc, D, rotates. The inner surface of the ring, R, is nickel-plated to prevent injury from the mercury. The brake disc, D_1, rotates in the gap between L and the upper pole-

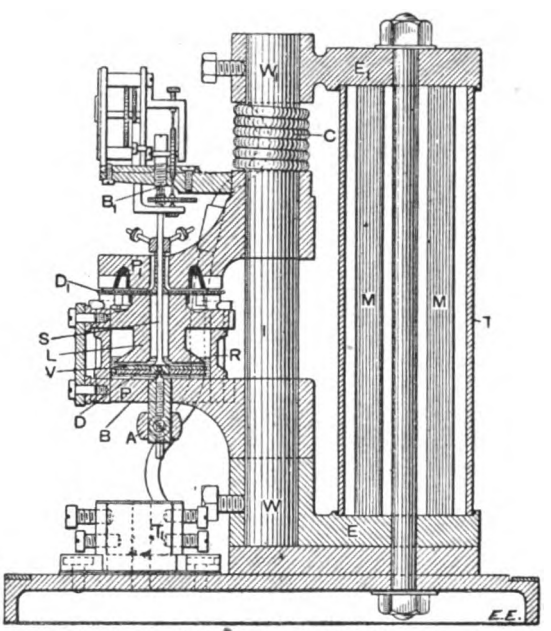

FIG. 8.—Chamberlain and Hookham Meter.

piece, P_1, both of which are deeply grooved radially to increase the Foucault current effect. This grooving also has the effect of reducing the area of cross-section, causing the projecting radial bars to be partially saturated, the result being that the strength of the brake field is almost independent of the total induction. Besides the retarding force on the brake disc, two other retarding forces are present—namely, that due to fluid friction of the driving disc on the mercury, and that due to solid friction at the bearings and in the counting mechanism. These are all made as small as possible and are practically negligible compared with the brake friction.

Solid friction at the bearings is reduced to a minimum by the following ingenious arrangement: the floating power of the armature is so adjusted that at small current it is just able to support the weight of the spindle and discs. There is then a very light pressure on the upper bearing, which is very delicate and almost frictionless. As the current increases, however, the centrifugal force of the mercury draws the armature down on to the much stronger and more durable bearing at the lower end. By this means the delicate upper bearing is used only at small currents, when friction has a comparatively large effect. The flotation of the lower disc is adjusted by attaching to it a disc of vulcanised fibre.

A correction is made for fluid friction by slightly increas-

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TABLE 6.

Meter.	Maximum current in amperes	Normal pressure in volts.	Resistance in ohms. Main circuit. At one ampere.	Resistance in ohms. Main circuit. At maximum current.	Resistance in ohms. Shunt circuit	Power wasted at maximum current. Main circuit.	Power wasted at maximum current. Shunt circuit.	Power wasted at maximum current. Total watts.	Fall of potential in series circuit at maximum current.	Starting current per cent. of maximum.	Temperature coefficient.
Elihu Thomson	10	100	0·0948	0·0958	3,101	9·58	3·22	12 8	0·958	1·4	−0·32
Schuckert	15	110	0·0420	0 0438	2,535	9 9	4·77	14·67	0·66	1·93	−0·13
Ferranti	25	—	0·0154	0·0131	—	8·19	—	8·19	0·327	0·8	+0 07
Perry	20	—	0·00327	0·00331	—	1·32	—	1·32	0·066	1·25	−0·47
Chamberlain and Hookham.	25	—	0·0137	0·0157	—	9·8	—	9·8	0·392	0·8	−0·22

ing the armature field at higher speeds, without altering the brake field. This is effected by attaching to the iron piece, L, a flat iron bar (not shown in the drawing) which bends downwards by the side of the lower pole-piece. This forms a magnetic shunt circuit energised by a few series turns. When the current is very small it weakens the armature field by shunting some of it, but as the current increases a reversal takes place, the armature field being strengthened by the shunt induction. Besides this there are a few series windings placed on the upper polar extension of the permanent magnets, and having such a direction as to strengthen the magnets.

The current enters at the rim of the armature disc, passing radially to its centre, and is then led round the two series windings already mentioned.

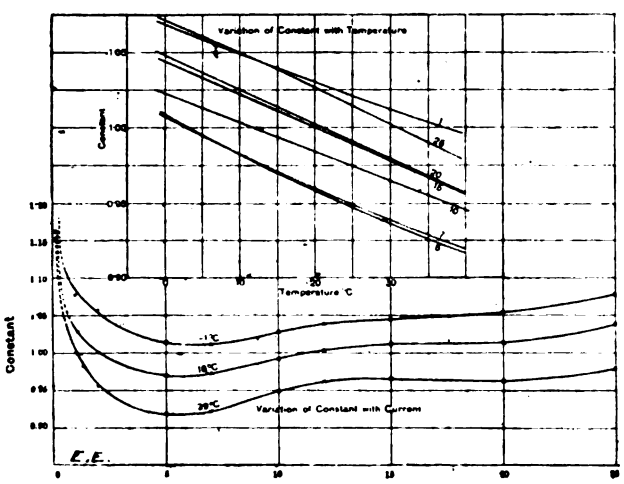

DIAGRAM V.—Chamberlain and Hookham Meter. Maximum Current, 25 Amps.

The results of the tests on this meter are given in Table 5, and shown graphically on Diagram V. Referring to this, it will be seen that the constant rapidly decreases as the current is increased, the curve crossing the declared value at about 8 per cent. of the maximum current, and having a rather low value till at about 45 per cent. it crosses the declared value again, after which it remains fairly level until within 20 per cent. of the maximum current, when it bends upwards. Solid friction, which, of course, is not compensated for in this meter, must account for the high value of the constant at low currents, and partly uncompensated fluid friction for the final rise. Perhaps also the low value at about 20 per cent. of maximum current may be due to the compensating effect being too great, as it probably would be at low speeds.

TABLE 5.—Chamberlain and Hookham Meter.
Maximum current, 25 amperes. $a = 624$. $K^1 = 1$.

Current A.	At −1deg. C.		At 16deg. C.		At 39deg. C.	
	w	K	w	K	w	K
1	0·1608	1·076	0·1678	1·032	0·1768	1·00
2	0·3281	1·057	0·3478	0·998	0 3640	0 953
5	0·856	1·011	0·897	0·966	0·945	0·918
7	1·200	1·010	1·250	0·971	1·316	0·922
10	1·688	1·026	1·750	0·991	1·830	0·947
12	2·002	1·038	2 073	1·003	2·168	0·960
15	2·480	1·046	2 578	1·010	2·700	0·963
20	3·290	1·052	2·435	1·011	3·615	0 960
25	4·030	1·075	4·176	1·037	4·430	0·978

The curves showing the effect of temperature are also given on Diagram V. The constant appears to vary in a very uniform manner, inversely as the change in temperature, the maximum effect differing very little from the mean. The mean temperature coefficient is − 0·22 per cent. per degree C. It is probably due to the combined effect of the increase of the electric resistance of the brake disc and decreased fluid friction, both of which would tend to decrease the constant as the temperature rises.

The starting current of this meter was found to be 0·2 ampere, or 0·8 per cent. of the maximum current. Its resistance is also very low and its general construction good.

General Comparison.

A very fair idea of the relative advantages and disadvantages of each meter may be obtained from Table 6.

The first two columns simply show the current, and in the case of energy meters the pressure for which each meter is intended. The resistance of the main circuit given in the next two columns was measured by means of a standard ammeter and a standard reflecting voltmeter, and the resistance of the shunt circuits on a Wheatstone bridge.

Considering first the Elihu Thomson meter, it will be noticed that its resistance is comparatively large, the fall of potential at 10 amperes amounting to nearly 0·96 volt. The temperature coefficient is also comparatively large, and the starting current 1·4 per cent. of the maximum current, which is, perhaps, not excessive for this class of meter, especially when used on alternate-current circuits.

The Schuckert has an advantage over the Thomson meter in that its resistance is very much less, reducing the fall of pressure and wasted power, but, on the other hand, its starting current is higher, being 1·93 per cent. of the maximum. Its temperature coefficient is also much less than that of the Thomson meter.

Turning now to the ampere-hour meters, the first point to be noticed is that their resistances are very much lower than is the case with the energy meters. Not only do they save the three or four watts absorbed in the pressure circuit, but the watts wasted in the main circuit appear to be much less.

The Ferranti meter starts with a very small current, 0·8 per cent. of the maximum, and has an extremely low temperature coefficient. The Chamberlain and Hookham meter has an equally low starting current and a moderate temperature coefficient, its resistance being rather higher than that of the Ferranti for the same maximum current. The Perry meter has an extremely small resistance, causing a fall of pressure of less than a tenth of a volt at maximum current, and absorbing only 1·32 watts. In this respect it is far in advance of all the others, but it has the disadvantages of comparatively high starting current and temperature coefficient.

Conclusion.

In conclusion, the author must acknowledge his indebtedness to the following gentlemen, who have lent their assistance in various ways: to Prof. Ayrton, for having afforded facilities for carrying out the experimental tests, and for his liberal assistance in supervising the paper; to Mr. Carter and Mr. W. M. Nelson, students at the Central Technical College, the former for his assistance in the laboratory, and the latter for having rewritten and arranged the results in their present form; and, lastly, to the manufacturers of the various meters for placing specimens at his disposal.

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TELEGRAPHY WITHOUT WIRES.

BY H. MELVILLE DOWSETT.

On Saturday, September 25, in connection with the Society for the Extension of University Teaching, a demonstration of "telegraphy without wires" took place in the grounds of F. Crisp, Esq., J.P., D.L., New Southgate, under the direction of Signor Marconi.

The apparatus for the production of the Hertzian waves consisted of a battery of dry cells generating four volts, connected on to the thick wire coil of a Ruhmkorff (Fig. 1).

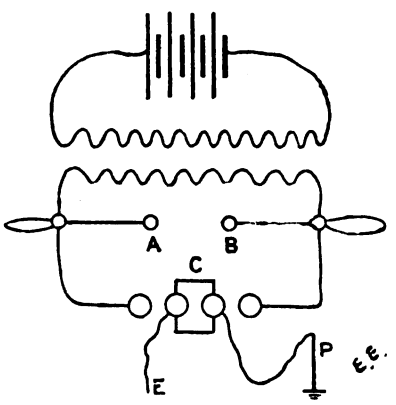

FIG. 1.

The outer coil transformed these volts high enough to bridge a gap of 5in. When the two balls, A and B, became separated by about this distance, the current took the alternative path through the oscillator, C. This was of the Righi type and composed of four balls, the two outer ones of which being connected to the dischargers, A and B, and of the two inner balls, the one went to earth by a coil of aluminium wire, and a connection from the other was carried up a pole standing about 12ft. above the ground and left with its end free. The receiver consisted of a small Marconi coherer, which set in action a relay, and messages were then turned out in ordinary telegraphic form. The resonator used consisted of an exhausted glass tube about 2in. long, having two platinum wires fused into it, which each held a small cylindrical rod of silver, separated from each other by a very small distance.

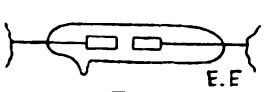

FIG. 2.

On the floor of the tube (Fig. 2) a dust of manganin and nickel is placed, together with a very slight trace of mercury, as it was found that this addition improves the action of the resonator. The connections were similar to those of the oscillator, one wire of aluminium going to earth, and another covered wire being left with its end free, at the top of a bamboo pole of the same height as that holding the wire from the transmitting instrument.

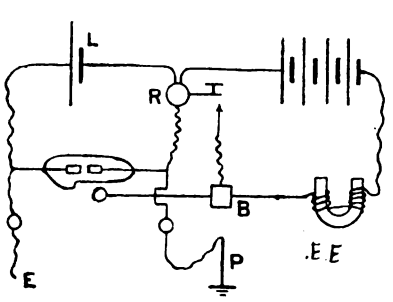

FIG. 3.

The accompanying diagram (Fig. 3) illustrates the connections. M and N are coils of iron wire of many turns, producing large self-induction effects, so that no current runs through the resonator from the battery, L, which is of such a strength that the current just does not pass through the coherer. The Hertzian waves give the extra impulse needed to complete the circuit. The relay is connected on to a battery and an electromagnet, and shunted so that the current through it does not interfere with that through the resonator. An electric bell arrangement, B, is used to tap the coherer, and in such a manner that no currents can be taken by it. The outer balls of the oscillator are left very dull, but the inner two have half their surfaces in a small oil-bath, and are thus kept electrically clean. By this means the path of the oscillation can be easily measured, as the spark when once past the conveying spheres does not wish to return to them because of the great opposing resistance, and the wave therefore vibrates within the inner limits. The diameters of the balls were about 1½in. each, while the length of the spark was ¼in. in the first and third gap, and slightly less in the oil-trough. As the sparks pass through the white vaseline oil, decomposition occurs and the liquid darkens, but in this state it is even found to act better.

The apparatus used on Saturday had already signalled a distance of over nine miles, and was therefore interesting

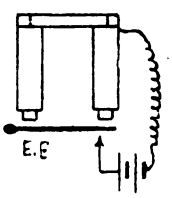

FIG. 4.

on that account, but the record of 12 miles appears to have been broken quite lately by Signor Marconi while experimenting on Salisbury Plain, when a very much greater length appears to have been covered, but the true distance the inventor was not at liberty to disclose. For experimenting at short distances the conveying leads to the coherer were disconnected, and two copper strips about 1ft. 6in. long and 1in. wide took their place. At a distance of a few yards, when thus arranged, a very small spark from a couple of dry cells connected to a small horseshoe electromagnet (Fig. 4), about 1½in. long, with a make and break spring contact affixed, was sufficient to make the coherer respond, so sensitive was it.

All that is required is that the waves sent off should be tuned to the same pitch as those which the resonator can receive. This is easily done by altering the length of wire on one of the poles until the paths of the oscillations correspond. As the dot-and-dash system of telegraphy was used, it was simply a case of allowing the spark at the oscillator to be of a long or short duration to obtain the requisite signals. An ordinary switch suited the requirements very well.

Signor Marconi stated that the higher the leads from the oscillator and from the resonator were carried in the air, the farther was it possible to signal, and if poles were found too short, then kites were used, and in this case the electricity obtained from the air when they were flown high enough was sufficient to enable the operator to do away with a primary battery. Of course, for long distances a stronger machine would do instead of a kite. On being asked whether "telegraphy without wires" would replace the ordinary telegraph, he gave it as his belief that such would not be the case. The new telegraphy would be used where wires were not possible, as for railway signals, for ships, and in war, etc. As for the manner in which the wave travelled, Signor Marconi had come to the conclusion that it made its way along the ground.

It is certain that the field open for the use of this mode of signalling is very great. Take, for instance, the case of a squadron of ships at sea. A fog rising they may all become separated, but if one was left as a pilot, and it continued signalling all the ships—which should each possess a resonator tuned differently—then, no shield being used round any of the instruments of the pilot, the waves would go out in all directions, not interfering with each other because their lengths were different. Wherever a vessel might be, the coherer it carried would pick up its own particular wave and respond. Then, if far from the leading ship, its approximate distance could be found by lifting or lowering the wire left free in

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air, until it was found that the continuous signals did not arrive. From the height of the wire, its position with regard to the first vessel could be roughly calculated. Of course, up till now the relation between the height of the wire and the distance the waves will travel has not been much experimented with, and no law has yet been found; but it is known that such a law does exist.

Again, the position which a strayed vessel should steer to regain its companions is easily found, for if the coherer is shielded by being placed in the focus of a parabolic mirror—as the Hertzian waves, like light, can be reflected—impulses will be received in one direction only, and the shielding arrangement being moved round the resonator, that direction can be found. In ordinary sailing, it might not be found convenient to use a number of coherers tuned differently, and one might be used to signal the whole body of ships at once. Then if at any time one vessel only was to receive an order, a shield in all directions but the one required would cut off communication from the others. Or, continuing, with reference to military affairs, if used on a battle-field, there might be the chance of the waves being caught by the enemy, but it is very unlikely that his instruments would be tuned the same. One thing is certain, that it would be impossible to interrupt telegraphic communication by cutting the wires, as there would be no wires to cut, but where the operator or receiver was stationed there only could the waves be interfered with.

Many are the uses to which this new form of electric signalling can be put; it appears to be adaptable to almost everything, and in the experienced hands of Signor Marconi we may soon expect to hear of rapid developments which will repay him for the time and labour spent on this subject.

A METHOD OF DETERMINING MAGNETIC HYSTERESIS LOSS IN STRAIGHT IRON STRIPS.*

BY J. A. FLEMING, M.A., D.SC., F.R.S., PROFESSOR OF ELECTRICAL ENGINEERING IN UNIVERSITY COLLEGE, LONDON.

(*Concluded from page 398.*)

In all the above observations with the iron strip used, which was 12 mils thick, this correction has been applied, and it is sufficient for this purpose to take as B in the above formula the value, B_1, of the effective induction.

The eddy-current loss varies from point to point in the bar, being always proportional to the square of the maximum value of the induction density. Hence, properly speaking, the mean value of the eddy-current loss should be obtained by taking the mean square value of the induction all along the half-length of the bar, and using the mean-square value instead of the B^2 in the formula above.

We have, however, found that the point on the half-length of the bar at which the actual induction has a value equal to the root-mean-square value, or to the square root of the mean of the squares of the distributed induction, is always very close to the point at which the 1·6th root of the mean of the 1·6th powers of the distributed induction is found. In other words, the induction at the effective point is the induction corresponding to the mean eddy-current loss as well as to the mean hysteresis loss. This is shown by the curves given in Figs. 4 and 5, in which the curve marked B is the curve of variation of the maximum value of the induction density along the half-length of a bundle of iron strips, and the curves marked $B^{1·6}$ and B^2 represent (to different scales) the variation of these powers of B. In a bar 5cm. long (see Fig. 5) the points where the actual induction had a value equal to $\sqrt{m \cdot B^2}$ and to $\sqrt[1·6]{m \cdot B^{1·6}}$ were only separated by a fraction of a millimetre. Hence by another curious coincidence we are enabled to apply the proper correction for the eddy-current loss by taking the square of the effective induction, B_1, and putting its value into the expression

$$\frac{B_1^2 \, n^2 \, t^2}{10^{16}},$$

where n is the frequency and t the thickness of the strip in mils.

In order to put the method to a test, a very careful determination was made by the ballistic method of the hysteresis loss of a sample of the transformer iron strip used. A ring coil was prepared, and a series of (B-H) cycles of magnetisation taken, and a hysteresis loop drawn, and from this loop it was found that for this iron the hysteresis loss was ·25 watt per pound per 100 cycles per second, for a maximum value of the induction density

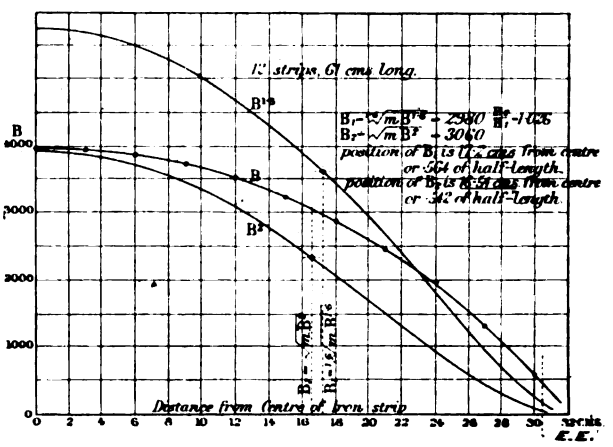

FIG. 4.

equal to 2,500 C.G.S. units. Straight strips of exactly the same iron were then tested by the method here described, which for shortness will be called the "straight coil" method, and the results of these tests with the iron in different conditions of hardness are shown in the Tables III., IV., and V. It will be seen that the results of the "straight coil" test with the wattmeter, as given in Table III., gave exactly the same mean value for the hysteresis loss of the strip when not bent and unbent, as did the calculations made from the ballistic test—viz., ·25 watt per pound per 100 ⁓ per maximum induction density of 2,500. The difference in the time of taking the tests is, however, immense. A very few minutes suffices to take the wattmeter tests, and the necessary calculations can be made in a comparatively short time. Many dozens of tests of irons can be made by the straight-coil method in the time occupied by one ballistic test.

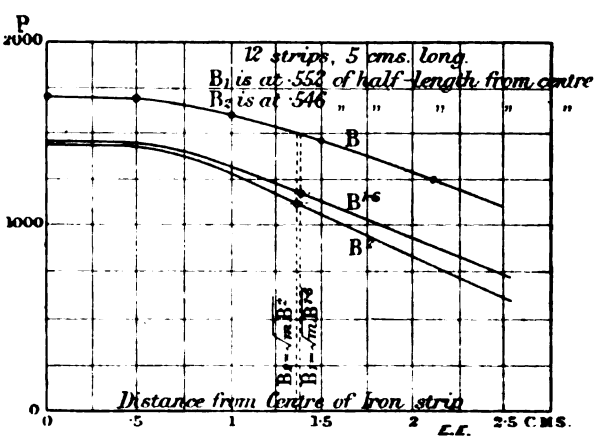

FIG. 5.

There is another method by which the bifilar wattmeter can be calibrated, but which is not so generally convenient as that above described. If the shunt and series coils of the wattmeter are joined up in series with each other, so as to form a dynamometer, and if a known current, I, is passed through these coils, causing a deflection, θ, in the movable coil; then when the instrument is used as a wattmeter with a total shunt resistance, R, including the added non-inductive resistance, the true power corresponding to a deflection, θ, is $I^2 R$ watts. Hence, from a curve showing the deflection given by various currents, we can at once determine the constant of the instrument, when used as a wattmeter, with given shunt resistance. If this standardisation is taken with continuous currents, then it is necessary

* Paper read before the Physical Society on June 11, 1897.

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TABLE III.—Hysteresis Test by "Straight Coil" Method of Annealed Transformer Iron Strip. Six Strips used (New) 61cm. long, 2·54cm. wide, and 12 mils thick.

Voltmeter scale reading in mm.	Effective induction density, B_1.	Wattmeter scale-reading. Iron in.	Wattmeter scale-reading. Iron out.	Total iron loss in watts per pound.	Eddy-current loss in watts per pound.	Hysteresis loss in watts per pound at 80 ⌒⌣.	Hysteresis loss in watts per pound at 100 ⌒⌣ and 2,500 B.	Mean hysteresis value.
303·0	6,719	87·6	17·5	1·247	·245	1·002	·257	·25 watt per pound per 100 ⌒⌣ per 2,500 B.
225·3	5,702	66 0	15·3	·9027	·176	·727	·243	
131·8	4,284	40·0	7·8	·5747	·099	·476	·251	
95·1	3,623	43·0	8·1	·4377	·071	·367	·251	

TABLE IV.—Hysteresis Test by "Straight Coil" Method of Transformer Iron Strip Same Strips used as in Table III., but once bent and unbent.

Voltmeter scale reading in mm.	Effective induction, density, B_1.	Wattmeter scale-reading. Iron in coil.	Wattmeter scale-reading. Iron out of coil.	Total iron loss in watts per pound.	Eddy-current loss in watts per pound.	Hysteresis loss in watts per pound at 80 ⌒⌣.	Hysteresis loss in watts per pound at 100 ⌒⌣ and 2,500 B.	Mean hysteresis value.
56·9	2,786	19·0	4·2	·303	·042	·261	·273	·28 watt per pound per 100 ⌒⌣ per 2,500 B.
128·8	4,244	39·0	8·4	·635	·098	·537	·288	
204·0	5,424	58·1	12 4	·948	·160	·788	·285	
273·0	6,346	76·0	15·9	1·247	·219	1·028	·289	

TABLE V.—Hysteresis Test by "Straight Coil" Method of Transformer Iron Strip, the same quality as in Tables III. and IV., but bent and unbent several times. Twelve Strips used 30cm. long, 12 mils thick, cut from the same Pieces used for the Ballistic Galvanometer Test.

Voltmeter scale reading in mm.	Effective induction density, B_1.	Wattmeter scale-reading. Iron in coil.	Wattmeter scale-reading. Iron out of coil.	Total iron loss in watts per pound.	Eddy-current loss in watts per pound.	Hysteresis loss in watts per pound at 80 ⌒⌣.	Hysteresis loss in watts per pound at 80 ⌒⌣ and 2,500 B.	Mean hysteresis value.
374·5	3 778	135·7	105·1	·539	·078	·461	·296	·28 watt per pound per 100 ⌒⌣ per 2,500 B.
281·4	3,219	101·4	78·1	·415	·057	·358	·297	
199 5	2,672	71·2	54·8	·277	·038	239	·268	
111·6	1,964	42·1	32·9	·160	·0215	·139	·252	
71·1	1,625	57·0	43 1	·125	·017	·107	·282	
50·4	1,314	39·2	29·9	·083	·011	·072	·261	

TABLE VI.—Hysteresis Test by "Straight Coil" Method of Transformer Iron Strips. Twelve New Annealed Strips used, never bent. Wattmeter Standardised by Potentiometer and Continuous Currents.

Voltmeter scale reading in mm.	Effective induction density, B_1.	Wattmeter scale reading. Iron in.	Wattmeter scale reading. Iron out.	Total iron loss in watts per pound.	Eddy-current loss in watts per pound.	Hysteresis loss in watts per pound at 80 ⌒⌣.	Hysteresis loss in watts per pound at 100 ⌒⌣ and 2,500 B.	Mean hysteresis value.
497·0	4,742	90·6	26·0	·517	·118	·399	·178	·21 watt per pound per 100 ⌒⌣ per 2,500 B.
338·8	3 576	63·6	17·1	·340	·069	·271	·190	
267·0	3,136	50·7	14 7	·295	·053	·242	·210	
204·9	2,715	39·8	11·7	·232	·038	·193	·210	
130·8	2,138	51·6	14·6	·154	·025	·129	·208	
110·3	1 957	44·0	11·9	·133	·022	·111	·205	
77·1	1,628	31·0	8·7	·093	·016	·070	·191	
49·5	1,295	21·1	6·1	·062	·010	·052	·187	
398·5	3,913	71·0	17 5	·466	·083	·383	·234	
282·0	3,223	100·9	25·1	·334	·056	·278	·230	
200·5	2,679	73·2	18·1	·242	·039	·203	·226	
100·0	1,950	42·9	11·0	·118	·021	·097	·181	
77·2	1,627	61·4	16·1	·103	·016	·087	·217	
49·2	1,302	41·2	11·7	·067	·010	·057	·203	

N.B.—The method of standardising the wattmeter by use as a dynamometer employing a continuous current as above does not give such consistent or accurate hysteresis determinations as when it is standardised on a known copper resistance with known alternating currents.

to eliminate the effect of the earth's field by taking right and left deflections. The curve connecting square of current strength and the deflections of the movable coil is nearly a straight line, in the case of the bifilar wattmeter. Standardising our wattmeter in this way with a continuous current, we then made another set of hysteresis measurements with 12 strips of perfectly new annealed transformer strips (Sankey's), with the results shown in Table VI. Two other sets of observations for hammered and hardened iron are given in Tables VII. and VIII.

As a matter of fact, in the above experiments in the observations given in Tables III., IV., V., VII., and VIII., the wattmeter was standardised by sending known and measured currents through the copper coil and obtaining a wattmeter constant by finding the deflections corresponding to known copper losses in the copper coil. Thus are found the following figures, when using the wattmeter to measure power taken up in the magnetising coil alone:

Known copper loss (C^2R) calculated from observed current and coil resistance in watts.	Scale deflections of wattmeter in millimetres.	Watts per millimetre of scale deflection of wattmeter.
·398	39·1	·0102
·292	28·9	·0101
·197	19·0	·0103

In the case of the observations given in Table VI., we

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TABLE VII.—Hysteresis Test by "Straight Coil" Method on Hammered Transformer Strip (Unannealed). Six Strips used 61cm. long, 2·54cm. wide, and 12 mils thick.

Voltmeter scale reading in mm.	Effective induction density, B_1.	Wattmeter scale-readings. Iron in.	Wattmeter scale-readings. Iron out.	Total iron loss in watts per pound.	Eddy-current loss in watts per pound.	Hysteresis loss in watts per pound at 80 ⌒⌣.	Hysteresis loss in watts per pound at 100 ⌒⌣ and B 2,500.	Mean hysteresis value.
114·0	3,975	54·5	23 5	·562	·086	·476	·284	·290 watt per pound per 100 cycles at B 2,500.
160 0	4,737	72·9	30·2	·778	·123	·655	·297	
206 0	5,438	90 5	37·5	·969	·161	·802	·290	

TABLE VIII.—Hysteresis Test by "Straight Coil" Method of 18 Strips of Iron of Inferior Quality. Length 61cm., width ·63cm., thickness 26·5 mils.

Voltmeter scale reading in mm.	Effective induction density, B_1.	Wattmeter scale reading in mm. Iron in.	Wattmeter scale reading in mm. Iron out.	Total iron loss in watts per pound.	Eddy loss in watts per pound.	Hysteresis loss in watts per pound at 80 ⌒⌣.	Hysteresis loss in watts per pound at 100 ⌒⌣ and B 2,500.
83·4	2 054	51 9	23·7	·319	·110	·209	·360
136·0	2,644	79·7	34·1	·517	·183	·334	·360
176·0	3,028	101·0	42·8	·659	·239	·420	·386

Calibration Table of Wattmeter (Table VII.).

C^2R.	Wattmeter deflection.	Watts per mm.
·1875	20·9	·00897
·3263	36·9	·00884
·1195	13·3	·00898

Calibration Table of Wattmeter (Table VIII.).

C^2R.	Wattmeter deflection in mm.	Watts per mm.
·272	30·0	·00908
·381	41·4	·00920

employed the method of determining the wattmeter constant by passing known currents through its coils joined up in series and used as a dynamometer, and from the curve showing relation of $(\text{current})^2$ to deflections we could at any moment find the wattmeter constant.

The method described above has this great advantage that the test can be made on fairly large samples of iron, and it can be made with an alternating current having any desired and practical form factor. The iron is tested under conditions which are exactly similar to those under which it will be used in transformer manufacture, and, in fact, the straight magnetising coil and iron sample constitute an open-circuit transformer of very small power factor.

The above described method effects a great saving of time in comparison with the ballistic method, whilst at the same time it is an absolute method and does not depend upon comparisons with other iron samples of supposed known hysteretic value.

DOUGLAS AND ELECTRIC TRACTION.

We have been favoured by Mr. Nesbitt, the town clerk of Douglas, with an advance copy of a very lengthy report on electric traction and lighting, which has been prepared for the authorities of Douglas. The first part of this report, consisting of some 250 pages, brings the history of the movement down to the point where the committee unanimously resolve "That the town clerk be and he is hereby instructed to convene a special meeting of the Council to consider the report and recommendations of this committee with regard to the approval of the overhead electric traction." This shows that the committee, after a careful examination and consideration of the various methods of traction passed under survey, came to the conclusion that the best system they could recommend was electric overhead traction. The general conclusions are given as follows:

General Conclusions and Review.

In submitting the foregoing somewhat lengthy and detailed statement of particulars, data, and information relative to many important installations of mechanical traction which the deputation inspected *en route*—in a tour of inspection necessarily extensive—within the time at its disposal, the deputation wish it to be most clearly understood that such statement is intended to be principally descriptive and illustrative in relation to matters of fact of the various methods and systems of traction in operation, and of the various works and machinery inspected in the different towns which were visited during the itinerary. In addition to being descriptive, the statement also contains an interesting and suggestive reflex of the views and opinions entertained by professional experts and municipal authorities in relation to the different systems coming under their special cognisance and within the range of their practical experience. And again, in submitting the information in detail, and collating and apparently emphasising the opinions of those generally considered competent to judge, the deputation do not by any means desire to imply, or to suggest, that the members thereof, either in their individual or collective capacity, up to this juncture—except where explicitly stated in the descriptive report—are in any sense committed to such opinions, or that they even directly or indirectly endorse them. In making a general summary the deputation freely acknowledge that they approach the consideration of this important question with a full sense of the very great responsibility attached to it, and of the enormous importance to the Corporation and the community at large of taking any initial step towards embracing a new departure in a matter which involves, not only very large considerations affecting the interests of every individual ratepayer, but at the same time greatly affects the material comfort and convenience of the residents and visitors to Douglas. At every stage of the inspection the deputation were more and more impressed with the progressive movement going on in connection with tramway traction and its developments, and with the importance of making a complete enquiry before submitting any recommendations on the matter. The definite conclusions to be deduced from their investigations—which they have endeavoured to pursue most thoroughly—is undoubtedly a matter of most anxious consideration to the deputation, and they clearly recognise that it is not merely a matter of the cheapest form or description of traction to be used, but that a much larger and more comprehensive question is involved affecting in many ways the most vital interests of the whole borough. The deputation, therefore, wish to emphasise the fact that they approach the consideration of the conclusions to be arrived at solely on the merits, with but one aim and object in view—the general well-being, development, and interests of the town of Douglas—with minds absolutely freed from prejudice, entirely impartial and strictly unbiassed. At this point, too, it may be desirable to state that it will be observed whilst primarily dealing with the important subject of traction many other matters having direct or incidental reference to tramways have been dealt with most comprehensively, and although the utility of this course of action may be considered open to question, and its necessity at the present time probably far from apparent, the object of the deputation being not so much to acquire scientific data or technical information with reference to motors and their operation, as to learn financial results and to obtain impressions of the general convenience of the different systems under examination, the deputation believe it desirable, taking into consideration the fact that in the event of any improved method of traction being decided upon, it will be necessary to make application to the Insular Legislature for approval of any scheme, to submit the fullest details with

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regard to mechanical appliances and precautions adopted and enforced to ensure public safety. A thorough expert study of the most approved machinery and equipments would no doubt be necessary and be undertaken, and the deputation is fully satisfied that if not actually now, at some time or other the details submitted will be serviceable, the deputation having acquired considerable knowledge as to general management and detail which cannot fail to be of great use, and which could not under any circumstances have been obtained without personal investigation and enquiry verified and confirmed by subsequent voluminous correspondence. Having submitted these few preliminary observations indicative of the position of the deputation with regard to the report as a whole, the deputation now proceed to submit the following summary of their conclusions.

Steam or Mechanical Motors.

In analysing the report it will be noticed that in relation to mechanical motors performing what may justly be denominated the busiest city work, there are five different systems to which special reference has been made and particular attention directed—viz., (1) steam locomotives; (2) fireless locomotives; (3) Serpollet locomotives; (4) compressed-air motors; (5) Luhrig gas motors.

In connection with electric traction six systems have been enumerated and described—viz.: (1) accumulators, or storage batteries, as inspected in Paris; (2) accumulators, or storage batteries, and overhead conducters worked in conjunction, as inspected at Dresden; (3) overhead conductors and underground conduit conductors worked in combination, as inspected at Berlin; (4) surface contact or closed-conduit conductors, as inspected in Paris; (5) underground conduit conductors, as inspected at Dresden and Prescot; (6) overhead conductors, as inspected at Versailles, Dresden, Berlin, Hamburg, Brussels, and Bristol.

With regard to the capabilities, advantages, and disadvantages of mechanical motors—other than gas-engines—as distinguished from electric motors, the deputation entertain the opinion that almost sufficient has been said in the previous portions of the report to show the trend of their views in relation thereto. It will, therefore, only be necessary to add the supplementary remark that even the most recent and most fully developed installations of mechanical motors possess insuperable objections in respect of street obstruction, in conjunction with the equally strong objections urged against them owing to the annoyance caused to the general public by the steam, smoke, smell, dust, noise, and general ugliness and unsightly character which invariably appertain to systems of this particular description.

At one time great expectations were entertained with regard to the ultimate success of the compressed-air motor, but enquiries made by the deputation elicit the information that the system has not received the measure of success anticipated. Compressed-air traction has long been one of the possibilities, but in actual work its success has not been so pronounced as seriously to enter into competition or threaten the supremacy of other forms of traction. Apart from their being very expensive to work, the appearance of these motors is decidedly adverse to their adoption. The closeness of the axles in these motorcars, too, is such that as the car proceeds a continual see-saw rocking motion is experienced, which, it is alleged, is damaging to the rails, and the deputation from personal experience can testify that this see-saw rocking motion is intensely disagreeable to the passengers. The numerous reservoirs required to carry the whole quantity of air and the other mechanical adjuncts necessary for a complete journey which are carried by the motorcar, involve an enormous total weight. The process of compressing air is exceedingly expensive, having to be done from time to time as the heat is thrown off. It is estimated that 75 per cent. of the power employed in compressing and distributing it is lost. The distribution of compressed-air power to a district by means of pipes has invariably resulted in failure. The greatest attempt hitherto made in this direction, and one in which the natural and mechanical difficulties have been most determinedly contested, and that over a series of years, is that made by the Paris Compressed-Air Company, which recently stood with the enormous deficit of over one million sterling. The deputation therefore, for the reasons stated, are under the necessity of dismissing the compressed-air motor, familiarly known as the Mekarski system, as quite impracticable. Although particular care and attention was bestowed upon the Serpollet system as inspected in Paris, the deputation is of opinion, for the reasons set out in the body of the descriptive report, that the system would be quite unsuitable for use in any part of Douglas, the objections urged against the other systems of mechanical traction being in many respects equally pertinent to this. It may be stated here that the cost of operation per car mile by compressed air is approximately 5·02d.

Taking all the circumstances, therefore, into most careful consideration, and impressed with an anxious desire to do justice to every system inspected, the deputation has to record its strong conviction that steam mechanical motors of every kind are not, under existing circumstances, adapted, and are, as a matter of fact, decidedly unsuitable, for the reasons previously adduced, for use in any public thoroughfare or on the promenades of Douglas, and this conclusion, it may be stated, is unanimously arrived at quite irrespective of the question of cost.

Gas Motors.

Although oft-repeated enquiry was made in every likely direction, the deputation was unable to see any system of tramways operated by gas traction on the Continent, and it was a source of much disappointment to find on arriving at Dresden that the Luhrig gas motor, to which reference has already been made, had ceased to be worked in that city. It may be of interest here to state that the Luhrig motor was running experimentally for some time at Croydon, and whilst running there, and before the adoption of the cable system of tramways for Upper Douglas, was inspected by Mr. Alexander Bruce, J.P., chairman of the Isle of Man Tramways Company; Mr. Aldworth, the general manager; Mr. R. D. Cowin, chairman of the late Board of Commissioners; Mr. J. A. Brown, a member of the late Board; and the town clerk. The engine is a patent operated by the Gas Traction Company. It has not the objection of being separate from the car, but is built in combination with it. In 1895, when inspected by the gentlemen named at Croydon, the great vibration and switchback-rocking motion which was experienced was sufficient to emphatically condemn the system so far as Douglas was concerned. Several members of the deputation have since had opportunities afforded them of inspecting the gas tramcars running between the South Shore, Blackpool—where the line joins the electric conduit lines, worked by the Corporation—and St. Anne's and Lytham. As is generally known, the season circumstances prevailing in Blackpool are in many respects similar to those in Douglas, the population being subject to enormous fluctuations. The gas-car line runs chiefly along a country road, which is paved the width of the track and for 18in. outside the rails, the remainder of the road being laid in ordinary macadam. The rails in use are of the usual girder type, the weight being 92lb. to 97lb. per yard. The length of the line to Lytham is seven miles, and consists of a single track with a number of passing places. The gauge of the track is 4ft. 8½in., and the steepest gradient on the line of route is 1 in 26. That portion of the line laid within the borough has been constructed by and belongs to the Corporation, but the lines outside the borough have been laid for the Blackpool, St. Annes, and Lytham Tramway Company, who now work them. Only one mile of the lines within the borough is leased, and that is to the Gas-Car Company. The remainder is worked by the Corporation. The route for the gas-cars, which has been open since July, 1896, is laid in the ordinary manner without any apparatus whatever beyond the paving and the rails. Ordinary coal gas is used in the cars. The gas is compressed at the depôt into storage cylinders, the maximum pressure being 150lb., the reservoir on the car being charged by means of a flexible hose pipe, an expeditious process which occupies only about a minute. The storage capacity is about 400 cubic feet, which, it is stated, is sufficient for a run of nine or ten miles. One car can be charged from another, and this is naturally looked upon as a great advantage. An ordinary gas-engine is used for working the compressing machinery, the engine provided in the first instance being of only about 14 h.p., but for running the increased service during the summer season additional power has been provided.

It is to be observed that this gas-compressing engine and plant is not required to store the energy for working the cars as in a compressed-air system. The power for working the cars comes from the combustion of the coal gas in the engine on the car, and it is therefore of a very small size compared with the engines required for a compressed-air plant. Each of the cars which were provided when the system first commenced is fitted with a double-cylinder gas-engine of the Otto type, arranged under the seats, the flywheel being enclosed in a recess formed in one side of the car. When the flaps or doors on the outside are opened, the whole of the machinery is exposed to view. The engine is constantly rotating, even when the car is brought to a standstill, and the motion is communicated to the car wheels by gearing thrown in and out of action as required by the driver. In ascending a gradient, or at other times when extra power is required, the driver can throw into action a supplemental set of gearing giving a slower speed with a corresponding increase in the power exerted. This action is particularly noticeable when ascending a sharp gradient near St. Annes Station.

It is stated that with the gas-cars 35 cubic feet are used per car mile, and the company is charged a special rate for the gas. At St. Annes the charge is 3s. per thousand cubic feet. The cost of gas per mile has averaged about 1·15d., inclusive of all waste at the depôt—such as experimental trips, blowing-off, etc. The gas-cars, of which there are at present a number in use, weigh about seven tons. The cars are two-storeyed, and the carrying capacity is only 40—16 inside and 24 out. The bodies of the first cars provided and the bogies were made by the Ashbury Company, but the engines, which are of the Luhrig

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patent, similar to those used in Dessau, and of 8 h.p., were made in Germany. The cost is about £750 per car, including the engine. One of the cars, it is said, ran 6,000 miles before being overhauled for the first time, and it is stated that each of the original cars has run about the same number of miles. Before the effect of the gas upon the iron can be properly judged, it is thought that two or three years must elapse. The action of the ammonia is very destructive, and the piston, which is the vital part, and is very expensive to renew, gets badly cut, and the dust also has a tendency to damage the engine. Although, as previously mentioned, the steepest gradient on the line is only 1 in 26, the cars have sometimes considerable difficulty in surmounting it, and if a stoppage is made half way up the ascent, the car must go back and recommence. The engineer, however, states that the cars can be constructed to climb a gradient of 1 in 16.

The fares on the gas route are: from South Shore Station, Blackpool, to the borough boundary, about 1½ miles, 2d.; from South Shore Station, Blackpool, to St. Annes, 4d.; from South Shore Station, Blackpool, to Lytham, 6d. The cars stop when required. Accidents, it is said, are very rare, generally consisting of collisions with 'buses.

The cost of the gas-car lines is stated to be as follows: paving, per yard of single track, £1. 10s. 11d.; rails, per yard of single track, 10s. 3d.—total cost per yard of single track, £2. 1s. 2d., equivalent to £3,622 per mile of single track.

The principal objections urged against the gas-cars are (1) the unpleasant and highly objectionable smell; (2) the incessant vibration; (3) the difficulty of ascending gradients; (4) the noise and rattle of machinery. The advantages are (1) the low cost of traction; (2) the absence of any overhead apparatus or the conduit.

The traction on the gas route is supplied by a company, separate from the one by whom the line was laid and is managed. The latter company have a seven years' contract with the former, under which they supply the cars and pay 4½d. per mile run, in return for the haulage of the cars, the services of the drivers, and all repairs, gas lighting, and cleaning of cars. The company owning the line pay the conductor. The speed is eight or nine miles an hour, and the cars run at intervals of 15 minutes in the borough, and 30 to 40 minutes outside. During the present season arrangements have been made for a 7½ minutes' service. The employés on the gas line are not provided with full uniform, but with caps only. The manager of the company states that the gas system is working satisfactorily, and no great difficulty has hitherto been experienced in the running of the cars. The cars run at a very fair speed, but the vibration is clearly apparent. The system, however, is purely in its experimental stage, its efficiency and capabilities have not yet been fully demonstrated, and its financial success under varying conditions has yet to be clearly proved. Admitting, however, that the financial question is but indirectly involved, the system possesses many drawbacks and disadvantages—the noise and rattle of machinery, which is intensely disagreeable, and which must tell heavily against this system, equally with a system involving the use of locomotive engines; the smell of the gas, which is very objectionable, and the amount of vibration render this type of haulage as at present in operation quite unsuitable to Douglas. The deputation, however, judging from the information at present available is of opinion that this method has not yet become sufficiently developed to justify them in making a recommendation either for or against its adoption, and they therefore merely submit the facts collated by the town clerk, and leave the question an open one for the present.

Electric Traction.

Accumulators.—Having thus disposed of steam, compressed air, and gas traction, the investigation is consequently narrowed down to the different forms of electric traction. Before taking into consideration the various systems appertaining to electric traction, it may be assumed as a matter of general observation that there is a consensus of opinion with regard to the desirability of substituting some method of mechanical traction for horse traction. Whilst difference of opinion undoubtedly exists as to the precise method to be employed, there appears on all hands to be a tacit assumption that improved facilities of transit must take place at no distant date. At the same time, the absence of any expression of public opinion on the tramway question may probably cause a natural hesitation to embark on an innovation without a positive expression of the public desire. However, from a sanitary point of view, there can be no doubt but that the substitution of mechanical traction for horse traction would be a highly desirable improvement in the public interest. Sanitarians are unanimous in considering that the fewer horses there are in the streets the better for the general public from a health standpoint. To localise this argument, which it is impossible to gainsay, the cleanliness of the thoroughfares immediately adjacent to and running parallel with the unequalled promenades encircling the margin of Douglas Bay, is an all-important consideration. The flexibility of the service, equally in the public interest, is also very important, and the question arises as to whether it is not a duty to the public to provide rapid transit and facilities of intercommunication as far as it is possible and compatible with public safety and the interests of the ratepayers. Indeed, it appears to be acknowledged that if a perfectly flexible system of traction, well equipped, reliable, safe, and under good control, with an appreciable acceleration of speed—where this could safely be done—could be introduced, it would be an immense public improvement and undoubted convenience. Advocates of all systems of mechanical traction invariably point to the cruelty inflicted on the horse as a strong reason for giving up horses and substituting other motive power, and they have a most powerful case indeed. The contention of humanitarians cannot be denied—the system of horse traction is a system which lends itself, even under the most favourable circumstances, and no matter how much care may be exercised, to much cruelty and hardship being inflicted on the dumb animals performing the arduous haulage. A system of traction which reduces a horse's useful life to from three to five years can be described in no measured terms. Many things contribute to this result. The condition of the permanent way, the ruling gradients, the speed of running, the number of times the car is stopped, the weight of the car empty, the average weight of the passengers carried, all have a material influence on the work done by a horse working on a tramline. It is, however, generally agreed that the hardships to which a tram horse is subject are the necessary accompaniments of his unfortunate position, and that a change from horse to mechanical traction would no doubt effectually mitigate the condition of the tram horses. Generally speaking, it is assumed by competent authorities that, if properly treated, the horse will live and work up to 20 years of age, but the treatment accorded to the horse kills him long before he reaches old age, and the working "life" of a tramway horse is three to five years only. Under this condition of things, therefore, it appears to be the duty of everyone interested in tramway matters to do all in their power to ameliorate the hardships endured by what has been described as "the noblest help of man," and to attain this end it is desirable to substitute some system of mechanical traction for horse traction.

With regard to No. 1, accumulators, or storage batteries, the great advantage possessed by this method over all other forms of electric traction is that by their use the necessity for either the overhead wires, etc., or the objectionable slot which pertains to the conduit system is entirely obviated. This fact, which is generally conceded, gives the accumulator system a distinct advantage of immeasurable superiority over any other system from the reason of its being absolutely self-contained, and as requiring no fixed provision either above or below the surface of the streets. On the other hand, it is a matter of common knowledge that the accumulator system is not generally looked upon as satisfactory on account of the expense attending its working, which expense has been considered prohibitive. Notwithstanding the many patents which have been taken out within the last few years, the cost per mile run is nearly double that of cable traction and of overhead electric at a 7½ minutes' service. As Sir Arthur Forwood said in the recent debate upon a similar subject by the City Council of Liverpool, the system of carrying the power on the cars themselves by means of accumulators is gradually being exploded as being heavy, involving great weight on the cars, difficult to maintain, and in many ways impracticable. The disadvantages may be briefly summarised as follows: (1) the additional weight of the cars—two or three tons—for which power has to be provided in addition to the normal weight; (2) the liability of the accumulator to get out of repair; (3) the great expense of maintenance and repairs; (4) the constant recharging which is necessary in order to efficiently work the system; (5) the highly objectionable smell of the acids used; (6) the possibility of injury being caused to passengers' clothing, with consequent claims for damages; (7) the comparative ineffectiveness of the accumulators as compared with either the overhead or conduit methods of traction, which has the effect of slowing the cars very much when ascending even slight gradients.

With regard to the first objection, it will be clearly understood that the more power there is provided the more the weight of the accumulator is increased, and all this dead-weight necessitates further increased power. It will be remembered that in Dresden, where the overhead conductor system is allowed, except within a very limited area, an additional disadvantage is that the accumulators have to be carried for the greater portion of the journey simply as dead-weight, and are then supplying no power. The disadvantage, however, would not be applicable to the promenades in Douglas, neither would the objection with regard to the reduction in speed on account of the gradients. The accumulator system of traction has been in use in Birmingham for some time, and although the deputation has not been enabled to visit Birmingham, particulars have been obtained by the town clerk, and are submitted as being useful for purposes of comparison.

(To be continued.)

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ROYAL PHOTOGRAPHIC SOCIETY.

The forty-second annual exhibition of the Royal Photographic Society of Great Britain opened on Monday, 27th ult., in the gallery of the Royal Society of Painters in Water Colours. On the Saturday evening preceding a soirée was given by the president and council of the society. The visitors—who were, indeed, too numerous to mention; the hall was uncomfortably crowded—were received by the president, the Right Hon. the Earl of Crawford, K.T., F.R.S. The exhibits number about 500, and are set forth in the "Photographic Annual," vol. xxii.—a beautifully illustrated number—which serves as a catalogue for the exhibition. The photographs exhibited show a marked tendency on the part of the amateur to produce artistic effects rather than to cultivate technical fads. Very few apparatus are shown this year. Mr. F. F. Ives exhibits a photochromoscope and stereoscopic folding chromogram. The photochromoscope is an instrument based upon the fact stated by Clerk Maxwell in 1861, that all the colours of the spectrum and all the colours in nature are equivalent to mixtures of three colours of the spectrum itself—red, green, and blue. It contains red, blue, and green glasses, against which the corresponding transparency of the chromogram is placed; two coloured glass reflectors help to throw the image against the eye-pieces, by which they are examined. The effect obtained is a very pretty one, showing the natural colours in very vivid hues and with a most intense perspective. This instrument is fitted out with the Welsbach light, but similar ones with electric light have shown even better results. A more powerful lamp may be used in this case without causing inconvenience through overheating. A camera for taking these triple images is shown by the same exhibitor. There are numerous specimens of the genus X-ray photograph, No. 394, by W. Grant, representing a finely-coloured one of spiny-tailed lizard, showing injury to the feet and fracture to the bones being especially clear and well defined. The Autotype Company shows two collotpyes of coral-form illustrations to "Electric Movement in Air and Water," by Lord Armstrong, C.B., F.R.S.

During the course of the exhibition there will be displays by means of the optical lantern every Monday, Wednesday, and Saturday evening. Amongst those announced is one arranged for October 20, by Mr. Eric Stuart Bruce, entitled "The Aerial Graphoscope." The exhibition will remain open until November 13.

COMPANIES' MEETINGS AND REPORTS.

BABCOCK AND WILCOX, LIMITED.

The sixth ordinary general meeting of this Company was held on Friday at the Cannon-street Hotel under the presidency of Mr. Andrew Stewart (the chairman of the Company).

The **Chairman**, in moving the adoption of the report and balance-sheet, said the past year's work had been of a most satisfactory and agreeable character. They had paid to the shareholders for the half-year ended December 31, 1896, an interim dividend of 6 per cent. per annum on the preference shares and 5 per cent. on the ordinary shares, which amounted in all to £10,000. They now proposed to pay for the half-year ended June 30, 1897, a dividend at the rate of 6 per cent. on the preference shares and of 10 per cent. on the ordinary shares, amounting in all to £17,000, making 15 per cent. on the ordinary shares for the year. They had placed to the reserve fund the sum of £35,000, and they had carried forward a balance of £5,654. 16s. During the past year they had opened new branches and extended some of those in existence. The sales of the patent boiler had increased throughout the entire markets at home and abroad where they had established business connections. The marine-boiler department had made satisfactory progress. The new works at Renfrew were now quite finished, and the new modern plant, with the old plant removed from the Kilbowie works, was in full and successful operation.

Sir William Arrol seconded the motion, which was agreed to.

The **Chairman** moved, "That a dividend for the half-year ended June 30, 1897, be paid on the preferred shares at the rate of 6 per cent. per annum (under deduction of income tax); that a dividend for the second half of the financial year be paid on the ordinary shares of 10 per cent., free of income tax, making 15 per cent. per annum for the year, and that £5,654. 16s. be carried forward to the accounts for the current year, these dividends to be payable on and after September 27 to the shareholders whose names are on the register as at September 10, 1897."

Mr. J. G. Mair Rumley seconded the motion, which was agreed to.

Mr. Andrew Stewart and Mr. A. T. Simpson were re-elected directors, and the auditors were reappointed.

BURY, ROCHDALE, AND OLDHAM TRAMWAYS COMPANY.

The eighteenth ordinary half-yearly meeting of shareholders of the Bury, Rochdale, and Oldham Tramways Company, Limited, was held at the Grand Hotel, Aytoun-street, Manchester, on 24th ult. The chairman of the directors, Mr. John Coomer, presided.

With regard to the question of electric traction, the **Chairman** reminded the shareholders that at their last half-yearly meeting he mentioned that they had offered to convert to overhead electric traction the section running between Rochdale and Littleborough. The terms which they named were undoubtedly favourable to the local authorities if they wished the Company to do the work. As he stated at the meeting six months ago, they never contemplated entering upon the work except with the approval and the goodwill of the authorities. The Corporation of Rochdale seemed to prefer that the Company should for the present, at any rate, continue to work by steam under the present arrangements, and there at present the matter rested. The Chairman concluded by moving the adoption of the report and balance-sheet, and the declaration of a dividend at the rate of 5 per cent. per annum.

A **Shareholder** said no reference was made to the question of municipalisation in the report, but he desired to know whether there was any probability of the Corporations of Rochdale and Bury taking over the tramways.

The **Chairman** said: With regard to this question, gentlemen, you are aware that the tenure on which we hold the tramways has somewhere about five years yet to run, and I don't think that we can profitably anticipate what the Corporations may do when that tenure expires.

The report and balance sheet were then adopted, and the dividend declared, the **Chairman** remarking that he hoped six months hence they would again have a 6 per cent. dividend to recommend.

The meeting concluded with thanks to the chairman and the directors for their services during the half-year.

IPSWICH TRAMWAY COMPANY, LIMITED.

The shareholders of the Ipswich Tramways Company, Limited, held their annual general meeting in the Old Museum Rooms, Ipswich, last week. Mr. W. B. Dick presided.

The directors' report for the year ended December 31, 1896, stated that during the year 413,737 passengers were carried. The balance-sheet was as follows: liabilities—outstanding tradesmen and other bills, £168. 12s. 6d.; auditor's fee, £3. 3s.; deposits on season-tickets, 10s.; reserve fund, £500; profit and loss account—profit to date, £1,183. 16s. 5d.—total, £1,856. 1s. 11d. Assets: conductors' change, £1. 15s.; cash in Messrs. Bacon and Co.'s bank, £426 14s. 9d.; cash in Messrs. Bacon and Co.'s bank, on deposit, £810. 10s. 8d.; provender in store, £10. 5s. 9d.; outstanding debts, £11; balance of capital account as per accompanying statement, £565. 15s. 9d —total, £1,856. 1s. 11d.

The **Chairman**, in moving the adoption of the report and balance-sheet, observed that last year was a very satisfactory one as compared with previous years. At their last annual meeting he told them that the directors were in negotiation with a traction company. Well, those negotiations were not completed, and until they were completed he could not say more. But he hoped to be able to communicate the result to Mr. Titchmarsh within the next fortnight.

The resolution having been adopted, the **Chairman** stated that he had been daily expecting to hear from the traction company; in fact, the previous day he had sent his private secretary to see Mr. Vignoles, the engineer and manager to the traction company, but he had been unable to do so. However, he was quite sure that if the traction company completed the negotiations, the town of Ipswich would have a magnificent service of trams. They would relieve the streets by getting rid of the horses; they would get a car with 15 h.p. underneath it that would mount any incline, and carry a large number of passengers; there was no smell, no smoke, no noise, and a more perfect model of conveyance did not exist. He hoped the negotiations would be satisfactorily terminated, and return something substantial to the shareholders, who had lost a large amount of money.

WILLANS AND ROBINSON, LIMITED.

Directors: Mark Robinson, Esq., M.I.C.E., chairman; Sir Gilbert A. Clayton-East, Bart., deputy chairman; Captain H. Riall Sankey, R.E. (Ret.), M.I.C.E.; Lieutenant-General Sir Richard H. Sankey, K.C.B., R.E.; Thomas O. Lazenby, Esq., J.P.

Seventh half-yearly report of the directors, to be submitted at the ordinary general meeting of the Company, to be held at the Victoria Works, Rugby, at 3.30 p.m. on Wednesday, October 6, 1897:

After writing off as depreciation from plant, patents, etc., the sum of £4,162. 11s. 2d., and paying interest upon debenture stock, the balance to the credit of profit and loss account for the half-year (including £2,052. 9s. 6d. brought forward) is £13,549. 0s. 6d. Out of this the directors propose that dividends be paid at the full rate of 6 per cent. per annum upon the preference shares, and at 7 per cent. per annum upon the ordinary shares, together amounting to £7,486. 5s. 2d. The amount payable to the directors, in accordance with the articles of association, is £1,203. 1s. 9d., leaving a balance of £4,859. 13s. 7d. From this the directors propose to carry £2,000 to the debenture redemption fund and £1,000 to the reserve fund, as before, leaving a balance of £1,859. 13s. 7d. to be carried forward. The directors feel that they may congratulate the shareholders upon the result of the half-year's trading, which enables them not only to propose the usual dividend, but also to make the usual reserves, notwithstanding the great interruption to business due to the move from Thames Ditton. The interruption has been the more serious owing to the further extension of the shops put in hand last spring, which has kept the works in an unfinished state, and will neces-

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sarily continue to do so throughout the current half-year. It is probable that it will be found desirable, in the course of next spring, to arrange for the issue of the balance of the capital authorised by the resolution of February 22, 1897.

CONTRACTS FOR ELECTRICAL SUPPLIES

CONTRACTS OPEN.

Glasgow.—The Corporation are prepared to receive tenders for the electrical equipment of the Springburn and Mitchell-street route, particulars of which appear in our advertising columns. Tenders by October 18.

Russia.—The Municipal Authorities of Novorossisk, South Russia, are inviting tenders for the concession for the construction and working of an electric tramway, and for the electric lighting of the town. Tenders by November 1.

Ploesti (Roumania).—Tenders are invited for lease of lighting the town by electricity for a period of 40 years, also for power transmission purposes. Particulars may be obtained on application to the Municipal Authorities at Ploesti. Tenders by Nov. 15.

Southampton.—The Corporation invite tenders for the supply and erection of various engines, alternators, motor-alternator, rectifiers, high-tension switchboards, continuous current generators, balancing and volt raising transformers, low-tension switchboards, and a battery of accumulators and accessories, particulars of which appear in our advertising columns. Tenders by October 18.

Brussels.—Tenders are invited by the Administration of the Belgian Government Railways for the installation of electric lighting at the Brussels Railway Station (South). Specification No. 268 can be obtained from that authority. Tenders will be adjudicated publicly on October 6 at the (Bourse) Exchange at Brussels. On the same day the same authority will accept tenders for lamp-posts, reflectors, etc.

Sydney (New South Wales).—Tenders are required by October 18, at noon, at the General Post Office, for supplies to the Telegraph, Telephone, and Post Office Departments, including iron, copper, and insulated wire, insulators, nails, screws, nuts, bolts, electric batteries with all accessories and chemicals, diaphragms, arc lamps, incandescent lights, 11,000ft. carbon for arc lamps, and various other appliances.

Singapore.—The Municipal Commissioners of the town of Singapore, Straits Settlement, invite proposals for the lighting of the public street lamps for five years from January 1, 1899. Tenderers may submit proposals for lighting by gas or oil, or partly with one illuminant and partly with the other. Further particulars may be obtained on application to Mr. C C. Lindsay, M.I.C.E, 167, St. Vincent-street, Glasgow, or to Mr. J. Polglase, secretary to the Municipal Commissioners of Singapore, Singapore. Tenders may be sent either to Mr. Lindsay, up to November 30 next, or to the Secretary up to December 31.

Queensland (Australia).—The Municipal Council of Ipswich, Queensland, is inviting tenders for the supply and erection of the following electric lighting plant, etc.: tubular boilers, pipes, pumps and heaters, alternators and exciters, switchboard, high and low tension mains, junction boxes, transformers, etc. Specifications and all particulars as to conditions, etc., may be obtained from Messrs. Gordon and Gotch, St. Bride-street, Ludgate-circus, London, E C., and tenders have to be forwarded to the town clerk (Mr. Albion Hayne), Council Chambers, Ipswich, Queensland. Tenders by November 15.

Glasgow.—The City Council invite tenders for the electrical equipment of the Springburn and Mitchell-street route of the Corporation tramways. Specification, with form of tender and plan of route, can be obtained on application to Mr. John Young, general manager, 88, Renfield-street, Glasgow. Intending contractors must remit to the General Manager the sum of £10, by bank draft, payable to Glasgow Corporation Tramways, and this sum will be returned to them on receipt of a bona fide tender, together with the plan of route. Sealed tenders, marked "Springburn and Mitchell-street Route, Tender for Electrical Equipment," to be lodged with Mr. J. D. Marwick, town clerk, City Chambers, Glasgow, by 10 a.m. on October 20.

Belize (British Honduras).—Tenders are invited by the District Board of Belize for the lighting by electricity of the town of Belize. The system decided upon is that known as the three-wire or neutral-wire system, and comprises boilers, engines, dynamos, accumulators, copper mains, flexible leads iron lamp standards, switches, fuses, lamps (glow), and lamps (arc), meters, etc. Full particulars of the requirements of the Board can be obtained on application to Mr. A. R. M. Simkins, M.I.E.E., care of F. Otto, Esq., Tower-chambers, Moorgate-street London, E.C. (Telegraphic address, Helios, London). Tenders should be addressed and should reach Mr. Simkins by October 20, and should be enclosed in a sealed package, marked "Tender for Electric Lighting."

Plymouth.—The Corporation are prepared to receive tenders for engineering works in connection with the tramways of the borough, full particulars of which appear in our advertising columns. The contracts are divided into two—viz. (Contract No. 10) overhead trolley line, posts, brackets, etc.; (Contract No. 11) tramcars, trucks, motors, trolley arms, etc. Contractors may tender for either of the contracts, but not for a part of any contract. Copies of the conditions, specifications, and forms of tender, bound up together, may be obtained on deposit of £2. 2s., for each copy, which will be returned on receipt of a bona fide tender upon the prescribed form, and within the stated time. A copy of the drawing of posts will be sent to those wishing to tender for Contract No. 10. Sealed tenders, endorsed "Engineering Contract No. —," must be delivered to Mr. J. H. Ellis, town clerk, Plymouth, not later than October 2. The acceptance of any tender will be subject to the contractor paying the standard rate of wages obtaining in the district where the work may be carried on.

Hull.—The Corporation are advertising for tenders for the electrical equipment of their tramways, to the extent of about nine miles double track and half mile single track. It will be open to contractors to submit tenders for various systems, and the contract, which will not be divided, will include engines and generators, switchboards, feeders, poles, brackets, trolley wire, rail bonding, and all accessories, also the first instalment of cars (15 motorcars and five trailers). It is expected that the specification, lithographed plans of the routes, and other particulars will be ready for issue early in September, and copies, when ready, may be obtained from Mr. A. E. White, city engineer, Town Hall, Hull, by persons proposing to tender, upon payment of a deposit of £10, which will be refunded upon receipt of a bona fide tender and return of the papers and plans supplied. Cheques to be made payable to Mr. Thos. G. Milner, city treasurer. Tenders, endorsed "Tender for Tramway Equipment," are to be addressed to the Chairman of the Works Committee, and delivered at the Town Clerk's Office, Hull, before noon on November 5.

Madras.—Tenders are invited for the utilisation of water flowing from the Periyár Lake for purposes other than irrigation and not incompatible with the use of the water for drinking. The irrigating season extends over nine to ten months, during which time the discharge is likely to be from 1,100 to about 500 cubic feet a second, according to the demands for irrigation and the available quantity in the lake. Subject to the risk of interruption by accident or drought, supply can be given throughout the irrigation season. No supply can be guaranteed at other times, but, so long as water is available, the Government will be prepared to issue it in such daily quantities as may seem to it advisable with reference to the time which is likely to elapse before the supply is replenished by the setting in of the rains. The fall from the tunnel to the foot of the hills is approximately 900ft., and the distance measured along the course of the stream about 6,800ft. One cubic foot per second falling 900ft. is estimated to produce over 60 effective horse-power. Intending lessees should state the quantity of water required in cubic feet per second and the annual rent offered for each cubic foot per second. No rent will be charged for the first year from the date of the concession; for the second year the charge will be one-fifth, and an additional charge of one-fifth will be made every year until the full rent is reached. The whole or part of the concession may be surrendered on a year's notice being given. Lessees will construct at their own expense, on plans to be approved by Government, all the weirs and other works required to divert the water from the river below the tunnel. For further information, application may be made to the Chief Engineer for Irrigation, Madras, by whom tenders will be received up to October 31, 1897.

BUSINESS NOTES.

Hornsey.—It has been unanimously decided by the Urban District Council to apply to the Board of Trade for an electric lighting provisional order.

Change of Address.—Messrs. W. P. J. Fawcus, M I.C.E., and S. V. Clirehugh, M.I.E.E., have removed to Prudential buildings, 78, King-street, Manchester.

Burnley.—Colonel W. L. Coke, Local Government Board inspector, has held an enquiry into applications of the Corporation to borrow various amounts, including an item of £3,046 for electric lighting.

Personal.—We regret to hear of the death of Mr. H. Wilhelm (of the firm of Wilhelm and Co.), who had been seriously ill for some time. We are informed that Mr. Haldmaier will carry on the business of the firm without any change.

Metropolitan Electric Supply Company.—The transfer registers will be closed from 4th to 11th inst., both days inclusive, for payment of an interim dividend on the ordinary shares numbered 101 to 50,000 inclusive.

Oldbury.—At a special meeting of the Council it was decided to apply to the Board of Trade for a provisional order under the Electric Lighting Acts 1882, authorising and empowering the Council to supply electricity within their district.

Chester.—A Local Government Board enquiry was held at the town hall, Chester, on 23rd ult., in consequence of the application of the Chester Town Council for sanction to borrow, among other sums, £20 000 for the purposes of electric lighting. Colonel W. L. Coke, M I.C.E., was the inspector.

Eastern Extension, Australasia, and China Telegraph Company.—The directors have declared an interim dividend for the quarter ended June 30 last of 2s. 6d. per share, free of income tax, payable on the 15th inst. The share register will be closed from October 7 to October 14, both days inclusive.

Bradford.—The Gas and Electricity Supply Committee of the Bradford City Council have decided to adopt a recommendation of the Electricity Sub-Committee to the effect that all public lamps at Heaton and Frizinghall supplied by the Shipley Gas Company

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be replaced by incandescent electric lamps wherever the necessary mains are available.

New Company.—The Electrical Vehicle Syndicate, Limited, has been registered. Capital £25,000, in £1 shares. Objects: to further and develop the use of electricity in connection with traction, and to carry on the business of electrical engineers, manufacturers, and proprietors of electrical vehicles, metal workers, contractors, etc.

Electro-Chemical Lamp Syndicate, Limited.—This Company has been registered by Templer and Co., 3, Pope's Head-alley, E.C., with a membership of 23, each of whom is liable for the sum of £1 in the event of winding up, with the object to carry on the general business of electricians and electrical engineers. The registered office is at 3, Pope's Head-alley, E C.

Wandsworth.—The District Board of Works have received notices from the County of London Electric Lighting Company of their intention to lay electrical conduits in the following streets: Rusholme-road, Lytton-grove, Beechcroft-road, and at Park-side, Wimbledon Common, from Fairlawn to the parish boundary. It has been resolved to offer no opposition to the work being carried out.

Electrical Vehicle Syndicate, Limited.—A Company under this title has been registered by Deacon and Co., 9, Great St. Helens, E.C.. with a capital of £25,000 in £1 shares, with the object to further and develop the use of electricity in connection with traction, and to carry on the business of electrical engineers, manufacturers and proprietors of electrical vehicles metal workers, contractors, etc.

New Swindon.—The following recommendation of the Electric Lighting Committee has been approved by the District Council: "That in view of the possibility of incorporation of the towns, the committee deemed it advisable at the present juncture to postpone further proceedings with respect to the provision of electric light, and that the Board of Trade be approached with a view to the extension of the time limit, and the area to be covered by the order."

Battersea.—The Electric Lighting Committee's recommendation that Mr. R. Hammond, M.I.E E., be appointed to prepare and submit a scheme for the erection of works and the laying of trunk and other mains for the electric lighting of the parish was not accepted by the Vestry at its last meeting. After discussion, it was agreed that an electrical engineer should be advertised for, Mr. Hammond to take his chance with two other selected candidates.

Bromley (Kent) Electric Light and Power Company, Limited.—This is a Company registered by Todd and Co., 22, Chancery-lane, W.C., with a capital of £20,000 in £5 shares. Its object is to carry on the business of electrical engineers, electricians, contractors, suppliers of electricity, and electrical apparatus manufacturers. The subscribers are to appoint the first directors. Qualification, 20 shares. Remuneration as fixed by the Company.

Rotherhithe.—At the last Vestry meeting it was reported that a letter had been received from Mr. Sydney Morse asking, on behalf of the County of London and Brush Provincial Electric Lighting Company, Limited, for the formal consent of the Vestry to the company's application for a provisional order under the Electric Lighting Acts. The General Purposes Committee recommended the Vestry not to consent to this application, and this was agreed to.

St. Helens.—The Mayor, accompanied by several members of the Tramways Sub-Committee of the Corporation, has visited Prescot and inspected the working of the new Simplex system of electric tramway traction. Rails for the demonstration of the working of the system are laid down in the grounds of the Prescot Insulated Wire Company. The object of the visit is to ascertain the suitability of the system for the working of the St. Helens tramways by electricity.

Darlington.—The technical college is shortly to be opened by the Duke of Devonshire. Lectures will be delivered as follows: physiography, by Mr. Thomas Hall; building construction, Mr. W. E. Turnbull; mathematics. Mr. W. E. Blain; German, Miss Dodds; French, Mons. P. Bazire; machine construction and drawing, steam and the steam-engine, Mr. W. R. Alton; magnetism and electricity, inorganic chemistry (practical and theoretical), Mr. A. F. Hogg.

Bexhill.—At the last meeting of the Urban Council the question was asked whether the ratepayers had a right to demand a poll of the town in respect to the proposed borrowing of £20,000 for electric lighting. The Deputy Clerk replied that it could only be done at private expense, but any ratepayer had a right to oppose the matter at the Local Government Board enquiry. It was said that a number of ratepayers were very anxious that a poll should be taken, and he himself would like to see it made.

Isle of Wight.—With the object of determining how long it would take a torpedo boat to pass Cliff Fort and other sea defences on the western side of the Isle of Wight, and also of what value the electric searchlight is in discovering torpedo boats, some interesting experiments were carried out on Wednesday night in the vicinity of the Needles Passage. During the past year considerable attention has been paid by the authorities to the best means of preventing night attacks by torpedo boats.

Smethwick.—A meeting of the inhabitants of Rolfe-street, Smethwick, and the locality, has been held for the purpose of considering the proposal of the District Council to establish a refuse destructor on the site formerly occupied by the Crown Forge. It was decided to present a petition to the District Council protesting against the erection of destructor works in Rolfe-street, and a committee was appointed to prepare the memorial. It was further agreed to request the representative of the ward on the Council to support the memorial.

Messrs. W. Lucy and Co., Limited.—We have received from Messrs. W. Lucy and Co., Limited, of the Eagle Ironworks, Oxford, a very handsomely got-up catalogue, profusely illustrated, and bound in cloth boards. This catalogue relates almost exclusively to bookstack and library fittings of first-class design and construction, but Messrs. Lucy and Co. also state that they are prepared to give estimates for electrical installations and plant, etc., and that they give special attention to the electric lighting of libraries, bookstores, etc.

Aberdeen.—The Electric Lighting Sub-Committee of the Aberdeen Harbour Board have had under consideration the offer of the Town Council to supply the electric current for the lighting of the quays at a reduction of 12½ per cent. on the Brighton rates, which are now charged in the city. It was decided to recommend the Board to accept the offer, since the supply will be about as cheap as could be got by a private installation, while, owing to the development of the system, considerable changes might have to be made in the course of a few years on any private installation.

British Columbia Electric Railway Company, Limited.—It is notified to the holders of such part of the scrip of the British Columbia Electric Railway Company, Limited, 4½ per cent. first mortgage debentures represented by provisional certificates to bearer that the same can be lodged at the office of the Company's agents, Messrs. Sperling and Co., 8, Austinfriars, London, E.C., on and after October 4, between the hours of 11 and 2 (Saturdays excepted), to be exchanged for the definitive bonds. Scrip must be listed in numerical order, and lodged three clear days for examination.

Walsall.—The Electric Lighting Committee of the Town Council have reported that the total number of consumers supplied on August 31 last was 83. The engineer has been instructed to prepare plans and specifications of the additional plant, which will have to be laid down in the course of the ensuing year, and the town clerk has been instructed to advertise for tenders for the necessary works. The engineer has also been instructed to prepare a report of any extension of mains which he deems desirable for the Council to undertake, and an estimate of the probable cost thereof. This report was adopted.

Smoking Concert.—The Electro-Harmonic Society held a smoking concert in the Banquet-room of the St. James's Hall Restaurant on Friday evening, 24th ult., under the direction of Messrs. T. E. Gatehouse and Alfred E. Izard. The programme was, both in selection as well as in execution, somewhat above the level of the usual smoking concert. The vocalists were Mr. George Aspinall and Mr. R. E. Miles, A.R.A.M Mr. Bertie Parker and Mr. Izard rendered several solos on the violoncello and piano respectively, while Messrs. Churcher, Ganthony, and Schneider divided amongst themselves the humoristic contributions.

Edinburgh.—A slight breakdown in the electric light system in Princes-street occurred on the 28th ult., resulting in the portion of that street between Hanover-street and St. David-street being in darkness for several hours. On enquiry being made at the electric light station at Torphichen-street, it was ascertained that everything was in proper working order there, and no reason could be given for the lamps having gone out. It is supposed, however, that a fuse had probably blown. The accident, it was stated, was purely of a local character, only two lamp circuits—eight lamps—being affected. The supply of light to private consumers was not interfered with at all.

Yarmouth.—The report of the Electric Light Committee for August stated that the number of customers had been increased to 228 for 11,050 lamps. The income was £313. 10s., and the expenditure £183. 1s. 6d., leaving a balance of £130. 8s. 6d. to meet capital and other charges of £180 per month. Messrs. Bateman's tender for coal for the generating station at 14s. per ton was accepted. Eight arc lights were ordered to be placed on the covered market, a circuit laid for lighting the outside of the front of the covered market with bulkhead lights, and an additional circuit for lighting the offices, the cost being £250. The annual cost of maintenance will be £130.

Export.—The *Mechanical World* says although there was rather a large falling-off in the export trade of this country in telegraph wire and apparatus connected therewith during the past month as compared with July last, yet on the whole the August shipments were rather above the average for that month, they having amounted to £93,475 as compared with £136,547 in the preceding month, and only £65,176 in August last year. The trade this year to date shows a considerable improvement over the two preceding months; the figures showing a total of £700,748 for the first eight months of 1897, as against £461,578 in the corresponding period of last year, and only £338,169 in the first eight months of 1895.

Rushall and Pelsall.—The Clerk has reported to a meeting of the Rural Council that in accordance with their resolution he had sent notices to the parish councils calling their attention to the fact that the two electric lighting companies were applying for power to make electricity and supply it to the rural district but in reply he had only received a letter from the Rushall Parish Council, stating that they left the matter in the hands of the District Council. The Chairman said he thought it would be a very good thing for the district, and that the parish councils should support it. The Clerk remarked that these companies were compelled to serve notices on them, so that if they wished they might object. The Chairman said that as they did not

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object they need say nothing on the matter. It was consequently dropped.

Copper.—Messrs. Henry R. Merton and Co.'s fortnightly circular states the visible supply in England and France, and advised from Chili and Australia, as 32,988 tons, showing a further decrease during the past fortnight, the stock at the end of August having been 33,267 tons, and a month ago 33,603 tons. The price has further advanced, the quotation for Chili bars and G.M.B.'s being £49. 12s. 6d, as against £49. 2s. 6d. a fortnight ago, and £48. 12s. 6d. a month ago. The supplies from North America during the fortnight, as well as the total from other sources, shows a marked decrease. The total from all sources for the fortnight has been 7,899 tons, as against 19,659 tons for the whole of August, and the deliveries have been 8,178 tons, as against 20,396 tons for the whole of August.

Bermondsey.—A special meeting of the Vestry has been held to consider the following motion: "That the Vestry apply to the Board of Trade for a provisional order authorising the Vestry to supply electricity for public and private purposes within the parish." The motion was agreed by 30 to 12. It was pointed out during the discussion that the Board of Trade required that a fair number of streets should be included in the area in which it would be compulsory for the Vestry to lay the supply mains within two years of the granting of the provisional order, and the committee suggested that the following should be the compulsory streets—namely, Dockhead (from Mill-street to Jamaica-road), Bermondsey-wall, Spa-road (from Grange-road to Neckinger-street), Jamaica-road, Mill-street, Bermondsey New-road, and Southwark Park-road.

Thorne.—The Lighting Committee having stated that they had been unable to arrange terms with the gas company as to the lighting of the town—a question of 6d. per lamp separating them—the Parish Council, after a long discussion, eventually decided that it would be better to convene a meeting of the ratepayers to consider the matter. This was accordingly done, and during the debate at this meeting the Chairman said that he was well aware that many influential gentlemen of the town were of the opinion that, failing an agreement with the gas company, electricity should be introduced, and he held in his hands estimates from more than two parties who had offered to erect plant for lighting the 70 lamps in the town with electricity, and also for supplying electric light to the large houses in the town. A motion to support the action of the committee was carried.

Books Received.—We have received—too late to be reviewed in this issue—a voluminous and profusely illustrated work, published by Cassell and Co., Limited, and entitled "Electricity in the Service of Man: A Popular and Practical Treatise on the Applications of Electricity in Modern Life," by Dr. Wormell, D.Sc., M.A. This is a work from the German of Dr. A. R. von Urbanitzky, revised and enlarged by R. Mullineux Walmsley, D.Sc.(Lond.), F.R.S.E., etc. (president of the Northampton Institute, etc.). — "The First Principles of Electricity and Magnetism," by C. H. W. Biggs, editor of the *Electrical Engineer*. Illustrated with about 350 diagrams, etc. Published by Biggs and Co., London. This book, which is intended for beginners in practical work, will be reviewed in a later issue of this journal — "The Principles of Alternate-Current Working," by Alfred Hay, B.Sc (Edin.), lecturer on electrotechnics of the University College, Liverpool. Illustrated. Published by Biggs and Co., London.

St. Pancras.—The report of the Electricity and Public Lighting Committee states that the gross profit over the period of six months ending June 30 last earned by Regent's Park station amounts to £5,063. 2s. 8d., and by the King's-road station £293. 15s. 11d., a total for the two stations of £5,356. 18s. 7d. This result is eminently satisfactory; in the case of Regent's Park station it represents an increase of more than 15 per cent. per annum over the period ending December 31 last; whilst in the case of King's-road station a gross profit of £293. 15s. 11d. on the six months is earned as against a loss of £847. 2s. on last year's working. The net result of the six months' trading, after meeting all payments of instalments of loans and interest, is a profit on Regent's Park station of £2,040. 2s. 9d., and a loss on King's-road station of £739. 15s. 9d., to which is added the deficit of £800. 12s. 7d. at December last, leaving a profit balance carried forward on account of both stations of £499. 14s. 5d.

Communication with Klondike.—The invention sketched out by that charming writer, Frank R. Stockton, in his "The Great Stone of Sardis," which is now running in *Harper's Magazine*, seems to have attained tangible shape. An American journal, referring to the difficulties of travel to Klondike, says: "Prominent business and railroad men propose to inaugurate an electric sleigh service, capable of travelling 60 miles an hour on a smooth surface. The Pullman Palace Car Company has by this time completed a model of the sleigh. It is to be furnished with upholstered berths and heated and lighted with electricity, so that the coldest weather will not trouble the traveller. On the first trip through it is proposed to take a number of men who will smooth over the rough places, and then a fast trip will be possible. Passengers' baggage and freight will be carried at a reasonable rate. All the plans of the company are patented. The same journal also states that the building of a railway from Juneau to Lake Testin is now assured, also that rapid progress is being made on the cable tramway now constructing at Chilkoot Pass."

Bath.—Three reports from the Electric Lighting Committee are before the Urban Sanitary Authority. It is stated that the total cost of the mains extension will amount to £2,371. At the meeting of the committee on the 26th ult., the report of Mr. Hammond as to the progress made at the works was submitted. It was resolved "That the sub-committee be requested to consider and report on the advisability of placing a bracket lamp on Mr. Alderman Taylor's premises in New Bond-street in accordance with his offer, and also of placing brakets on other suitable premises, and as to the advisability of suspending the lights over the middle of the streets." The Clerk read a letter from the Local Government Board enclosing sanction for loan of £5,800, and asking for further particulars with regard to Mr. Hammond's fees and the drainage of the works, and reported that he was obtaining the further particulars required. The Clerk read a letter of this date from the consulting engineer asking for a further payment on account of his commission. Resolved: "That a further sum of 500 guineas be paid to him on account of his fees." At the meeting of the committee held on September 8 it was resolved that the question of the suspension of lamps over the centre of the streets be not entertained.

Bristol.—At 1 p.m. the extension from Old Market-street to Fishponds was opened on the 28th ult. This important extension of the system of electric traction has been awaited with considerable interest. The cars are of the same character as those which have been running to Eastville for several months, but after leaving the Eastville depôt the wires are carried over the centre of the roadway by means of wires from side to side of the road. This system dispenses with the brackets, and allows the use of a much lighter post. Before the public were carried along the line a party of invited guests assembled at Old Market-street, and in charge of Mr. George White, the managing director, and the secretary, Mr. Sam White, were taken first to Fishponds, and then to the St. George's power-house. The car was driven by Mr. Challenger, the traffic manager. The bulk of the party consisted of the members and officers of the Stapleton Urban District Council, through whose district the extension runs. At present the line is open only to Fishponds, but ultimately Staple Hill will be reached, where a large depôt is to be erected. The power-house at St. George has been greatly enlarged and almost entirely remodelled, four enormous direct-driving machines having been laid down. The customary luncheon followed, at which the usual toasts were proposed and responded to.

Bedford.—The Town Council have adopted the following report of the Electric Light Committee's: "(*a*) The committee report that they have instructed the engineer (1) To proceed with the construction of an underground sub-station at the junction of Harpur-street and Midland-road, in order to meet the increased demand for electric current in that locality. (2) To make the necessary arrangements for laying the electric mains and erecting the lamp standards in Bushmead-avenue so that the public lighting thereof may be completed about the end of October next. (*b*) The committee further report that the electric mains have now been laid in the following additional streets—viz., Newnham-road, Gery-street, Castle-road (east of the Circle), Embankment, Bushmead-avenue, Goldington-avenue, and Shakespeare road. The committee will be glad to receive applications for private lighting from any residents in such streets." With regard to Section I., Alderman Richards said the committee had had many applications from residents in that locality for the light, and unless they constructed this transformer station the mains would have been overloaded. This extra work was one of the penalties of success. As to the rest of the report, the committee were preparing for the future, and they wished it made known that any residents in the localities named could have the electric current supplied to them on application.

Glasgow.—The Government enquiry into the Glasgow telephone service was resumed on the 29th ult. Mr. Fleming, of Kelvinside, said that any man who was at present satisfied with the service was fit for heaven. The telephone alarmingly increased profanity in Glasgow clubs. He worked away at the telephone handle with as good results as if he were grinding a disembowelled organ. The service and staff were starved to make a big dividend. He was reported to have written to the Telephone Company: "There are no oaths strong enough in the English language to express my sentiments towards your company. (Laughter.) If you complain to these girls, they simply say 'engaged' immediately afterwards. That is their revenge." (Laughter.) He had never heard of any who were satisfied with the telephone; they were fit for heaven if they were. (Laughter.) He was against putting the telephone into the hand of corporations; they had too much to do already. If they got their own way they would provide howdies and hearses, and take charge of the whole population. (Loud laughter.) He had written to the company: "Fancy your own feelings every time you try the cursed thing, whirling away at a —— handle with no more result than if you were grinding at a disembowelled hurdygurdy." (Great laughter.) A number of witnesses said the Telephone Company had throttled telephonic extension in Glasgow. The enquiry was adjourned.

Paddington. — Edgware-road is to be lighted by electricity. The Works Committee reported to the Vestry on September 24 the receipt of a letter from the Vestry of Marylebone stating that if the Vestry of Paddington would pay a moiety of the expense, they would arrange with the Metropolitan Electric Supply Company for lighting Edgware-road, from Marble Arch to Chapel-street, upon similar terms to those obtained in respect of the lighting of their six lamps in Regent-street—viz., to lay mains, supply lamps and carbons, light, maintain, extinguish, etc., for a term of three years, for the sum of £30 per lamp per annum; the burning hours to be the same as those of the gas lamps—*i.e.*, 3,940. Seventeen standards would be necessary, which would cost about £14 each;

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the total cost of installation, including standards, refuges, etc., would be about £400, so that each Vestry would have to pay, say, £200 for the installation, and £15 per lamp per annum. The committee recommended the Vestry to agree to light Edgware-road, from Marble Arch to Praed-street, by electricity, upon the terms set forth in the letter from the Vestry of Marylebone. During the debate which ensued it was suggested that the proposed installation of the electric light in the Edgware-road should at least be carried as far as Blomfield-road, and, if possible, as far as the High-road, Kilburn, or as far as the Prince of Wales, Harrow-road. The recommendation was agreed to *nem con.*

East London Technical College.—The session of this college, which is just commencing at the People's Palace, Mile End-road, E., comprises, besides London University courses, lectures on engineering, chemistry, and physics for the day classes, and science and trade (commercial and general) for the evening classes. The staff of the college contains a long list of lecturers and teachers under the director of studies (Mr. J. L. S. Hatton, M.A.), and the following professors: Messrs. D. A. Low, Wh.Sc. (engineering), J. T. Hewitt, M.A., D.Sc., Ph.D. (chemistry), R. A. Lehfeldt, B.A., B.Sc. (physics), A. G. Cooke, M.A. (electrical engineering), R. Christie (art). A conversazione was held on Monday evening, the 27th ult., Sir John H. Johnson in the chair. Various attractions, such as concerts, X-rays, and vitascope exhibitions, etc., were provided. The most interesting of the exhibitions was perhaps that in connection with the cathodic rays. Specimens of coral were shown in vacuum tubes, and the brilliant hues produced by the current while passing through the former, and rendering the same phosphorescent, were greatly admired. At the close of each lecture the audience were allowed to admire the bones of their hands thrown on a small celluloid screen by the X-rays. The carpenters' and the electric engineering workshops attracted not a few visitors, who in the latter were told all about dynamos, motors, and incandescent lights. The members of the students' union enjoyed a dance to themselves. A large number of attendants proffered light refreshments during the evening.

Islington.—The report of the electrical engineer (Mr. A. Gay) is to be discussed at the meeting of the Vestry of St. Mary to-night. It appears that the cost of this undertaking is somewhat high as compared with similar undertakings, owing to number of houses which had to be purchased to provide for further extension. We quote from the report: The buildings are constructed throughout of high-quality selected brickwork, steel, and Portland cement concrete. Both the engine and boiler houses are faced with white glazed bricks for the purpose of cleanliness and light, and the buildings are practically fireproof. A full suite of offices, workshops, etc., have been provided to meet all possible future requirements, although these matters are often left until the station has been running some time. The stack is sufficiently large to take three times the number of boilers originally laid down. The engine-house is large enough also to provide for similar extension. Three walls of the future boiler-house are standing, and these have been taken to a depth of 13ft. below the ground level in order that the ground when required may be excavated to that depth in a manner similar to the existing boiler-house. A railway runs the whole length of the works as well as to the future boiler-house, so that when the latter is opened up the coal can be delivered direct, while the railway on the premises also enables goods and mathinery to be delivered straight into the works with a minimum of cost. It is usual in analysing the cost of electric light undertakings to deal with the capital cost per kilowatt of the whole installation; in other words, if the capacity of the plant is equal to 1,000 kw., and the total expenditure £100,000, the capital cost per kilowatt would amount to £100. Taking nine electric undertakings in London whose accounts for 1896 are published, Mr. Gay finds that the capital expended averages £150 per kilowatt. In the case of Islington, the capital expended up to the end of 1896 was considerably in excess of this, amounting to £204 per kilowatt. The expenditure authorised by the Vestry up to the date of this report (including the immediate extensions) amounts to about £150,000, and, assuming that up to the end of 1898 a further sum of £40,000 for extension of mains, etc, is authorised (which the engineer takes to be an outside figure), the total expenditure to that date would amount to £190,000, and this divided by 1,160, being the total kilowatt capacity of the plant, when the extensions included in this sum are complete, will reduce the capital cost per kilowatt from £204 to £163, or only £13 above the average. The fact that the cost falls to the extent of £41 per kilowatt on the first extension proves that the high initial expenditure is not due to extravagance, but chiefly to provision having been made for the future, for it is not at all uncommon to find the capital cost per kilowatt rise materially as extensions take place. At Islington every extension of machinery will tend to reduce rather than increase this figure. The engineer's opinion is that in five years the capital cost per kilowatt will not exceed that of other installations in London of similar size, while the general excellence of the installation cannot be disputed.

Gravesend.—The Town Council have discussed the following report of the Paving and Works Committee on electric lighting: "Mr. Reeves, the secretary of the Electric Supply Corporation, Limited, and of Messrs. Crompton and Co., Limited, attended by invitation to confer with the committee with regard to the terms on which the first-mentioned company would be willing to introduce electric lighting into Gravesend. After consideration, Mr. Reeves was of opinion that the Supply Company would modify the terms mentioned to the town clerk, and set forth in his report as follows: '(1) In the event of the Corporation acquiring the undertaking at the expiration of seven years, the company would allow as a rebate from the goodwill payable whatever net profits had been made during that period. (2) The purchase of the Corporation at the expiration of 42 years would, as provided by the Electric Lighting Act, 1888, be a fair market value without goodwill. (3) The Corporation is asked to bind itself to adopt electricity for street-lighting purposes generally, but it is admitted that the refusal of the Corporation, if persisted in, will not be fatal to the scheme. On the other hand, if the electric light were generally adopted for public purposes, the charge of 4d. might be lessened to 3d. per unit. (4) It is considered, subject to the advice of the company's engineer, that they might bind themselves compulsorily to lay five miles of main within two years. (5) The company would undertake to lay a main along any road which the Corporation would publicly light with electricity, and any inhabitant in such road, as well as in the compulsory area, could obtain electricity at a maximum cost of 7d. a unit 'for the first two hours,' and thereafter 4d. per unit. (6) The Crompton open conduits would be used wherever practicable as a kind of sewer, in which the mains are laid, and through which they can be drawn for repair and other purposes without disturbing the roads.' Upon Mr. Reeves retiring, the committee resolved, and now beg to report, that they are in favour of the introduction of electric light into the borough by Messrs. Crompton and Co., Limited, and the Electrical Supply Corporation, Limited, with which they are associated." The Town Clerk read a letter from Mr. Frank Reeves, who thus replied to the three points on which the committee desired further information: "(1) If the Corporation will go in for lighting the whole or the greater portion of the streets by electricity, we will agree that the supply shall be at the rate of 3d. per Board of Trade unit; (2) the Board of Trade provisional orders contain a clause empowering local authorities, by notice served upon the lighting company, to open up and remake the roads for and at the expense of the electric company; (3) electricity at the price of 4d. per unit is equivalent to gas at the price of 2s. 7d. per 1,000ft." These minutes have been confirmed.—A quarterly general meeting of the Gravesend and Northfleet Tradesmen's Association was held last week. During the discussion on electric lighting, Councillor Cobham contended that the question was whether an electric light company should come into the town, break up the streets, and carry on the lucrative speculation in the town for personal profit, which they were justly entitled to make as well as gas, water, and railway companies. Indirectly the people got the benefit of the commodity supplied by all of these companies. Ought the Corporation of Gravesend to be the great profit-makers for the benefit of the people at large? He was supposed to be a "progressionist," and as such he said most decidedly the Corporation of Gravesend should enter into the speculation. Whether it paid or not, it was the duty of the Corporation to undertake the supply, and if they did so it would be at a profit to be applied to the reduction of the rates. He spoke of the advantages of electric light, and then went on to remark that it was too much to expect the Corporation to undertake the establishment of electric lighting works after the rebuff over the water question. If the Corporation allowed a company to come into the town an arrangement should be made to supply street lamps at cost price. He had asked a representative of Messrs. Crompton and Co. if they could supply Northfleet as well as Gravesend, and the reply was the firm could, and would, if allowed to place the mains in the roads. He moved "that it was desirable that the electric light system be introduced into Gravesend, considering its introduction by a private company would be for the public good," but the resolution fell to the ground for want of being seconded.

TRAFFIC RECEIPTS.

Bristol Tramways.—The traffic returns for the week ended September 24 were £2,584. 1s. 10d., compared with £2,223. 19s. 0d. for the corresponding period of last year, being an increase of £360. 2s. 10d.

Birmingham Tramways.—The traffic receipts for the week ending September 25 were £3,658. 10s. 0d., as compared with £3,535. 18s. 11d. in the corresponding week in 1896, being an increase of £122. 11s. 1d.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended September 26 amounted to £1,407, as compared with £1,168 in the corresponding week of the previous year, being an increase of £239.

City and South London Railway.—The returns for the week ended September 26 were £891, compared with £925 for the corresponding period of last year, being a decrease of £34. The total receipts for the half-year 1897 amounted to £11,694, compared with £11,813 for the corresponding period last year, being a decrease of £119.

South Staffordshire Tramways.—The traffic returns for the week ending September 24 were £617. 19s., as compared with £629. 4s. 10d. in the corresponding week of the previous year. The aggregate receipts so far this year were £24,084. 8s. 9d., as compared with £23,583. 18s. 7d. in the corresponding period in 1896.

D.S.D. Tramways, Dublin.—The traffic receipts for the week ending September 24 were £560. 9s. 2d., as compared with £543. 11s. 2d. in the corresponding week in the previous year, b ing an increase of £16. 18s. 0d. The number of passengers

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carried was 85,170 in 1897 and 76,839 in 1896. The aggregate returns up to date are £9 707. 3s. 5d., as compared with £10,531. 8s. 7d., being a decrease of £824. 5s. 2d. The mileage open is the same as last year—viz., eight miles.

PROVISIONAL PATENTS, 1897.

SEPTEMBER 20.

21496. An electrical water-level indicator or recorder. Percy Rhodes Cobb, 115, St. Vincent street, Glasgow.

21534. Improvements in electric arc lamps. Benjamin Joseph Barnard Mills, 23, Southampton-buildings, Chancery-lane, London. (Bennard H. Pomeroy, United States.)

21554. Improvements in telegraphic or telephonic relays and circuit arrangements for same Alfred Charles Brown, 129, Algernon-road, Lewisham, London.

SEPTEMBER 21.

21623. Improvements in electric connecting devices applicable to lamp sockets, wall plugs, and the like. Charles Ludwig Rudolph Ernest Menges, 45, Southampton-buildings, Chancery-lane, London.

21657. Improvements in and relating to electrolytes for secondary batteries. Wilhelm Decker and George von Struve, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

SEPTEMBER 22.

21669. Improvements in insulators for telegraph and like wires. George Ashby, Fairfield, Kingston-on-Thames.

21704. Improvements in secondary electric batteries or accumulators. Samuel Walter Hart, 73, St. Stephen's-road, Upton Park, London.

21705. Improvements in and relating to secondary electric batteries or accumulators. Samuel Walter Hart, 73, St. Stephen's-road, Upton Park, London.

21732. Improvements in inner globes for enclosed arc lamps. Bernard Mervyn Drake and John Marshall Gorham, 66, Victoria-street, Westminster, London.

21745. Automatic telephone. Elias Elkan Ries, 115, Cannon-street, London.

21753. Improvements in the manufacture of insulated electrical conductors. Mervyn J. P. O'Gorman, 4, South-street, Finsbury, London.

SEPTEMBER 23.

21795. Improvements in electric switches. John William Astley, trading as the Central Electrical Engineering Company, 17, Hanover-street, Keighley.

21818. Improvements in electric arc lamps. Thomas Edgar Adams, 18, Buckingham-street, Strand, London. (Complete specification.)

21819. Improvements in and connected with electrical storage batteries. Edward John Wade, 84, Beechdale-road, Brixton-hill, London.

21822. Improvements in or relating to arc lamps and the feed mechanism thereof. Charles Oliver, 31, Southampton-buildings, Chancery-lane, London.

21829. Improvements in and connected with electric lighting. Norman Staniland and Oliver Prescott Macfarlane, 45, Southampton-buildings, Chancery-lane, London.

21836. An improved appliance for facilitating reference to business names and addresses, particularly to telephonic purposes. Edward Howe, 53, Chancery-lane, London. (John D. Browning, United States.)

SEPTEMBER 24.

21951. Improvements in and relating to electrical alarms. Rudolf Hettmann, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

SEPTEMBER 25.

21976. Improvements in appliances used in connection with the electro-deposition of metals. Fred Greenfield, 24, Temple-row, Birmingham.

21990. Improvements in electric glow lamps. Jacob Atherton and Sebastian Ziani de Ferranti, 70, Palace-chambers, Westminster, London.

22022. Manufacture of insulating material for electrical purposes. Clayton Beadle, 28, Southampton-buildings, Chancery-lane, London.

22023. Improvements in electric arc lamps. Oliver Imray, 28, Southampton-buildings, Chancery-lane, London. (Sigmund Bergmann, United States.) (Complete specification.)

22024. New or improved apparatus for closing and opening electric circuits at pre-arranged times. John Drayson Dymond and Warburg, Dymond, and Co., 115, Cannon-street, London.

22032. Improved detachable securing mechanism for electric incandescent lamp shades. Paul Philipp Adolph, 322, High Holborn, London. (Complete specification.)

22044. Improvements in electric batteries, electrodes, and method of making the same. Reginald William James, 1, Queen Victoria-street, London. (The Bell Electric Company, United States.) (Complete specification.)

21974. Improvements in or relating to electric telephones. Thomas Sloper, 14, Brittox, Devizes.

22045. Improvements in electric batteries. Reginald William James, 1, Queen Victoria-street, London. (The Bell Electric Company, United States.) (Complete specification.)

SPECIFICATIONS PUBLISHED.

1896.

19455. Automatic switches and safeguards for electric traction systems. Thompson and Walker.

19455a. Automatic switches and safeguards for electric traction systems Thompson and Walker. (Date claimed under Patents Rule 19, September 3, 1896.)

19871. Electric automatic regulating or controlling apparatus. Blackburn and Spence.

21340. Collectors for electric tramways and railways. Smith.

23256. Electric lighting for velocipedes, cabs, broughams, omnibuses, tramcars, or any other vehicle, and the method of generating and storing electrical energy therefor by the utilisation of the motive power of the said velocipedes, cabs, broughams, omnibuses, tramcars, or any other vehicle. Armstrong.

23942. Electric switches and cut-outs or circuit breakers. Belfield. (Wurte.)

24177. Dynamo-electric generators. Wade, Moores, and Farrell.

24381. Electric switches. Cotterell and Russell.

25346. Automatic brake for an electric motor. Siemens Bros and Co., Limited, and Grimston.

27776. Obtainment of metals or alloys by electrolysis or hydro-electro chemical action. Marino.

28288. Anodes for the electro-deposition of nickel. Canning.

1897.

13107. Electric arc lamps. Bergmann.

13971. Controllers for electric motor circuits. The British Thomson-Houston Company, Limited. (Priest.)

16629. Conduits for electric conductors. Newton. (American Silex Company.)

17583. Elect ic condensers. Bradley.

17924. Field magnets for electric generators and motors. Tuson.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	9½-9¾
Brush Company, Ordinary	2	1-1¼
—— Non. Cum., 6 per cent. Pref.	2	1¼-1½
—— 4½ per cent. Debenture Stock	100	103-107
—— 4½ per cent. 2nd Debenture Stock	100	94-98
Callender's Cable Company, Debentures	100	108-113
—— Ordinary	5	7-8
Central London Railway, Ordinary	10	9¾-10¼
——	6	5¾-6¼
Charing Cross and Strand	5	12-13
Chelsea Electricity Company	5	10½-10¾
—— 4½ per cent. Debentures	100	110-113
City of London, Ordinary	10	25-26
—— 6 per cent. Cumulative Pref.	10	17-18
—— 5 per cent. Debenture Stock	100	130-135
City and South London Railway, Consolidated Ordinary	100	67-69
—— 4 per cent. Debenture Stock	100	138-140
—— 5 per cent. Pref. Shares	10	15½-15¾
County of London and Brush Provincial Co., Ordinary	10	12¾-13¼
—— 6 per cent. Cum. Pref.	10	15½-16
—— 4½ per cent. 2nd Debenture Stock	10	15-15½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1½ 2
—— 5 per cent. Debentures	—	89-94
Edison and Swan United Ordinary	2	2¼-2¾
—— 5 per cent. Debentures	5	4-5
Electric Construction, Limited	2	2-2¼
—— 7 per cent. Cumulative Pref.	2	3¼-3⅝
Elmore's Copper Depositing	1	1⅛
Elmore's Wire Company	2	⅝-¾
W. T. Henley's Telegraph Works, Ordinary	10	19-20
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	109-114
House-to-House Company, Ordinary	5	9-9½
—— 7 per cent. Preference	5	10¾-11¼
India Rubber and Gutta Percha Works	10	21½-22½
—— 4½ per cent. Debentures	100	103-107
Kensington and Knightsbridge Ordinary	5	13½-14½
—— 6 per cent. Pref.	5	8½-8¾
London Electric Supply	5	1½-2
Metropolitan Electric Supply	10	18-19
—— 4½ per cent. First Mortgage Debenture Stock	100	118-122
National Telephone, Ordinary	5	6¾-6¾
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	15-17
—— 5 per cent. Non. Cum. Third Pref.	5	6-6½
—— 5½ per cent. Deb. Stock	100	105-110
Notting Hill Company	10	15-16
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8-8½
—— £4½ shares	4½	7½-7¾
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	105-107
St. James's and Pall Mall, Ordinary	5	16½-17½
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	36-39
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	8	10¾-11¼
Westminster Electric Supply, Ordinary	5	14¾-15¼
Yorkshire House-to-House	5	8-8½

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NOTES.

Manual of Electrical Undertakings.—We have received a copy of Mr. Emile Garcke's stupendous work, the "Manual of Electrical Undertakings," which we hope to review in our next issue.

Medical Electricity.—The international congress of neurology, psychiatry, medical electricity, and hypnology, which has been held at Brussels, came to an end on Saturday, September 18 last.

Electricity from Dust Destructors.—The Fulham Vestry have, it is said, determined to establish a system of dust destructors and electric light producers similar to that inaugurated recently by Lord Kelvin at Shoreditch.

The Michigan College of Mines.—We have received the prospectus of this college for the session 1897-98, and note that it contains a thorough and well arranged course of instruction, including electrical engineering and electricity and magnetism.

New Simplon Railway.—The Milan Chamber of Commerce has passed a unanimous resolution in favour of a new railway through the Simplon. The province will grant towards the new undertaking a sum of 500,000 lire (about £20,000), and the city will make a grant for a similar amount.

Forthcoming Lectures.—The attention of our readers is directed to the short course of special lectures to be given at the Finsbury Technical College on Thursday evenings, from October 14 to November 4, by Prof. Silvanus Thompson on "Recent Developments in Electro-Chemistry." Prof. Thompson's ordinary course of Monday evening lectures this winter is mainly directed to dynamo design.

The Danish Telegraphs.—His Majesty the King of Denmark has appointed Mr. Meyer as director of telegraphs in place of Lieut.-Colonel Höncke, who has retired on pension. Lieut.-Colonel Höncke has taken part, as the delegate for Denmark, in all the international conferences since that held in London in 1879, and his retirement from long and honourable service has called forth many expressions of regret and good feeling.

The African Telegraph.—Mr. Rhodes, after personal investigation, has decided to change the route of the African Trans-Continental telegraph. The Mazoe-Mount Darwin district, where the line was destroyed by the rebels, has been found both difficult and unhealthy, and a route is being planned from Umtali by the Mount Bismarck district on to Tete. From that point to Blantyre, in British Central Africa, the line is already in position.

Electricity in Italy.—In the province of Como the Société Varésienne of tramways and electric railways has applied for a concession of the important hydraulic force in the valley of Veddasca-Maccagno, which they wish to use for the electric traction of the lines from Varese to Prima-Capella and Varese to Luino, as well as for the electric lighting or distribution of energy to houses. The works will be situated about three miles from Luino.

Explosive Dynamos!—A newspaper reporter is supposed to know something of everything, but after reading the following in a local newspaper a short time back, we begin to think that there are more things in heaven and earth than are dreamt of even by the ubiquitous journalist. In giving a graphic account of a fire at some electrical works, the young man (he *must* be young) delivers himself of this eloquent sentence: "It was nothing short of providential that a number of dynamos stored in the building failed to explode, otherwise the damage to surrounding property would probably have been enormous." Oh, it would; it *would!*

The Electric Lighting of Bridgwater.—For some time past we have been hoping to be able to publish a report which we have received of the sub-committee appointed to consider the question of lighting the borough of Bridgwater by electricity; but owing to the continued pressure on our space we have been unable to do so yet. The report is one which merits perusal on account of the care taken in its compilation, the abundance of facts and figures given, and the extremely lucid and concise way in which it is written.

The Lighting of Railway Stations.—The following statement is made on the authority of the *Financial News*: "A further instance of the delegation of duties usually undertaken by railway companies themselves is to be furnished by the Great Central. Already an ancillary company to supply the rolling-stock for the London extension is in operation, and now another is to be formed to provide electric light to the chief stations. The capital is to be £75,000, and Mr. W. P. J. Fawcus, of the Edison and Swan United, will be chairman."

The Northampton Institute.—The syllabus of this institute, which is situated in Clerkenwell, and is, perhaps, more familiarly known by its sub-title, "The City Polytechnic," has issued its syllabus for the ensuing session. We note that the applied physics and electrical engineering department is under Mr. R. Mullineux Walmsley, D.Sc., F.R.S.E. (the principal), the chief assistant and lecturer being Mr. C. V. Drysdale. Sections for all branches of electricity are formed, and the syllabus shows that a solid and most thorough electrical education is given.

The Danger of Niagara Falls.—The number of fatalities which occur through people being swept over Niagara Falls by the force of the current has of late attracted considerable attention, and to lessen the danger it is proposed to stretch a light wire cable encased in a tube across the river just above the danger line, which is below the navigation line. It is also suggested that incandescent lights should be fixed to the cable for use at night. At the end of another 3,000 years these lights will not be necessary, for we are told by Dr. Spencer and Prof. Gilbert that at the rate the earth is sinking in that neighbourhood, Niagara will by then have dried up.

The Financial Security of Electrical Undertakings.—A unique proposal was made a short time ago at Innsbrück by the management of the Savings Bank, which indicates what sound securities electric light undertakings are considered. The management (which is under the supervision of the provincial authorities) passed a resolution to lend the municipal authorities £50,000 at 3·6 per cent. in order to enable them to buy the electricity works of Messrs. Ganz and Co. The provincial authority, however, rejected the proposal when it was submitted for their sanction, on the ground that according to the by-laws the Savings Bank was not justified in granting a loan at such a low rate of interest.

Smuggling will be Impossible.—*L'Elettricita* says that in consequence of the great success which has been obtained by the use of the Röntgen rays in the French Customs Houses, the Chemical Central Laboratory in Rome is investigating the question with the view of adopting this mode of search in the Italian Customs House service. The result of the experiment will be embodied in a report to Mr. Branca, who will then decide in which way they shall be applied. For the ordinary traveller who does not seek to elude the revenue officer this system would spare him the annoyance of having his luggage disarranged, but amateur photographers will have to look out for their plates, and amateur smugglers will be considerably hampered in their movements.

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The Junior Engineers.—The volume of the *Proceedings* of this institution, edited by the secretary, Mr. W. T. Dunn, is of more than usual interest to electrical engineers, in that various papers and descriptions of visits are connected with this branch of engineering. In our opinion, the most useful and interesting part of the institution work is in the visits paid to central stations, to gasworks, waterworks, big engineering works or factories. That the visitors gain breadth and depth of information very serviceable to them in their practical work can well be gathered from the contributed papers on such visits. The volume is an exceedingly good one, and redounds to the credit of the editor and of the institution.

The Central London Railway.—Following on an article published by the *Daily Mail*, the secretary of the Central London Railway Company writes to that paper to say there are 12 miles of tunnelling to be completed in connection with the new Central London Railway, and of these over six miles have been excavated. The contractors are proceeding with the work at a satisfactory and exceptionally rapid rate. He also states that at no time has there been any suggestion of friction with the Great Eastern Company, with whom they are on the most amicable relations, the negotiations between the two companies being of a purely business nature. It is hoped that the railway will be opened to the public as soon after Christmas of next year as possible.

Wire-Robbers.—It seems to be the fashion in America among a certain class of thieves to strip off trolley and feeder wire, and then to chop it up into convenient lengths suitable for melting into pigs to prevent identification. Where current is not carried all night, and where the wires pass through unfrequented localities, we fail to see how this can be avoided. In England the danger does not appear so formidable because our wires can scarcely avoid passing through crowded localities, but should it at any time threaten to become a serious nuisance, we should more than likely put our legal system at work without delay. A vigorous police system, where justice does not often err on the side of mercy in dealing with larcenies and petty crimes of that order, is a very wholesome institution.

Telegraphing at Sea.—The Channel squadron, which has been spending some time in Palmas Bay, has been carrying out an elaborate programme of torpedo exercises, mining operations, and search-light experiments, for which the bay offers admirable facilities. According to advices received at Portsmouth, an interesting experiment, tending to show the advantages accruing from the higher training of signalmen, was also tried. The eight battleships which form part of the squadron were connected by telegraphic cables, the signalmen becoming for the nonce telegraph operators. Some hundreds of messages, which would in the ordinary way be sent by semaphore or flag signals, were successfully transmitted by these submarine cables, and great importance is attached to the plan, which has many advantages over visible signalling.

Government Contracts.—We have before us a return of the contracts made in the United Kingdom for manufactured articles by the several Government departments for the year ending March 31, 1897, either with contractors outside the United Kingdom, or with contractors or agents in the United Kingdom who obtain the articles from abroad. In the departments using electrical apparatus—viz., the Admiralty, the Post Office, and the War Office—the total contracts amounted to just under £30,000, and the electrical items amount to nearly £12,000, of which about £7,600 come under the Post Office Department. A good many of the articles are the specialities of foreign makers, but we fail to see why such things as voltmeters and ammeters, for instance, could not be obtained in England. However, we can do no more than call the attention of manufacturers to the fact.

Swiss Electric Traction.—It is proposed to apply electric traction to the tramways which unite the town of Bienne to Boujean, and it is said that the Geneva Tramways Company has received three very advantageous offers for it. The electric tramway from Lugano to Tesserete will soon be adapted. It will start from the Gothard railway station, and the length of the line will be about five miles. The estimates provide for about £2,560 per mile as the cost of establishing. The electric tramway from Orbe to Chavornay carried 3,875 passengers and 176 tons of merchandise and luggage during the month of August. The gross receipts for the month amounted to just over £90. The Municipal Council of Châtelard have adopted the preliminary agreement between the commune and Messrs. Dufour Bros. relating to the establishment of an electric tramway between Montreux, les Avants, and Montbovon.

The Telephone Service Through the City.—In reference to the notice from the Postmaster-General requiring the consent of the City Commissioners of Sewers to laying underground telegraphs in the City, intimating that failing such consent a difference would be deemed to have arisen between the Postmaster-General and the Commission, and stating that the Postmaster-General would apply to the tribunal having jurisdiction to hear and determine such difference, the Streets Committee reported at the meeting of the Commission on Tuesday. They recommended that the Commissioners should adhere to their previous decision in the matter; that while they did not object to the Post Office authorities opening the streets for the laying of underground telegraph wires for their own purposes, they did object to give their sanction to wires being laid for the use of the National Telephone Company unless the company were prepared to provide an improved service at a reduced cost. After a long discussion the report was agreed to.

Obituary.—Mr. Peter Lund Simmonds, who was at one time well known as a writer on applied science, and who took an active part in the management of several of the chief international exhibitions, died on Sunday last in the Charterhouse at the advanced age of 83. Mr. Simmonds's real name was Lund. He was born at Aarhuus, Denmark, in 1814, and was adopted by Lieutenant George Simmonds, R.N., whose name he took. Mr. Simmonds was a voluminous writer on agriculture, food supplies, and commercial matters generally, and a most laborious and industrious worker. His best-known book was on "Waste Products and Undeveloped Substances." This was published in 1862, and went through several editions. He was proprietor and editor of the *Technologist* 1862-66, and the *Journal of Applied Science* 1870-81. He was superintendent of one of the departments of the British Section of the Paris Exhibitions of 1867 and 1878, and manager of the British Section at Amsterdam 1869 and 1883, and at Antwerp 1885. For the last years of his life he was in reduced circumstances, and found a refuge among the brethren of the Charterhouse.

The Abolition of Index Boards.—The Deutsche Strassenbahn-Gesellschaft, of Dresden, which was the first public company to put index boards on their cars, back and front, to indicate the destinations, have now abolished them on account of the inconvenience they cause. The objection which has been raised—that it is impossible to tell where a car is going if there is no board behind—is said to be not only of no consequence, but is the very reason why it should not be put there. People who want

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to board a car should wait at the regular stopping places, and they would then have plenty of opportunities of finding out where each car was going to. In the case of electric cars, it is said that the number of accidents caused by people attempting to board from behind when the car is in motion is very considerable, and to have a board at the back is only a tempting of providence, besides being very tantalising to hurrying humanity. It is said that in such towns as Berlin, Frankfort, Leipsic, etc., where the rear index board has already been abolished, there has not been the slightest agitation for a renewal of the old state of things, and it encourages people to wait at the proper stations.

Spontaneous Inflammation of Gas Produced by Carbide of Calcium.—M. Victor, professeur de sciences, writes to *Cosmos* in reference to the statement in that paper, that there was a highly inflammable gas mixing with acetylene and produced by the reaction of water on impure carbide of calcium. He says that his personal observations lead him to the same conclusion. He had noticed that acetylene produced from carbide of inferior quality gives off in burning a whitish cloud with a phosphorus odour which fills the whole of the room. In proving the analogy of that vapour with that of phosphoric acid, he was led to believe that the gas in question was phosphuretted hydrogen. After those researches he adapted to his apparatus a purifier containing a reagent capable of absorbing phosphuretted hydrogen. Since then there had not been the slightest trace of the fume in the apartment, and the acetylene had lost its alliaceous odour. He thinks that a great deal of carbides contain phosphuret of calcium, which, in contact with water, produced phosphuretted hydrogen. This gas has the property of spontaneous ignition in the air, in giving off a white vapour, and a characteristic odour resembling that of carbide.

Acetylene Gas.—The Explosives Department of the Home Office has recently had under consideration the question of the restrictions to be applied to the manufacture and keeping of acetylene gas, and has conducted various experiments with the object of gaining information on this matter. The results show conclusively that acetylene gas *per se*, when under a pressure of something less than two atmospheres, is violently explosive; whereas at a pressure of less than one and a half atmospheres it appears to be reasonably free from liability to explosion, provided it is not admixed with oxygen or atmospheric air. For commercial and practical purposes it is considered sufficient to allow a pressure of 20in. of water above that of the atmosphere—*i.e.*, roughly about one and one-twentieth atmospheres—and it is accordingly proposed to draw the safety line at this point, and to declare acetylene when subject to a higher pressure to be an "explosive" within the meaning of the Explosives Act, 1875. In France and Germany the authorities have fixed the limit of danger at one and a half and one and one-tenth atmospheres respectively, and have imposed prohibitions or restrictions on the keeping or manufacture of the gas when it is at a higher pressure.

The Engineering Strike.—We are sorry to have to say that the prospects of a settlement seem as far off as ever. Important moves have been made this week which only serve to make the outlook more discouraging. Certain proposals were made to submit the whole matter to arbitration, but after careful deliberation the Employers' Federation refused to countenance them on the ground that such a step would be misconstrued at the present juncture. Twenty-one firms of the Ship Repairers' Association of the River Thames, who have just posted lock-out notices affecting 25 per cent. of the union workmen, say that "ever since conceding the eight hours' day, which in itself has proved most unsatisfactory, further encroachments have been made by the societies, although we had hoped that our concessions had reached finality. We have thus been forced to make a stand to protect the interests of the trade." Such action, backed up by such a statement, gives additional strength to the argument of the Employers' Federation that the granting of the eight hours' day would only be the thin end of the wedge, and, considering the enormous issues involved, it is but natural that the provincial employers should come to the aid of their London brethren in attempting to stamp out the demand at its inception, because experience has taught them that if an inch is given in London an ell will be taken in the country.

A Technical Education Conference.—With a view of extending the usefulness of the Craft School, in Globe-road, E., to the industries of the neighbourhood, the committee are desirous of conferring with workmen and employers in the building and furniture trades as to the kind of technical education required by those trades, and the best way of adapting the teaching given in the school to those needs and of bringing the facilities offered by the classes to the notice of the workmen, apprentices, and learners who might benefit thereby. It is therefore proposed to hold two conferences at the school, the first to be devoted to the needs of the building trades and the second to those of the furniture trades. The first of these meetings will take place on October 13, at 7.30 p.m. Tea and refreshments will be provided before the conference. Among those who have already signified their intention of being present are Mr. Henry Holloway, late chairman of the Central Association of Master Builders; Mr. Alderman H. R. Taylor, L.C.C., Operative Bricklayers' Society; Mr. George Dew, of the Amalgamated Society of Carpenters and Joiners; Mr. W. R. Lethaby, architect, one of the art inspectors of the Technical Education Board of the London County Council; Mr. Geo. Cole, district secretary National Association of Plasterers; and Mr. Paul Weighill, district secretary of the Operative Stonemasons. Names should be sent to Mr. H. E. Swift, the secretary.

The Cost of Producing Chlorine.—The Bombay Corporation in the early part of the year started a plant for electrolysing sea-water for sewage purposes. A report on the cost of working that plant has just been published, which is decidedly unfavourable to the electrolytic process. The report is made by Mr. B. H. Hewell, assistant engineer of the mechanical branch, who advocated the purchase of the installation, and who may therefore be considered impartial, but he remarks incidentally that it is rather too soon to make any strict comparisons, as the cost of starting a new plant is always comparatively heavy, and additional expenditure had to be incurred which is not likely to occur in the second half of the year. The total number of days the plant was at work during May and June was 34, and it may be estimated that, after deducting time for cleaning fires, oiling, etc., 22,000 grammes of chlorine were produced per day, 22,000 grammes × 34 days = 748,000 grammes, or, say, 15cwt. total production, at a cost of about £56 for working expenses. Good commercial chloride of lime, containing from 30 to 35 per cent. of free chlorine, may be purchased in Bombay for about £14 per ton, which would bring the actual cost of chlorine to, say, £42 per ton. The comparative cost is therefore as follows: chlorine produced by electrolyser, cost per ton £75; chlorine obtained from chloride of lime, cost per ton £42. In the above figures we take 1s. 1d. as the equivalent exchange value of the rupee.

Wireless Telegraphy.—Mr. J. Gavey, of the General Post Office, who is in charge of the experiments now being

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made at Dover with wireless telegraphy, delivered an address to the students at the opening meeting of the Upper Holloway Centre of the London Society for the Extension of University Teaching. After relating the discoveries of Faraday, Mr. Gavey recounted the more important discoveries made by Hertz and others, and showed how Signor Marconi was the first to turn those discoveries to practical account, and to invent a system which made it possible to send messages for long distances by means of Hertzian waves. He added that hitherto the system had been in the hands of scientific men only, but it was their object now to so modify it that it could be worked by a non-technical man, and to that end experiments were being made. In a special article the *Daily Chronicle* says that active preparations are now being made by the Post Office engineers for a most important experiment in wireless telegraphy for connecting Sark with Guernsey. The London correspondent of the *Birmingham Daily Post* says that: "Signor Marconi has signed a contract transferring the patent rights for Great Britain and Ireland of his invention for telegraphing without wires to a strong City syndicate, in which the Rothschilds have an interest. The invention will, for the time being, be worked and developed by the syndicate privately, but in order to bring its merits more prominently before the world a series of public demonstrations is to be organised during the winter." This does not tally with the statement made by Signor Marconi in a recent interview that it was not his intention to appeal for public funds, as his family supplied the means necessary for working out his invention.

Electric Apprenticeship.—It is as true of electricity as of anything else that the future of the industry is in the hands of those who are even now receiving instructions in it, and this is a fact which should never be lost sight of. In Boston, U.S.A., the National Brotherhood of Electrical Workers have adopted an apprenticeship system, which they deemed necessary to conserve the public safety and to advance the material well-being of electricians. To start with, a person cannot be admitted to the union as an apprentice unless he has attained the age of 18 years, and is not to be allowed to finish work in any branch of the trade under two years' service, and at the end of that time he is to be examined by an examining board consisting of three members appointed by the president. If he is found competent he will be promoted to the rank of journeyman, and shall not again work for less than journeyman's wages. Only one apprentice is to be allowed to one wireman. Eight hours are to constitute a day's work, with time and a half for all overtime. A first-class man is to be capable of doing all kinds of work appertaining to electrical construction in his class in a workmanlike manner from start to finish. His wages are to be not less than 12s. a day, except when selected to take charge of work as foreman, with three or more men under him, when they must amount to 14s. a day. A second-class man must be able to do work when so directed in a workmanlike manner, and for this he must receive not less than 10s. a day. The great question nowadays is the overcrowding of the professions, and it remains to be seen whether the examination in this system will be stringent enough to allow of the capable men obtaining maximum wages without difficulty.

A Decade of Electric Railway Development.—To a country in its infancy of electric traction, it is very interesting to observe what has been done in a country having longer experience of that method of transportation. Mr. W. J. Clark read a paper before the New York State Street Railway Association at Niagara Falls, in which he gave some instructive figures and a comparative statement of street railways in the United States. In 1888 there were 615 operating companies, and in 1897 that number had increased to 806; at the beginning of the decade the total mileage of street car tracks was 5,993, and at the end of the decade 15,250. The most striking fact, however, which we gather from Mr. Clark's figures is that while electricity has gone ahead by leaps and bounds, horse traction has declined very considerably. In 1888 there were 21 street railway systems operated by electricity, with a total mileage of 86, but by 1898 they had grown to the astonishing number of 698, with a mileage of 13,580. The total mileage of the systems other than electricity was 5,907 in 1888 and 1,670 in 1897. In 1888 the number of systems operated by horses was 566, and it fell to 167 in 1897. The number of cable and steam systems did not show much material alteration, but the cable mileage went from 217 to 515, and the steam from 216 to 145. Roughly speaking, the cable system only just about held its own, while horses and steam dwindled down. The increase in percentage of electric traction to the total is approximately 15,000 per cent., and the street railway mileage of the United States has increased over 156 per cent. during the period given—an increase due almost entirely to electricity, for we notice that the mileage of steam railways only increased 31 per cent.

High-Potential Testing Transformer. — The General Electric Company of New York have developed a 10,000-volt high-potential testing transformer, which consists of a small transformer wound on a rectangular core. The low-tension circuit is wound on one branch of the core, and on the other branch the primary coils are placed. There are four primary coils, each wound and insulated independently, and they are assembled on a sleeve of heavy insulating material. After assembling, each transformer is tested to a maximum strain of 35,000 volts between the high and low potential windings, thus ensuring safety from accident. By means of a porcelain series-multiple connection board, the apparatus can be used on either 52 or 104 volt circuits. The transformer itself is immersed in oil. On the top of the apparatus is a box with a glass window, enclosing a micrometer spark gap arranged as a shunt across the high-potential terminals. This box or cover carries four long contact studs fitting into sockets in the transformer box, and when the cover is lifted for the purpose of adjusting the spark gap it entirely disconnects the spark gap from the high-potential circuit. In using this transformer the spark gap is first set to discharge at the limit of voltage desired, then the apparatus under test is connected to the high-potential terminals on the spark-gap base and the potential again brought up to the amount desired, and held as long as necessary. The apparatus under test being thus connected in multiple with the spark gap, the accidental application of higher voltage than was intended will merely result in the formation of an arc across the spark gap, short-circuiting the apparatus and protecting it from damage. The transformer is designed to run on either 60 or 125 cycle circuits, and to deliver up to 10,000 volts at a normal current of ·05 ampere in the high-potential circuit. This can, however, be exceeded for shorter periods.

Salaries in England.—With the view of keeping our readers informed as to what other people think of the rate of salaries offered in England, we again quote the remarks of a contemporary—this time, *Electricity*, of New York. The editor says: "The smallness, not to say meanness, of the salaries offered in England for men competent to fill positions of responsibility and trust, as disclosed in the advertising columns of our English electrical contemporaries, has been the cause for uncompli-

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mentary remarks on this side of the Atlantic, and should be cause for shame among our British cousins. When we see the munificent salary of £120 (600dol.) offered to a lecturer in physics, and £135 (675dol.) offered for an electrical engineer to take charge of a municipal electric plant, it makes us wonder what inducement the mother holds out to her sons to become educated and useful citizens. Perhaps the reward England holds out to the rising generation is the reward of virtue, which, it is said, is its own reward; but if this be true, she must fold her hands to the inevitable consequences of being distanced by all her competitors in the progress of the arts and sciences. . . . But has she anyone to blame but herself? Instead of offering a premium to skilled mechanics, chemists, physicists, and others who might bolster up her failing powers, she offers them the discourtesy of hod-carriers' wages; and scientific papers, as a rule, have no comment to make." The labourer is always worthy of his hire, and there is no doubt that in England at present there is a tendency towards low salaries—a tendency strengthened by the fact of the supply of engineers being greater than the demand. We are strongly in favour of at least adequate remuneration, for there is no economy so false as that of underpaying officials; but, at the same time, before condemning the whole country as being niggardly it would be as well to enquire a little closer into the facts. *Are* the municipal electrical engineers of our more important towns underpaid? Do we *never* even hear of increases of salary being granted? Electrical engineers are only human after all, and if they had the opportunity of getting larger salaries they would seize it. On the other hand, they seem to be fairly contented with their lot, and changes are not particularly frequent. A town with a few thousand inhabitants cannot naturally pay a large salary, and if a man accepts the position of municipal electrical engineer in such a place at a salary, say, as low as £120, he knows perfectly well what he is doing. Perchance it is the position and the experience he wants more than anything else at that period of his life; but whatever his motive may be, this fact remains, that if competent men were not to be obtained for the salaries offered, the authorities would very soon get tired of wasting their money on incompetent men, and therefore salaries would be higher. There is a vigorous association called the Association of Municipal Electrical Engineers, and if things were quite so bad as we are asked to believe they are, this association would have attempted, and possibly have brought about, an alteration. In conclusion, we must ask our American contemporaries to remember that £120, though only of the face value of 600dol. in England, is equal to a salary of 1,200dol. in America. A man receiving a salary of £300 a year in England would require a salary of £600 to be in the same position in America, the difference being accounted for by the fact that living in America is twice as expensive as it is in England. And it is also well to remember that salaries are graduated according to the size of the towns and the importance of their electricity undertakings.

The Electric Lighting of Zurich.—The annual report of the municipal electricity works of Zürich, which has a population of 22,000, has just been published, and some particulars as to the state of the industry in that town may be interesting for purposes of comparison. At the end of last year the length of the cable conduits was 27¼ miles, an increase of about seven miles on the previous year. The length of tramway cable was about 25 miles, as compared with about 21½ miles at the end of the preceding year. The single secondary cable was 68 miles long, as compared with 48 miles the previous year, while in each of the two years the length of the single arc-light cable was 7½ miles. In 1896 there were three distributing stations, 24 transformer stations, and 17 transformer substations, and four transformer boxes. Two of the transformers were at 30 kw., 43 at 20 kw., and six at 10 kw. There were 85 open crossing boxes, two closed boxes, 539 house-connection boxes, and 686 house connections. There were 728 meters in use, including wattmeters and hour meters of various constructions. While in the previous year the number of customers only increased 25 per cent., last year the increase was 45 per cent. The principal cause of this is to be found in the abolition of a ground tax, which abolition has enabled many more citizens to become customers. The increase of motors shows that the public appreciate their utility, and the increase is all the more marked in consequence of the time being limited during which current is available for them. There are 41 public arc lamps with a total candle-power of 6,300, and 301 private arc lamps with a total candle-power of 41,986. The incandescent lamps number 18,322, consuming 19,167 units of 14 c.p.; the motors number 91, with 2,759 units; and the cooking and heating apparatus installations number 13, with 69 units. The total number of customers is 966. In consequence of the unforeseen increase in the number of customers during the past year, it was found that the four dynamos of 300 h.p. each had always to run at too full a load during the evening hours, which did not leave any reserve. In consequence of that, and of the overloading of several of the transformer stations, the usual high tension between seven and eight o'clock could not be supplied in the central part of the town. Therefore, the engine-house has been enlarged, and three additional dynamos of 3,000 h.p. have been put in. This, of course, provides a much larger reserve than is at present needed, but it has been done in view of the probability of a scheme being carried out to deal with the water power to be derived from works outside the town. During this year several new transformer stations and secondary cables will be added. The greatest amount of power supplied at any time during the past year was 393 amperes at 2,050 volts; the largest amount consumed at one time was 6,400 kilowatt-hours. The normal consumption was 3,600 kilowatt-hours. The increase in the average daily output is largely attributed to the motors, and also to the increased private consumption consequent upon the granting of easier terms. In 1896 the output in kilowatt-hours was 1,246,759. The phase meter gave a coefficient of ·85, so that the cables really carried 1,018,286 kilowatt-hours. Compared with that, the amount supplied to customers stood as follows in kilowatt-hours: Consumed by the yearly customers, 114,908; consumed by those who pay by meter, 497,820; for public lighting, 31,885; consumed in connection with the works, 35,386. That would give a commercial efficiency of 680,000 kilowatt-hours out of 1,246,759, or 54½ per cent. An improvement in the receipts is expected by the newly-introduced arrangement by which the incandescent lamps are changed without charge, but the price per kilowatt-hour has been raised from 7d. to 8d. The following figures give an idea of the cost of working, the percentage being on the 680,000 kw.: water, £7,255, or 2·66d. per cent.; management (including repairs, material, etc.), £1,790, or ·61d. per cent.; two months' renewing incandescent lamps gratis, £63. 10s., or ·02d. per cent.; amortisation of capital, £5,718, or 2·10d. per cent.; rebate allowed to large consumers, £1,212, or ·44d. per cent. The total cost was about £16,040, which works out at about 5·83d. per kilowatt-hour, as against the 8d. now charged to the customers.

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NOTES ON ACCUMULATOR CONSTRUCTION.

BY DESMOND G. FITZ-GERALD.

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III.

What weights of active material, per ampere-hour, are required in or on the peroxide and spongy-lead plates respectively? A general and categorical answer cannot be given to the question, since the weight depends (*a*) upon the chemical and mechanical nature of the active material; (*b*) upon the rate of discharge or density (Δ) of the current in the fluid portion of the circuit; and (*c*) upon the thickness and density of the layer of active material.

Taking the weight of *metallic lead* contained in the active material, the theoretical ampere-hour equivalent of lead, in the case of either element,* is 59·39 grains = 3·847 grammes = ·135oz. avoird. = ·008484lb. avoird. This datum, however, does not help us in practice; for, under any given conditions, only a certain percentage of the spongy lead and of the peroxide of lead constituting the actual active materials is converted into sulphate of lead, or into a compound of sulphate and oxide of lead, in the two elements respectively.

In practice, I have found that from ·52oz. to ·80oz. of spongy lead—according to the rate of discharge and the thickness and density of the deposit—is required on the spongy-lead element to give one ampere-hour. Using E.P.S. cells for tramcar traction, Reckenzaun found that ·58oz. of active lead on the spongy-lead plate would yield one ampere-hour. With respect to the peroxide element, I have found that from ·53oz. to ·86oz. of metallic lead, when converted into peroxide in the usual process of charging, will yield one ampere-hour. The latter weight may be required when contact with the active material is defective. In tramcar traction, Reckenzaun found that ·58oz. of peroxide active material, equivalent to about ·53oz. of lead, would yield one ampere-hour. J. S. Sellon found that ·53oz., and even ·34oz. of electrolytic peroxide, equivalent to ·46oz. and ·285oz. of metallic lead, would yield one ampere-hour. I assume, however, that, in the latter case especially, the cells were run down far below 1·85 volts, to which final E.M.F. my own values correspond.

To find the weight of metallic lead in a given weight of peroxide of lead (PbO_2), multiply by ·867. To find the weight of peroxide of lead corresponding to a given weight of metallic lead, multiply by 1·153. To find the weight of metallic lead in a given weight of oxide of lead (PbO), or litharge, multiply by ·93. To find the weight of oxide of lead corresponding to a given weight of metallic lead, multiply by 1·075. To find the weight of metallic lead in a given weight of red lead (Pb_3O_4), multiply by ·906. To find the weight of red lead corresponding to a given weight of metallic lead, multiply by 1.104.

A rough practical rule, in which any error is generally on the safe side, is to allow ·53oz. avoird. = 15 grammes of metallic lead, in the active material of each element, for every ampere-hour, when the accumulator is to be discharged slowly—say in 8 or 10 hours. But when the period of discharge is only five hours, then the quantity of active material, calculated as metallic lead, on each element may become ·6oz. When the time is only three hours, the active lead may become ·7oz. When the time is but two hours, the weight of active lead in each element will be about ·8oz. Supposing the battery to be capable of discharging in one hour, the weight of active lead in each element per ampere-hour would probably, in practice, reach 1oz.

Like all "rules of thumb," the above is open to destructive criticism; and the latter, *with the answer to it*, might be far more valuable than the rule itself, even to the man—happily not so prevalent as in former days—who prides himself upon being exclusively practical, and says that "an ounce of practice is worth a ton of theory." Let us ourselves apply the "destructive criticism." In the above "rough practical rule" the weight of active material is made to vary, in certain augmenting ratios, inversely as the time of discharge. Now there is an equation for time of discharge (θ) which will be universally admitted, since it is equivalent to the equation time = time. It is the following:

$$\theta = \frac{\text{capacity}}{\text{rate of discharge}} = \frac{\text{ampere-hours}}{\text{amperes}} \quad . \quad (a)$$

It will also (?) be universally admitted that capacity, or ampere-hours, will, *cæteris paribus*, vary simply as the weight of active material. If so, we may write:

$$\theta = \frac{\text{Weight of active material}}{\text{amperes}} \quad . \quad . \quad . \quad (b)$$

an expression which signifies that the weight of active material per *ampere-hour* is a constant. But if so, again, what becomes of our rule according to which the weight of active material varies *inversely* as θ, and is not a constant per ampere-hour?

Let us apply the destructive (and instructive) criticism from another point of view. When we diminish the period of discharge of an accumulator, we ordinarily increase the density of the current in like ratio (?) According to the density of the current is the quantity of hydrogen to be oxidised ($PbO_2 + 2H = PbO + H_2O$) at the surface of the peroxide element. Every ampere-hour of capacity utilised necessitates the oxidation of ·577 grain = 26 cubic inches of H. Taking the very ordinary density of ·05 ampere per square inch, 1·3 cubic inches of H must be oxidised and absorbed per hour per square inch of peroxide surface. We know that this quantity is readily oxidised and absorbed, and, moreover, that the resulting H_2O becomes diffused into the surrounding electrolyte; otherwise there would be an appreciable diminution of E.M.F., and also increase of resistance. Now, if we require a higher rate of discharge, it is (?) no use increasing the weight of active material per square inch of surface. As Prof. Eric Gerard, of the Electrotechnical Institute of Liège, demonstrated to the satisfaction of the International Committee at the Antwerp Exhibition (1885), this weight is already almost invariably in excess. What we have to do is proportionately to increase the extent of active surface instead of the current density. And, if this be done, there is no necessity whatever to increase the weight of active material per square inch of sectional surface; on the contrary, this may often be *reduced* with advantage.

Now what answer can we make to this criticism—with which, for the most part, we are no doubt cordially in agreement? I might say that the rule above given is actually based upon practical trials; but this statement, however satisfactory it might be to the "rule of thumb" man, would be but a weak defence, because it might very plausibly be said, "So much the worse for the practical trials!" But with respect to the former criticism, the readers of the *Electrical Engineer* who have noted what was stated in the first portion of col. 1, p. 363, are in a position to give a much more satisfactory answer. The equation (*a*) given above certainly cannot be brought into question; but it may be pointed out that, for a given accumulator, the *effective* capacity = the *effective* ampere-hours is not a constant value, but one which varies (decreases) very appreciably as rate of discharge = amperes is increased. That is to say, *effective* capacity, although necessarily, in any given case, measured by amperes $\times \theta$, does not vary as this product, but less rapidly than the factor *amperes* and more rapidly than the factor θ. Whereas the real capacity, masked by polarisation when the current supplies hydrogen more rapidly than it can be oxidised at the peroxide surface, is not only measured by the above product in any given case, but varies as this product whatever may be the separate values of amperes and θ.

Thus the equation (*b*) when applied to effective capacity, is actually incorrect. It is certain that θ decreases more rapidly than amperes increase—*i.e.*, that when amperes are increased, the product amperes $\times \theta$, which expresses capacity, diminishes whilst the weight of active material is constant. In this case the weight of active material becomes greater than that corresponding to the diminished capacity. When, on the other hand, amperes are diminished, and Δ is decreased proportionately, the product amperes $\times \theta$ is increased, and the weight of active material becomes less than that corresponding to the increased capacity.

* The electro-chemical equation of the reversible lead couple being $Pb + PbO_2 + 2H_2SO_4 = 2PbSO_4 + 2H_2O$.

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Now observation has shown, and will continue to show, that the peroxide of lead on what is called the positive plate is in the former case less completely, and in the latter case more completely, reduced or deoxidised. In the latter case, there may be scarcely any recuperation of E.M.F.; the oxidant is practically exhausted. In the former case, the partly exhausted peroxide may no longer be an oxidant sufficiently energetic to obviate polarisation with the original current; but it will continue to do so with a reduced current.

Now I think it will be seen, without any further explanation, why a larger quantity of active material per ampere-hour is required when θ is diminished and Δ is proportionately increased. It is simply because we require a more energetic oxidising agent (and, it should be said also, a more oxidisable electro-positive) towards the end of the discharge.

With regard to the latter spell of criticism, it will suffice to point out that the area of active surface in a given weight of accumulator has often to be accepted as a datum value, and that whatever this area may be, we are sometimes called upon to increase the rate of discharge, without greatly diminishing the capacity. Under these conditions, we are forced to have recourse to a means of obtaining the desired result, which, we admit, is, in the abstract, a bad one—viz., that of increasing the rate of discharge by increasing the density of the current and the weight of active material per unit of surface. To increase the rate of discharge without increasing the density of the current or the weight of active material per square inch of the support, it is necessary to augment the surface of the latter at the expense of its thickness. To do this without diminishing the life of the battery, and without incurring fresh difficulties due to the want of conductivity in the plates, is to accomplish the two great desiderata in the construction of light storage batteries, which were referred to in the article on "Storage Batteries for Motor-cars," in the issue of this paper on July 30 last year. And, speaking for myself, it is only quite recently that I have been able to feel as well as to see my way to carry these desiderata into effect.

THE MECHANICAL CONSTRUCTION OF ELECTRICAL MACHINERY.

BY F. M. WEYMOUTH.

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The Dynamo.

(*Continued from page 395.*)

Armatures.—Our remarks on the subject of armatures will refer more particularly to the construction of the core and its attachment to the shaft. As is well known, such a core consists of a series of thin, soft charcoal iron discs, insulated from one another, and held together between end plates so as to form a cylinder the axis of which is normal to the planes of the discs. Cores are divisible in practice into two main classes—namely, those in which the shaft forms a necessary part of the construction, and others in which the core is complete without the shaft, and may be put on or off the latter at will. The thickness of the discs may be anything from between 15 and 20 mils up to 50 mils. A thickness of $\frac{1}{16}$in. (62 mils) has been used successfully in some cases of which the writer has been informed; but in other cases such thickness has been accompanied by undue heating.

An example of construction of the first class above mentioned, is represented in Fig. 292 herewith. There will here be observed a heavy plate, *c c*, at each end, of gunmetal or cast iron, which, with the iron discs *a a* between, are all tightened against the collar *d* on the shaft, by a nut *e*, which engages with threads also on the shaft. The shaft thus here forms part of the construction; and the core cannot be removed therefrom except in detail. This general method, however, with variations, has been, and is much in vogue. The end-plates must be turned all over to ensure their balance. To give them proper strength they need thickening toward the middle. As the inner surfaces are necessarily parallel with the discs, this thickening entails a slope on the outside as shown at *t t*. If the plate has not this slope, but is yet sufficiently strong not to spring under the reactionary outward pressure of the discs when the nut is tightened, there must be great waste of metal towards its periphery. As exhibited at *w w*, the extra thickening pushes the end winding, shown dotted, further away from the core, thereby increasing the total length of the finished armature. It is thus the aim of some makers, more especially perhaps under the pressure of War Office and Admiralty requirements, to find and adopt methods obviating this waste of space at the armature ends, and to get the end winding as close as possible to the core consistent with due regard to insulation. The heavy end-plates, however, seem likely to continue in use in general practice, being simple and effective.

After the nut is finally tightened and locked, a cut is taken off the outer surface of the core in the lathe, for which purpose the discs need ordering with an outside diameter about $\frac{1}{8}$in. larger than finished size. This operation leaves a smooth, bright surface whereon to lay the winding. Some makers have demurred at the slight contact between the discs caused by the rag left in turning. Experience, however, shows that armatures run reasonably cool in spite of this fact. The discs are supplied with the central holes punched to the finished size to fit the shaft.

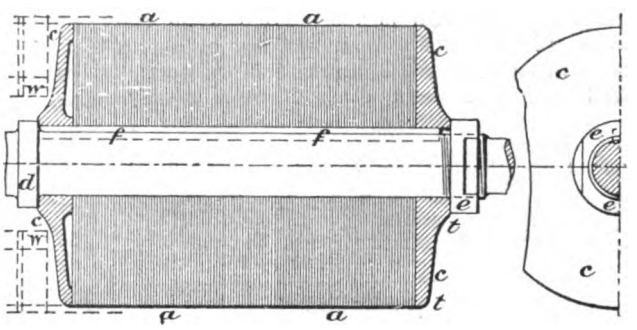

Fig. 292.

Preferably, with ordinary thicknesses, the hole may be slightly too large rather than too small; for in the former eventuality, after being put on the shaft (held vertical) they will individually grip the shaft on all sides, and the core when tightened up will be thoroughly firm: but in the latter case, with the holes too small, they will need easing out with a file or other means, entailing much extra labour. The insulation between the discs has been effected by coating one side of each disc with shellac varnish, either alone or with paper added—this latter being either manilla, brown, cartridge, or tissue paper. Experience has shown that a simple sheet of dry tissue paper without varnish is efficient; while at least one prominent firms puts nothing at all, finding that the black oxide on the surface of the discs provides all necessary resistance, thereby also getting a maximum quantity of iron into the core.

It will be observed that one end-plate is shown lightened out on the inside, which is, of course, optional according to circumstances. The core is driven with the shaft by a feather, *f f*, which engages also with the end-plates. A fine "gas" thread, say, 11 per inch, is used to take the nut: this does not cut deep into the shaft; while at the same time, owing to the smallness of the angle of the thread with the plane normal to the axis of the shaft, it permits of the nut being screwed up extremely tight with more ease than were Whitworth threads employed. The tightness should be such that the blade of a knife cannot be inserted between the discs. It is a poor core that permits this; and a slack build, besides being disadvantageous in offering a smaller sectional area of iron for passage of lines of magnetism than were more discs pressed in, does not afford such extra stiffening to the shaft as would be afforded when the discs are held thoroughly hard together. This latter condition is, of course, especially necessary if any slots, as for driving bars, are going to be cut along the peripheral surface after building. Experience teaches the advisability of locking the nut by a set screw put through it with its point penetrating either the shaft

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or the end-plate, this method being better than the use of a "lock nut," as this latter, under the circumstances, is apparently not always to be relied upon. Such precaution is, of course, especially necessary in the case of motor armatures on tramcars, or under any conditions involving much vibration. The writer has been informed, for instance, that experience gained in running showed the advisability of adding such set screws to all the armature nuts on the locomotives of the City and South London Railway.

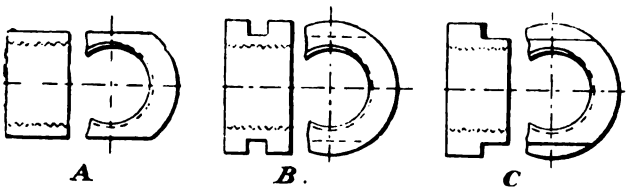

FIG. 293.

Nuts may be hexagonal, or cylindrical with two flats for a spanner. Fig. 293 shows three methods of cutting the flats. The method A, taking off the whole of two opposite sides, weakens the nut considerably. Method B requires a thin spanner, but causes least detriment to the nut. Spanners of ordinary thickness can be used with methods A and C.

In Fig. 294 is illustrated the same general type of armature, but with means of ventilation added. These are constituted chiefly in an increase of bore given to the core so that there is a clearance left between the sides of the bore and the shaft, which clearance is continuous with

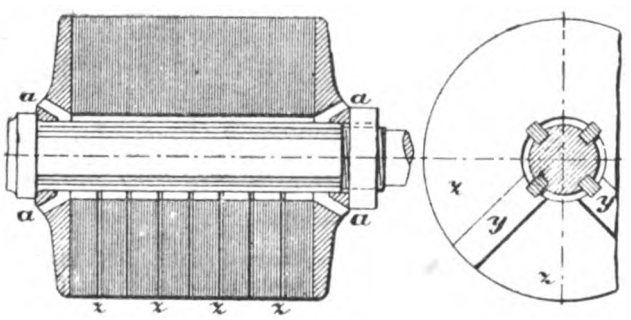

FIG. 294.

passages through the end-plates, as shown *a a*. Gaps, *z z*, in the lower half of the illustration are left along the length of the core allowing exit of air radially from the centre; though in this case gaps must also be left in the peripheral winding. Without these openings air may be caused, no doubt by the fan-like action of the commutator lugs when rotating, to course through from the back end, and be ejected from behind the commutator. The gaps, *z z*, may be arranged by strips of fibre, boxwood, brass, or steel, arranged radially between the discs as shown at *y y*, with their inner ends slotted so as to fit over the feathers. It would seem from experience in practice that ventilation may cause a machine to run 10deg. F. cooler than when not adopted.

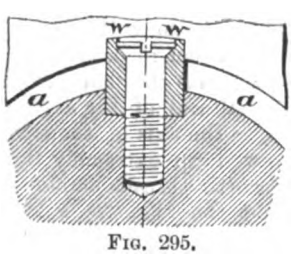

FIG. 295.

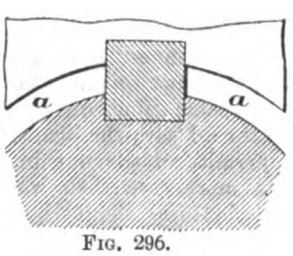

FIG. 296.

Methods of fixing feathers are shown Fig. 295. This point has, of course, additional importance when the feathers, besides driving, also entirely carry the core: for in proportion with the radial depth of the space, *a a*, and the narrowness of the feathers, there will be a tendency for the feathers to tilt out sideways: though this effect is of course scarcely possible with the proportions here illustrated. In Fig. 296 the feather has a square or rectangular section, and is held by simply being knocked tight into the groove in the shaft cut for its reception. These grooves, it may be mentioned, are cut by a square-ended drill, under which the shaft is made to travel slowly to and fro for the length of the feather required. In Fig. 295 the feather is held by screws as an additional safeguard; and also the outer surface of the feather, *w w*, is turned concentric with the shaft, involving the return of the shaft to the lathe after the feathers are fixed. The screws, which may be cheese-headed, or conical headed as shown, are sunk below the surface so that they may not be unscrewed by the tool in the lathe catching them on one side.

An example of an armature having means of ventilation which are different from those above described, is presented herewith in Figs. 297 and 298. This is a design of a two-

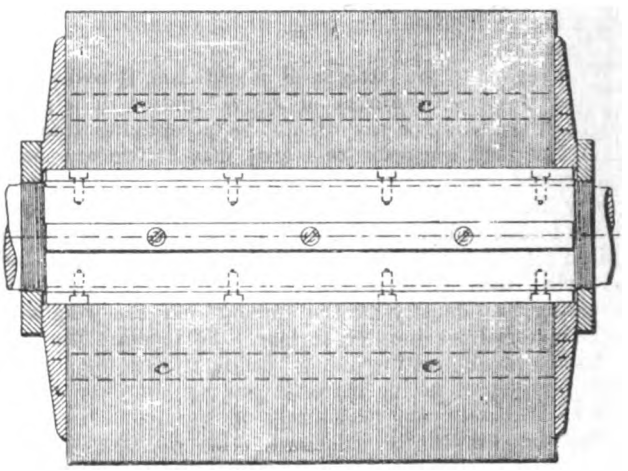

FIG. 297.

pole drum armature core, illustrating the practice of Messrs. The India Rubber, Gutta Percha, and Telegraph Works Company, Limited, of Silvertown; and we have to thank that company very much for the drawings, of which our diagrams are a reproduction. Some similarity will be observed between this and the design indicated in Fig. 294. The core is driven and carried by four feathers held by cheese-headed screws: the soft-iron discs are enclosed between

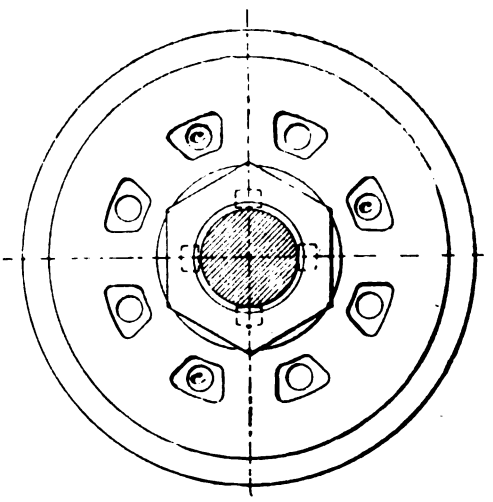

FIG. 298.

gunmetal end-plates, and the whole is held between two hexagonal nuts as shown. Ventilation is effected by apertures, *c c*, running through the core parallel with the shaft, so as to abstract heat as much as possible from its main body instead of from the centre merely. A clearance between the inner edges of the discs and the shaft is more for the purpose of retarding magnetisation of the shaft than for ventilation. The thickness of the discs is 26 B.W.G.—that is, 18 mils.

In the construction of their armature cores this company uses extremely thin discs separated by single sheets of dry tissue paper. The inner edges of the iron discs are gapped to fit the feathers, but this fit is made so tight that the edges against the feather buckles up slightly as the disc is pushed over them. Some half-dozen or a dozen discs being thus put on singly by hand, they are together forced

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down by a press till they are tight against the end-plates or other discs already in place. Caulking chisels are then used, with which the inner edges of the discs in contact with the feathers are struck down in a direction parallel with the shaft hard against the plate or discs below; the shaft for building purposes being placed in a vertical position with the lowermost end-plate on. Great solidity of construction is thus arrived at. When all the discs are in this manner fixed on, and the remaining end-plate is added, this and the discs are forced in the press hard down on to the end-plate below, and the upper nut is then screwed on tight; when the pressure may be removed. The nuts are thus not used for the actual operation of tightening the plates together, but merely maintain them tight after this operation has been performed. To ensure the non-contact of the discs toward the centre, the central holes in tissue paper are made of smaller diameter than the holes through the discs, but larger than the shaft; and the paper thus projects inward toward the shaft from between the discs. Eight lightening holes in each end-plate correspond with the ventilating holes through the core, though it would seem that air currents through these, and their direction, must depend on the arrangement of the end winding, if not effected by the fan-like action of the commutator lugs in the manner to which we have already made allusion.

(To be continued.)

THE CONSTRUCTION AND WORKING OF A TYPICAL TELEPHONE EXCHANGE.

BY J. WRIGHT.

(Concluded from page 431.)

Each operator is likewise provided with a set of 12 trigger switches, 24 cords, and a ringing key, which are fitted in the lower fore part of the switchboard.

The principle of the trigger switches, which are mounted in sets of 12 on an ebonite bar, will be best understood by reference to Fig. 5.

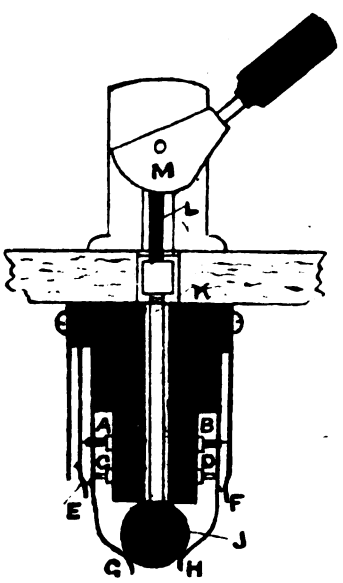

FIG. 5.

A B and C D are four omnibus bars, carrying a corresponding number of contact points for each trigger. They are connected with the ringing key. E and F are two thin springs making contact with A and B, and G H are two similar springs, slightly longer, making contact with C D. J is a cylindrical piece of ebonite carried on the end of a brass plunger, K, in such a position, with regard to the lower curved ends of the springs, G H, that when K is depressed these springs will be forced outwards, and will in consequence break their contact with C D, make contact with the other two springs, E F, and finally cause the latter to break contact with A B. This motion is communicated to the plunger, K, by a small ebonite rod, L, actuated by a cam lever, M, which is the only part of the apparatus exposed.

Next, as to the cords and plugs, there are two of these to each trigger. The plug is shown in Fig. 6, and consists of three metal contacts, A, B, and C, all insulated from one another, the main portion of the plug being protected by a sleeve, D, of insulating fibre. The cord is also three-way, and consists of three tinsel conductors insulated with cotton and braiding, covered by a spiral of brass wire to render them flexible, and braided on the outside with red and white cotton. One end of this cord is bound and screwed into the socket of the plug, the three tinsels being connected by screwed or soldered joints to their respective contacts, A, B, and C. B is known as the "base," and C as the "tip"; these are the chief terminals of the cord, the third, A, being connected to earth through a battery of one or two cells for the engaged test. The opposite end of the cord is finished off by neat binding, the tinsel itself terminating in soldered joints on small "watch-key" tabs, so called from their resemblance to that article in shape.

FIG. 6.

The rear ends of these cords are attached at the back of the board by spring contact fasteners, consisting of a small cylindrical peg and cap, both pierced with holes sufficiently large to admit of the passage of the watch-key tabs. The cylindrical cap contains a spiral spring, and is forced down over the peg until the apertures are in line with one another. The tab is then passed through and held in contact and position by the pressure of the spring.

As mentioned before, the cords are arranged in pairs and are about 5ft. in length so as to admit of ample scope for the operating, the spare length being retained in the body of the switchboard by a running pulley and counter-weight. They are connected respectively to the two pairs of trigger springs, E F and G H (Fig. 5). The ringing keys are similar in construction to the triggers, but are worked by a pair of knobs against the pressure of two spiral springs. The springs corresponding to E and F (Fig. 5) are connected with an automatic magneto generator for ringing. G and H

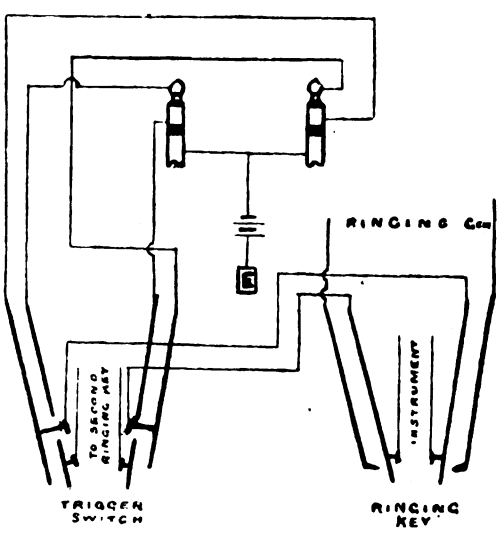

FIG. 7.

are connected with the omnibus bars, A B or C D (Fig. 5), and there is only one pair of omnibus bars to both ringing keys, corresponding to C D (Fig. 5), which is connected with the operator's instrument. It will thus be seen that each key can be used to ring on its own cord independently of the other.

A diagram of the connections between the two plugs, the trigger switch, and the ringing keys is shown in Fig. 7. From this it is evident that on depressing the plunger of the trigger switch by elevating its cam lever, the two cords are insulated from the ringing keys, and in consequence from the operator's instrument, and are simultaneously connected together; any two subscribers therefore whose

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lines have been connected with these cords by inserting the corresponding plugs in their respective jacks will thus be connected through. Again, it will be noticed that when the plunger is released both cords with their respective lines are brought into connection with the ringing key, and in consequence with the operator's instrument, so that she can either speak or ring over one or both lines.

Just below the subscriber's indicators is placed a row of 12 "ring-off" indicators, one to each pair of cords. They consist of a straight cylindrical electromagnet enclosed bodily in a hollow metal cylinder for protection. It has a circular disc armature at the back, and in all other respects is similar to the indicator in Fig. 3. The function of these indicators, as their name implies, is to receive the "ring off," which signifies that the subscriber has finished his conversation. They are connected in bridge across the trigger springs, E F (Fig. 5). In the more recent patterns of triggers used by the company a fifth spring is fitted on the trigger bar, which makes contact with E or F when the plunger is depressed, and insulates when it is released. One side of the ring-off indicator is connected to this spring and the other to the opposite one of the pair, E or F (Fig. 5). The indicator is thus cut out whilst the operator is making the necessary connections, and thrown into circuit again when the subscribers are through.

I shall now proceed to describe the meaning of the term "junctions" which has been previously made use of. A "junction" is a main line between two exchanges by means of which a subscriber on one is put in communication with a subscriber on the other. They may be divided into three classes—viz., "incoming" junctions, "outgoing" junctions, and junctions used both ways.

The first class, or incoming, junctions are those used in putting through incoming calls. If there be only a few junctions of this nature, as in the case of an outlying exchange, they are brought into the exchange in the usual manner, and terminate on a local jack and indicators similar to the type used for the ring off.

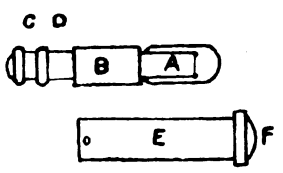

Fig. 8.

From the indicator springs on the local jack a second pair of wires branch off to a trigger switch exactly similar to that described in Fig. 5. The remaining pair of springs on the trigger end in a single cord. The junctions of several small exchanges, to the total number of about 24, are generally arranged with their triggers and cords on one section of the switchboard, and taken by one operator. The action of the trigger is the same as in the previous case: the operator receives a ring on a certain indicator representing one of the junctions; she releases the corresponding trigger, and by so doing connects the junction in question with her instrument through the medium of the omnibus bar and ringing key, which are connected as before. The operator at the distant exchange then asks for the number she requires, which is connected by the plug and cord, the trigger being simultaneously returned to its original condition of depression.

In cases where the distant exchange is a busy one, and there are in consequence a dozen or more junctions, the "speaking line" and "visual signal" system is adopted.

The speaking line is essentially a junction, which at the incoming end is connected directly on to an operator's instrument, who is constantly listening on the line. At the distant exchange it is connected to multiple jacks along the switchboard, and resolves itself into an outgoing junction for that exchange. The junctions are brought into the exchange as before on to a local jack and trigger switches, and are provided with cords, but instead of, as before, being supplied with indicators, they are worked from the speaking line and cleared by means of visual signals.

The latter consist of small three-volt lamps, A (Fig. 8), mounted on a wooden plug base, B, surrounded by two ring terminal contacts, C and D. The lamp is protected by a brass tube, E, and opaque bullseye, F, into the former of which the wooden base of the lamp fits. The whole is slipped bodily into a brass socket with spring contact clips at the back which impinge on the brass collars, C and D, and to which the connecting wires are attached. The lamps are so fitted that only the bullseye is visible to the operator. The lamp is worked by a battery of some half-dozen Obach dry cells or secondary batteries, and its action is governed by the relay shown in Fig. 9.

A (Fig. 9) are the coils of an electromagnet, B is a permanent controlling magnet, and C is the pivoted contact lever of the relay, making connection when active with the contact screw, D.

Fig. 10 is another type without the controlling magnet. This form of relay has a novel arrangement for adjusting the latent position of C. It consists of a thumb-screw, E, on the shank of which is wound a length of thread consisting of but few turns. F is a light spiral spring attached to C at one extremity and to the thread at the other It will readily be seen that the tension of the spring, F, on C can be regulated by a half turn or so of the screw, E.

The local terminals of these relays are connected in circuit with the lamp and battery, whilst the line side is connected to earth and to the fifth spring of the triggers previously mentioned in connection with ring-off indicators.

The indicator springs of the last multiple jack on the

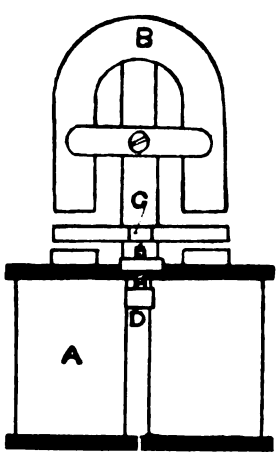

Fig. 9.

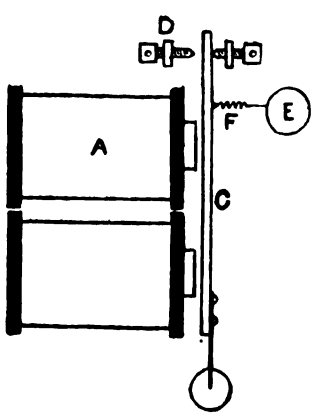

Fig. 10.

distant switchboard, from which originate the incoming junctions in question, are connected to a battery of some half-dozen cells in series, the other side of the battery being earthed. There is therefore a continuous current on the line until a plug is inserted in one of the multiple jacks If, therefore, a trigger plunger be depressed by raising the cam lever, which with visual signals is always kept down when not in use, a circuit will be closed through the line side of the relay, its lever will be attracted, and the lamp will be lit. If, however, a plug be inserted in one of the multiples at the distant exchange the connection with the battery is severed and the light goes out.

In using these junctions, the operator at the distant exchange first plugs in on the speaking line and asks for the number required. The listening operator then plugs the particular number over on a disengaged junction at the same time, putting up the lever of the switch and informing the distant operator the particular junction on which to find her number. On the conclusion of the conversation, the subscribers ring off, and in consequence drop the ring-off indicator at the distant end; the operator at that end then withdraws the plug, and the circuit is established which lights the lamp, thus signalling to the operator in attendance that the line is clear and may be used again. This recent addition has saved considerable time in operating, but is somewhat liable to get out of order owing to the complicated mechanism and circuits.

So much for incoming junctions. The outgoing are, of course, arranged in the same way as the distant ends of the incoming junctions to which they correspond, being multiplied along the board, and provided with an earthed battery circuit.

The junctions used both ways are employed in a few

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cases where the calls only amount to some half-dozen or so in a day. They are brought on to multiple jacks at either end, and the outgoing springs of the last multiple in each case are brought to an indicator.

The ringing generator is, as a rule, automatic. It consists of an Ericcsson multipolar magneto machine with a shuttle armature, and is driven by belt from a small hot-air engine, or, in cases where the electric current is available, by a compact electromotor with a Paccinotti ring armature, the voltage being cut down to give the required speed by a 32-c.p. or 50-c p. lamp placed in series with it. The leads from the generator are brought to a switch, by means of which the leads to the switchboard can be connected directly with them or with a cord and plug for borrowing the ringing from another exchange in case of a breakdown, or with a hand generator.

The night bell is another piece of apparatus which I must not omit to mention. It is an ordinary electric trembling bell and battery, the circuit of which can be closed by numerous contacts throughout the board. These contacts consist of bare tinned wires insulated from the metal work of the indicators, to which one side is attached, but running in a straight line just below the shutters of the indicators. At the back of the shutter is fixed a small, thin tongue of brass, and there is a corresponding projection on the lower part of the shutter, which, when the latter falls, presses the tongue into contact with the bare conductors and so completes the circuit and rings the bell. The latter is governed by a switch, and is only thrown into circuit during a slack time, such as the night hours, when the calls are few and far between.

I have referred several times already to the engaged test, and will now proceed to enlighten the reader on this subject. As already stated, the third contact on the plug—in fact, the whole of the shank, is connected to earth through a battery of one or two cells. When, therefore, a plug is inserted in a certain jack, its metallic bush, E (Fig. 2), will also be connected in the same manner, and, in addition, the bushes of all the corresponding multiple and local jacks throughout the board will be connected to earth through the battery. If now such being the condition of things, a second operator brings the "tip" of a plug belonging to her set into contact with the bushes of any other jacks corresponding to that number, she will experience a click in the receiver of her instrument owing to the passage of the current from the bush through the tip of the plug and half-winding of the receiver coils to earth by way of the fifth point referred to in the description of operators' instruments. This clicking sound is a sign that the required subscriber is already engaged.

For giving the engaged signal or "busy-back," as it is called on the junctions, a contact breaker is employed similar to that of a trembling bell, and with its battery is inserted in the circuit of one side of a translator or transformer, the other side being in the junction circuit; a condenser is also inserted between the contact pillar and spring. When this apparatus is started by the insertion of a junction plug in a specially contrived jack on the switchboard, the buzzing sound caused by the rapid make and break of the circuit is indirectly transmitted to the line as an audible signal.

The operating is easily understood. Each operator takes some 50 subscribers, and on receiving a ring from one of them she inserts a plug in the local jack, releases the corresponding trigger, and give utterance to the well-known "Number, please?" Having ascertained the number required, if it be a "local call"—*i.e.*, another subscriber on the same exchange—she takes up the remaining plug of the pair and makes the engaged test on the nearest multiple of that subscriber. If he be already engaged she replies, "Number engaged; ring again, please." If not, she plugs up with the remaining cord and plug, gives both subscribers a ring and puts up the trigger lever, leaving the two subscribers to converse at leisure. When the conversation is finished the subscribers ring off, and are at once disconnected. In the case of a junction call the operator proceeds as described with the speaking line; should she receive the "busy-back," she rings up the calling subscriber and informs him of the fact.

Occasionally all the junction lines to a certain exchange are in use, and the expression then made use of is "Junction engaged; will ring you."

Occasionally faults make their appearance, and are at once reported, and the lines on which they are supposed to exist are tested both inside and out. If there be a fault it is localised, and if it be a line fault is at once reported to the engineers, who clear it. If it be an instrument fault on the switchboard, it is rectified by the inspectors and staff at the exchange.

As may be readily imagined, a large and efficient staff are at hand to keep things in order and to carry out the routine of work in a systematic manner.

ELECTRICAL DEVELOPMENT IN ENGLAND AND FRANCE COMPARED WITH AMERICAN PRACTICE.

BY J. MCGHIE.

The outcome of a hurried visit to England and France is, perhaps, not so much the acquisition of the idea that both of these countries are hopelessly behind in the race, electrically speaking, with the enlightened sons of Uncle Sam, as the receipt of a very strong impression that they are much farther ahead than we have been led to suppose from the reports of the veracious foreign correspondents of the daily Press. True it is that electricity has by no means become the handmaiden of daily home and business life as it has on this side of the Atlantic, but, freed from the bumble-like restrictions placed upon its adaptation by sundry parliamentary wiseacres in the early eighties, when the industry needed most encouragement, it promises to become as widespread in its use in the United Kingdom as here in the United States. The period through which this country passed some eight years ago, when the boom of electricity in the lighting as well as in the railway branches enveloped every town and hamlet, has for some time dawned in Great Britain and France, and there is plainly evident a marked avidity to acquire as soon as possible a better means of illumination than is afforded by very poor and very poisonous gas, and a better method of transit than the poorer horse and the hearse-like tramcar.

The lack of private initiative, however, which has prevailed during the past few years is strikingly apparent. Under the Governmental restrictions imposed upon it, electricity as a field for investment presented few or no inducements to capital, and where in the United States thousands of dollars were poured out for the purpose of installing stations and spreading the use of the current, it seems to the ordinary observer that in England and France pennies only have been invested, and those with a niggardly hand and suspicious mind. The confidence in the future universal use of electricity which characterised the pioneers on this side seems to have been almost entirely absent from the minds of the men on the other; and that which is here termed European conservatism is simply either a pure lack of appreciation on the part of the English or French, or a determination to do nothing until, by the experience gained in the United States, capital could see its way clear to the assurance of a profitable return. Any lack of appreciation, however, is rapidly giving way before the active propaganda now being carried on. Indeed, it may be said to have already made way for a very lively realisation of the positive benefits to be derived from the use of electricity—a realisation of which certain American companies, with an eye kept vigilantly open for future business in Europe, have already taken advantage.

To glance over the list of projected companies having the utilisation of electricity as a basis for their appeal to the public in England, that country of easy flotations, is calculated to make one believe that the electrical millennium is near at hand. Hardly a city or town, however important, or a little Peddlington, however insignificant, but is desirous of having a station within its limits, and if the public were as sanguine as the promoters there is little doubt that the boom of electricity would assume overwhelming dimensions. It is, perhaps, fortunate that the mysterious *je ne sais quoi* which to the untutored envelopes all things electrical is still unpenetrated by the general public, otherwise England would probably see another panic such as was

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caused by the collapse of the great boom in the early days of railways. In view of this, an immediate widespread extension may not, therefore, be looked for, but instead a healthier, steady, and cautious increase.

It is not until the visitor has left Liverpool, when he lands, that the still chary use of electricity makes itself felt. The first impression gained from a view and a trip over the Liverpool Overhead Railway is that he has dropped among a distinctly electrical people. Here is a road which enjoys the distinction of being the first permanent elevated electric railway in the world, between six and seven miles long, running the entire length of the magnificent estate of the Mersey Docks and Harbour Board, from the Dingle to Seaforth. It is run without hitch or accident, and travelling upon it is a distinct pleasure. The road is phenomenally smooth, and the perfect manner in which the train service is carried on is a delight. Although this road was installed in 1893, and was preceded and followed by important subterranean electric railways in London, it is a strange fact that comparatively slow progress has been made in the adaptation of the electric motor to the street railway systems. It is as though the country had paused for breath after the exertion.

After leaving Liverpool, electrical installations of all kinds become markedly sporadic. Electric lighting is still a luxury to be enjoyed with the pride of possession, or gingerly with the satisfaction that comes of playing with a half understood and dangerous plaything. The pushing little private company, securing with a hurrah and the expenditure of a little palm money a franchise for nothing from a venal or semivenal board of aldermen, is practically unknown. The installation of an electric lighting plant is a matter of grave concern to be approached with a seriousness befitting the case. And here is apparent the extent to which municipal socialism has crept into English city life. A large number of the electric lighting plants concerned with city lighting which have been installed are not private but municipal, owned by the city or town, and operated by the corporation officials. To the American imbued with the knowledge gained from hard experience—that any municipal plant would prove a municipal curse in the hands of the politicians—this ownership and operation of electric lighting plants by the cities themselves is a source of wonder by no means diminished by a visit to the station and an examination of the accounts. It may be the thin end of the socialistic wedge leading to eventual universal State ownership, but so far as England is concerned the apparent results are gratifying. The process by which these are obtained is simple. The decision to acquire or establish a plant by a municipality is followed by the retention of the most talented consulting engineer it can afford—such men as Dr. John Hopkinson and Prof. Kennedy, for example—and the advice of this engineer is followed and not set aside for that of some man with a pull. The estimates are honestly called for and honestly treated, and the result is without exception the purchase of the best available machinery the town can pay for. The deliberation accorded the project, though to us some what slow, receives its compensation in the perfection of the result achieved. The erection of the plant is followed by the engagement of a competent operating engineer, and on his appointment the *rôle* played by "influence" is very minor. It is not a political position to be given away as compensation for value received, and it is held so long as the incumbent behaves himself. There is no dismissal on account of political differences and no retention on account of political services. The same rule applies to all the positions connected with the station. The net result of the injection of a little honesty into these municipal matters is a plant which is the pride of the taxpayer instead of a yawning gulf of expense.

The impression gained from a visit to English or French central stations is essentially agreeable. Instead of a station containing half a dozen different makes of dynamos, some driven by belt and some directly connected, with a switchboard on which all makes of instruments are discernible--a station which has grown up with experience of a costly interest-devouring nature, a concrete history of the development of the art, so frequently found here, the despair of the manager and the haunting *bête noire* of sundry shareholders—one finds a perfect whole, carefully designed and executed with thoroughness. One is not confronted with the "Oh, it'll do" earmarks of expediency. It is usually a consistent installation throughout. Indeed, there are but few stations in America which can compare in finish of detail, symmetry, and general perfection with some of the recent installations which I had the pleasure of seeing in England and France. It should be remembered, however, that both these countries have profited largely by our experience, and perhaps I may be giving them too much credit for avoiding the rocks and shoals which we encountered in our pioneer work. We have the apparatus, but do not seem to dwell largely enough upon the necessity of absolute thoroughness throughout the station. At the stations of Croydon, near London, and Versailles, near Paris, the cleanliness, neatness, and general consistency is noteworthy, and yet in each of these stations apparatus of American make alone is used.

One striking difference between English and American practice lies in the willingness with which the manager of an English station will give another valuable information regarding his experiences with his own plant. Here, our managers, outside the Edison fold, are as silent as carp regarding their methods of management, economies induced, and results achieved. They are "giving away no wrinkles" to the other fellow. He might some day become a competitor. He never does; but silence is golden, and thus much useful knowledge is withheld.

As I said before, electric lighting is still a luxury. This remark applies more strongly to the use of the current in houses and stores. Street-lighting by electricity is becoming very general in both countries, and both London and Paris have now very creditable services. During the past two or three years the incandescent lamp has had an arduous struggle against the mantle gas burner, the application of which did not necessitate the cost of a wiring installation, but it affords me pleasure to say that this light has been found so trying that it is rapidly dwindling in popularity. This assurance has been given me by lighting-station managers who have felt the competition. In France, where the gas companies are more powerful, the mantle gas burner is still a very active competitor. An excellent indication of the increasing use of electricity for lighting purposes lies in the fact that the manufacturers of gas fixtures are now turning out large quantities of fixtures wired for incandescent lamps. Such an increase can only have had one cause—the increased use of the current.

The business in electrical appliances and supplies is healthy in tone, and manufacturers are crowded with orders. English and French appliances are, as a rule, made with a little less utilitarian aspect than are ours. Their snap switches, fuseholders, cut-outs, etc., are not so homely. There exists a desire to render them artistic, and they can thus be used in places where our rosettes, cut-outs, etc., would need boxes to hide them in. American manufacturers of lighting supplies, before entering into competition with English manufacturers, would perhaps do well to study carefully the character of the demand before attempting to press upon the market the appliances which are accepted here. I noticed in many stations that American measuring and indicating instruments, as well as recording watt-meters, were used. To my enquiries I received replies very flattering to the manufacturers.

The most marked advance electrically made during the last two years in England and France is in the railway field. The urgent demand is for an improved method of traction, and both countries are in a position similar to that in which this country found itself in the early nineties. The improved method must be electric. Cable traction is now considered out of date so far as rapid transit is concerned. Compressed-air traction is the laughing stock of all street railway engineers and managers. Compressed air has been played upon the Transatlantic public altogether too often, and mention of the compressed-air car experiments in New York, in the presence of English, French, or German engineers, usually provokes a smile of pity for those furnishing the money for the experiments. They have long ago passed that point in Europe.

Electric traction is therefore the order of the day. The

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success of the trolley roads in Bristol, Birmingham, Dublin, Coventry, Lyons, Marseilles, Havre, and those in Germany is the common incentive to reform elsewhere, and the change is sure to come, and quickly. The municipal authorities of Glasgow and Liverpool have practically decided upon the use of electricity in lieu of horses. And this is not surprising when such competent men as F. S. Pearson, the chief engineer of the Metropolitan Street Railway Company of New York, can embody in their reports such assurances as the following, extracted from the report presented to the municipal committee appointed to examine into the question at Liverpool: "Mr. Pearson, in his report, states that he estimates the cost of operation per car per mile as follows:

	A.	B.
Overhead trolley	3·68 pence	£138,000
Slotted conduit	4·00 pence	150,000
Compressed air	5·02 pence	188,250

A. Cost of operation per car mile. B. Cost of operation per year on the basis of 130,000 car miles per mile of track.

"As compared with these figures, Sir David Radcliffe stated that at the same date the present cost of horse traction is 7·19d. per car mile, and the cost of operation per year £269,625."

The field for electric traction in England and France is large, but it should be borne in mind that in England at least a large number of the tramway companies' charters carry the municipal purchasing clauses, and that committees and not individuals will have to be dealt with. Furthermore, electric railway apparatus cannot be sold upon "wind." Neither Englishmen nor Frenchmen will purchase apparatus on the mere *ipse dixit* of an American manufacturer, and in both countries guarantees have an unpleasant knack of being enforced by the courts. If American apparatus is to make its way in England and France it must emerge successfully from the tests which will be applied to it, and manufacturers must be prepared to find the guarantee severe in its conditions, and it will not be possible easily to buy the cancellation of the guarantee.

One thing more: Americans should realise that they have to live down considerable odium caused by the supersmartness of certain of their compatriots in former days. The English and French have been gulled on many occasions, and to term a device American implies with them a quality of second-rateness extremely galling to the sensitive American. Bearing this in mind, the American manufacturer should be able to sell goods in England. He has no tariff to act as a deterrent, and provided his products are up to the standard success should meet his efforts.—*Western Electrician.*

A TALK WITH LORD KELVIN.

[A correspondent sends us a copy of the *Philadelphia Press* for September 19 containing the report of a conversation with Lord Kelvin. The report is interesting enough to partly reprint, which we do below.—ED. *E. E.*]

He (Lord Kelvin) could not be tempted to speak of his own paper read at that meeting, and it was only indirectly that it was learned that the common feeling there was that it was by all odds the master communication to that assembly containing the ablest scientific authorities of the British Empire. It was learned from a very close and dear friend of Lord Kelvin that the highest of tributes was paid to his own paper, it even being said upon the authority of Prof. Forsyth that it was the only paper that really contained suggestions new in their scope and authority.

Curiously enough, Lord Kelvin, in speaking of the Toronto meeting, not knowing that the supreme tribute to his own paper had been paid by Prof. Forsyth, spoke of Forsyth's address upon pure mathematics as being to him, and, as he thought, to all who heard it, the most interesting, perhaps, of all the papers read.

"It was," said Lord Kelvin, "as you may well imagine, a treatise upon what would commonly be regarded as the most abstruse, dry, technical, and dreary of subjects, excepting for the man of scientific profession. But Prof. Forsyth treated the subject of pure mathematics in such manner as to make it of romantic and fascinating interest even to the person who has no conception of the subject of itself. It was wonderful how he handled this subject so that it seemed not so much the romance of fiction as the romance of fact, and I do not remember to have heard or read any other paper upon that subject which seemed to me as that did to contain both suggestions of importance to the scientist and of real romantic interest to the layman."

Lord Kelvin said that the Toronto meeting had been greatly enjoyed by all of the members of the association who had found it possible to be present. It seemed to him that the success of that meeting might make it all the more easy at some day in the future for the meeting of this association to be held in Australia. "It may not be generally known in the United States that our association is prohibited by its rules from holding its annual meeting in London. That rule has been followed because the desire was to decentralise. We wanted to get away from the centralising influence of London itself. We have held our meetings in the principal cities of Great Britain every year, and we always have a good delegation from London at them. When Montreal invited us to hold our meeting there, there was some feeling that it might not be advisable because so many of the members of the association would be likely to find it impossible to take the trip across the sea. The invitation was accepted with a good deal of hesitation on that account. The meeting, however, was so successful that when we were invited to meet in Toronto there was less opposition than had been expressed when the invitation from Montreal came to us. I am inclined to think that before many years have passed our association will hold its annual meeting in Australia, and the success of our recent meeting in Toronto will be likely to persuade those who otherwise might have been doubtful about the expediency of going to Australia that it might be wise to hold our annual meeting there."

LORD KELVIN AT NIAGARA.

Before the meeting at Toronto, Lord Kelvin was able to spend several days at Niagara. It is an inference that the opportunity to witness and study the colossal electric plant which has been established there tempted this scientist, whose name will be ranked with the immortals, to come to the United States this year.

He had as long ago as 1881 felt free to express the opinion that it was possible to convey the electric current with commercial profit for many miles distant from the place of its development. He had, in fact, felt safe in asserting that it would be possible with a proper voltage and the right kind of copper wire to convey the electric current profitably as far as 300 miles from the place where the current was created. This opinion probably had more to do with the establishment of the great plant at Niagara Falls than any other one influence.

Lord Kelvin gave dimensions of a copper wire capable of carrying the current, and declared that he believed that as much as 40,000 volts might be conveyed over such a wire as he described, so that at a distance of 300 miles from the generation of the electric current that power could be utilised profitably for commercial purposes.

With that high authority influencing the capitalists who were willing to invest their money in the great enterprise at Niagara, it was possible to secure the funds needed for the establishment of that plant. Lord Kelvin had read with much interest the account of the building of the great pit, the establishment of the turbines, and the penstocks which feed them, and had in a general way a good idea of the plant as it had been established at Niagara very largely as a result of his own statements.

But the visible experience which he was able to enjoy in his brief stay at Niagara interested him intensely. He spoke of the success in establishing turbines and dynamos of 5,000 h.p. at that place successfully with all the joy of a great scientist.

ACTION OF THE DYNAMOS.

"It was a great thing to see those turbines capable of developing 5,000 h.p. connected directly with dynamos which transformed the power into an electric current. I went down into the wheel-pit, that cavernous place, and

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watched the movements of the turbines, the greatest, so far as I know, that have ever been established. I was greatly pleased with the manner in which these turbines operated, and I was much impressed with the perfection with which the dynamos had been established. I do not know whether there are any dynamos of larger capacity in the United States, but whether there be or not, I feel safe in saying that there are none which so perfectly perform the work for which they were established. These dynamos were constructed at the Westinghouse Works, and it was a notable achievement to build them so that they were able to transfer the power generated by the turbines without material loss into the electric current. The demonstration has been with entire satisfaction made of the ability to carry the electric current with commercial profit from Niagara to Buffalo. There isn't the slightest doubt of the scientific and commercial success of that test. I may say that I think that at present it may not be commercially advisable to carry the electric current much farther. Scientifically, it is entirely possible, and we cannot say what the future may develop. I have not changed my opinion that with proper apparatus the electric current can be carried as far as 300 miles from the place of its generation and be utilised with commercial success, but with the great water power which seems to exist in convenient places in the United States, it seems unnecessary to carry it that far. Of course, to do that would require an increase of voltage for every mile over which the current is carried."

Lord Kelvin spoke with great earnestness of the possi bility of utilisation of water power for the generation of electric current for commercial purposes, and while he did not say that he believed that this development would be one of the conspicuous features of the immediate future, yet it was a fair inference from what he did say that such was his opinion.

Manufacturing at Niagara.

Lord Kelvin did say that, of course, it was apparent to everyone that it was better, if possible, to establish an industrial plant within the immediate vicinity of the place where the electric current is generated, although for street car, for lighting and similar purposes, that, of course, would be impracticable. He spoke with great interest of the manufacturing industries which had already been established at Niagara—five in all. He seemed especially interested in the factory there, whose product is carborundum, an enterprise that went there for no other reason than because it was possible to obtain cheap power. Their product, which is a combination of carbon and silicum, is excessively hard, and is used for the purpose of making emery wheels.

Another factory of which Lord Kelvin spoke was that which manufactures acetylene, a combination of carbon and calcium. Lord Kelvin did not hesitate to speak of this product as one of the most important of the later energies of this century, and seemed to be of the opinion that it would come into universal use, not only for its illuminating properties, but also for its importance in procuring certain chemical reactions which are of value in commercial manufacture. There was, too, he said, a most interesting factory established there for the making of caustic soda, although this plant is many miles from the rock salt mines which furnish the elemental material for the manufacture of that substance.

"There are then upon the banks of the Niagara five important manufacturing industries, including the great paper mill," said Lord Kelvin. "They come there because they can obtain good power at a low price. The paper mill, it is true, uses water power, although I am inclined to think that corporation may find it to their better advantage to use the electric current. Here we have a great industrial development caused by the installation of power at the banks of the Niagara, and it seems to me that is only the beginning. I am satisfied that we shall see within a few years water power utilised everywhere for purposes similar to that of the Niagara plant. I do not know from personal knowledge, but only from hearsay, that upon the Canadian side of the river a plant is to be established for the creation of the electric current for power, and I was told here in Toronto that work had been begun with a similar end in view in the vicinity of Massena Springs, in New York.

Sewage for Fertilising.

"I saw at Niagara the system adopted there for utilising sewage for fertilising purposes. There has been some misconception entertained by those who have compared that system with that adopted at Shoreditch in England for the utilisation of dust. There is no comparison excepting in the fact that each of these systems utilises what heretofore has been wasted, and therefore practises economy with regard to those things.

"At Niagara the sewage through deodorisation is converted into a valuable fertiliser, but at Shoreditch they take the dust, the sweepings which come from houses, and instead of dumping them into the sea, as used to be the case, they burn them, and it has been demonstrated that 10 tons of this formerly useless stuff is now able to furnish as much heat for the creation of steam power as one ton of coal. That is a great saving. It makes it possible to utilise refuse which has heretofore been valueless and costly to remove for the creation of power which may be used for various domestic and municipal purposes.

"Whether the same results can be obtained elsewhere I do not feel authorised to say. I am satisfied that a good deal of the refuse obtained at Shoreditch contains cinders from the fireplaces of the people there which is almost like coke, and for that reason is valuable for heating purposes. I do feel justified in saying that it is a great step, and one which I hope will be carefully considered by authorities in other places."

Visited Pittsburg.

"We stopped at Pittsburg over a day or two, President Thomson and Mr. Ely still being most kind and considerate in their attention to us. They made it possible for us to visit what, in some respects, were as instructive and entertaining works as I have ever seen. We saw in Pittsburg the three manufactories, all of them, as I understand, under the direction of the Westinghouse interests, which are engaged in the manufacture of gas-engines, electric apparatus, and the air-brake. I was immensely instructed and entertained at these places. I saw the gas-engines there in operation, and I feel justified in saying that I believe this apparatus is going to be of the utmost importance and value in the immediate future, both for the generation of electricity for commercial purposes and for other uses.

"I knew in a general way of other gas-engines on my own side of the water, but I did not know until I saw this manufacture of the extent, the variety, and the value of the purposes to which this machinery can be put. I was very greatly interested in Mr. Westinghouse's narration to me of the manner in which natural gas was developed in Pittsburg. That day when I had the opportunity to go over these great works, will never be forgotten by me. I want to say that I was especially impressed by the arrangements for the construction of manifold varieties of useful appliances of practical electric power transmission."

The great scientist as he spoke of this showed really more enthusiasm, more of the zeal and fire of him whose realm is that of scientific development than he had revealed in speaking of any of his other experiences. Lord Kelvin seems to have been peculiarly impressed with all that he saw in the great yards of the Westinghouse Company. He spoke of the inductive motors there built, and he said that he would be glad if he were able to say in print how greatly he had been impressed by the scientific work of Schallenberger and Scott in electric measuring implements and other development as he had seen that work done there.

Of course, that is extraordinary praise. To have Lord Kelvin impressed by scientific work is to have the Great Master informed, and to compel from him willing recognition of the achievements of others.

Views of the Air-Brake.

Lord Kelvin spoke of the air-brake. It seemed to interest him especially. He said that it had been utilised in Great Britain with the happiest results, and he seemed entirely willing to approve the assertion of one of the greatest of American railway managers, that the air-brake and the steel rail had made the enormous development of the American railway possible.

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Lord Kelvin's day in Pittsburg, if we may judge by what he said about it last evening, will be one of the red-letter days in the memory of a man who has many of such happy recollections. He had already been prepared for a most interesting day by reason of his experience with the majestic dynamos established at Niagara Falls. He said: "It was a great stride when dynamos were established capable of generating 5,000 h.p. It was one of the most momentous of commercial developments. We have had dynamos that had generated perhaps one-half that power, but these sublime machines were built without previous experience, and were adjusted to the turbines also equally wonderful in their creation of immense power with absolute success. These machines were made by the Westinghouse Company, and I could not but feel, as I looked upon them, that they had made it possible to justify my own prediction in 1881."

Incidentally Lord Kelvin was asked if he had paid any attention to the work reported to have been done by Marconi, who is said to have made it possible to transmit signals by means of electric current without the use of wire.

Lord Kelvin said that he knew something of the apparatus and system developed by Marconi, and that it was true that he had been able by this apparatus to send a message or communication or signal for a distance of about nine miles. "But," said Lord Kelvin, "if it is of any interest, you may say that I do not at present believe that Marconi's system is of any practical advantage. It may be possible to send by it a message from shore to a light-house or a ship, but I do not now believe that for general practical commercial purposes the Marconi system will have any special advantage or availability."

Air-Motor Abandoned.

Lord Kelvin was willing to say briefly in reference to the use of compressed air as the motive power, that it had been experimentally tested in Glasgow and been abandoned. It seemed to him that it was a question of location, of local influences, and that no general statement could be made as to the commercial availability of that part at least for the propulsion of street cars. Yet, Lord Kelvin's rather guarded comments about this power suggested that at present at least he has no great faith in its commercial availability as a traction power, and it may be safe to venture the opinion that he has little faith in the commercial practicability or advantage of telegraphing without wires by any apparatus or system which has so far been suggested.

CONTINUATION OF EXPERIMENTS ON CHEMICAL CONSTITUTION AND THE ABSORPTION OF X-RAYS.*

BY J. H. GLADSTONE, D.SC., F.R.S., AND W. HIBBERT.

In the work recorded last year the authors sometimes introduced an aluminium scale into their photographs for the purpose of giving quantitative comparisons of the amount of absorption of X-rays due to various substances. They have now endeavoured to estimate the absorption by means of a Lummer-Brodhun photometer. The aluminium scale, when thus examined, showed that the rays absorbed by different thicknesses varied nearly in a logarithmic ratio.

Determining the absorption of different negative radicles of lithium salts, when the comparison is so made that the amount of substance traversed by the rays is in the proportion of the chemical equivalents, the following was found to be the order:

$$O, C_2O_4, PO_4, NO_3, SO_4, Cl, ClO_3, Br.$$

Experiments made to determine whether an element has the same absorption in the metallic and the combined condition showed that in the case of copper (and perhaps other instances) the metal absorbed more than its oxides.

The change of atomicity of a metal between one series of salts and another does not seem to be followed by any clearly marked difference in absorption.

In the case of carbon, the authors have been told by Sir William Crookes that the absorption of colourless diamond and the black forms of carbon are alike. In their own experiments it would appear that the absorption of carbon, when combined with hydrogen in amyl hydride, turpentine, benzene, naphthalene, and anthracene, differs little from that of charcoal or graphite, notwithstanding the addition of varying proportions of hydrogen, and the different manner of carbon linking. But benzene appears to be about 15 per cent. less absorbent than the others.

* Abstract of a paper read at the British Association meeting at Toronto.

SCREW GAUGE.*

At the meeting in Liverpool in 1896 your committee reported that sufficiently accurate gauges of the British Association screw threads were not generally procurable. They described methods of exactly measuring male threads, and proposed a form of gauge for male threads which they anticipated could be more accurately produced, and more easily verified than the forms in common use.

In continuation of this course they have been in correspondence with some of the principal tool-makers in England and America, with a view to procuring accurate gauges of the different screw threads of the British Association system constructed on the lines indicated in their last report.

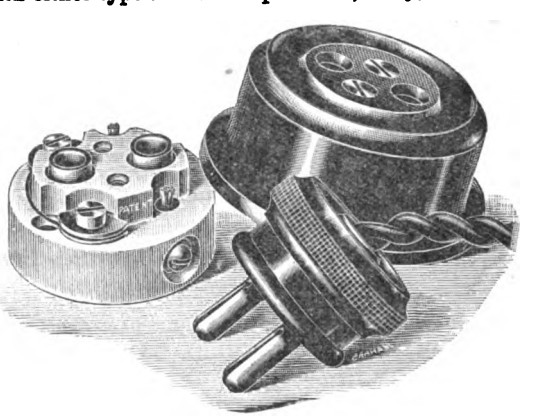
The Pratt and Whitney Company, of Hartford, Connecticut, had already begun to construct tools for these threads when the secretary of the committee wrote to them, and are giving close attention to their accurate production. The company have kindly promised to communicate with the committee as soon as the work is sufficiently advanced to allow them to make proposals for the supply of the gauges, and the committee hope that exact gauges will soon be obtainable from this source.

In the meantime they ask to be reappointed, with a grant of £20, including the £10 granted last year but not drawn.

* Second report of the committee of the British Association, consisting of Mr. W. H. Preece (chairman), Lord Kelvin, Sir F. J. Bramwell, Sir H. Trueman Wood, Major-General Webber, Colonel Watkin, Messrs. Conrad W. Cooke, R. E. Crompton, A. Stroh, A. Le Neve Foster, C. J. Hewitt, G. K. B. Elphinstone, T. Buckney, E. Rigg, and W. A. Price (secretary), appointed to consider means by which practical effect can be given to the introduction of the screw gauge proposed by the association in 1884.

UNIVERSAL WALL SOCKET AND PLUG.

We have received from Mr. A. P. Lundberg a specimen of his improved "Universal" wall socket and plug. He tells us that this pattern has been specially designed for high-voltage requirements. The gauge of the plug is exactly similar to that used by the same maker in his wall connections since 1884, and the sizes of covers have not been increased. The base can be fitted with either type of cover in porcelain, ivory, or hardwood.



The brass parts are well separated from each other, and nothing appears at the back to assist leakage. The fuse connections allow the fuse (which is a long one) to come quite clear of the contact tubes, and out of all danger. That description is borne out by an examination of the socket and plug, and will be shown so far as an examination of an illustration can show in that given herewith. The finish of the work is good, and it is evident Mr. Lundberg has carefully studied the requirements of a socket and plug, and has produced one that ought to be generally approved and have a large usage.

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All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C Anonymous communications will not be noticed.*

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RAINMAKING.

Of late years a good many methods have been tried in order to obtain rain over naturally rainless tracts. The success obtained does not seem to have been very great, but that is no reason why other experiments should not be more successful. If we mistake not, in various parts of America they have tried the effect of explosive shells fired upward into the atmosphere, because of a general idea that battles wherein many cannons have been used have frequently been fought accompanied by much rain. Whatever be the value of explosives in rainmaking, whatever, indeed, be the value of any artificial methods, it is clear that a close and careful examination into the conditions of natural rainfall may help the solution of the problem. Such an examination seems to have been commenced by French engineers, and Lieut.-Colonel Baudoin has formed very clear views upon the subject. These views are contained in a paper on "Modern Engineering," published in the *Bulletin de la Société des Agriculteurs de France*, a portion of which has been translated by Sir J. Thorold, and is published in the current issue of the *Journal* of the Royal Agricultural Society. Lieut.-Colonel Baudoin's views may be summarily expressed. He believes clouds to be formed of bubbles, not drops. The difference between a bubble and a drop is that the former is formed of two concentric vesicles with air in the centre and water between the two, while the latter is a vesicle entirely filled with water. Then the bubble reflects two images of the sun, the drop only one. Baudoin's theory of cloud formation may be given in Sir J. Thorold's words: "Let us see how clouds are formed. Everyone knows that there exists round our globe a current of electricity running from east to west which is called the great earth current. It partially escapes whenever it has a chance to form clouds, drawing water by a form of evaporation peculiar to itself." Further we read: "This is the theory: Every time a portion of the great earth current finds moist points, such as the waves on the sea, or grass wet with dew on the earth, some of it escapes, carrying with it the water in the form of bubbles. Driven by the wind the bubbles come together and form clouds, meeting the air, a very bad conductor. . . These clouds charged with electricity float until they meet wooded mountains, which allow the electricity to return to the earth by their points of vegetable matter. When this return takes place the bubbles burst, the water takes the form of drops, and falls of its own weight to the earth." We must confess this theory is very simple till we begin to ask questions. This great earth current—is it positive or negative? It must be one or the other—at least so it seems to us; but we wonder how it is generated. We wonder, also, how the electricity takes up the bubbles. When considering the theory of the formation of hail, we get more bewilderments. We are told, "Currents of the same direction attract one another, those of an opposite direction repel." Then we have wind varying in direction at varying heights carrying clouds. It is assumed that clouds thus carried act like currents in the same or in opposite directions; if in opposite

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directions, then repulsion takes place, and one cloud goes higher in the atmosphere, getting into a position of greater rarification, where evaporation takes place, the heat necessary for the process being abstracted from the surrounding bubbles, cooling them into ice, and they fall as hail accreting from the clouds below as they fall. The cause of rain is the taking away of electricity from the cloud bubbles. The artificial rainmaker is an apparatus for this purpose. The natural rainmakers are hills, trees, etc.; the artificial ones may be kites, as used by the Chinese, who all use them, but they know not why. Lieut.-Colonel Baudoin says: "During the periods of great heat the plains are without water, and suffer from disastrous droughts. It is most desirable to form a remedy for this, and we are about to indicate it. The absent mountain must be replaced. This is more simple and more easy than might be thought. In a country of great elevation it would be sufficient to fly a large kite to reach the clouds." In fact, the apparatus must be such as to permit of the conduction of electricity from the cloud to the earth, and when the electricity is separated from the bubbles, the bubbles burst, the water takes the form of drops and falls to the earth. As we say, this is an interesting theory, but we do not quite understand how it works. A cloud statically charged may or may not repel another cloud statically charged, but we should not deem this charge a current because the cloud moved its position owing to wind carriage. However, we conclude as we commenced, with the suggestion that a closer examination of how nature acts may lead to something practical in rainmaking if such an apparatus is required.

ONE TO TEN SHILLINGS.

The great interest that was taken in giving information as to the best way to become an electrical engineer in our issue of September 3 leads us to suggest a further effort from our readers. Some twelve months or more ago, during a conversation with Mr. Hamilton Kilgour, the electrical engineer at Cheltenham, he made the remark that there existed a great lack of information about details of electrical station work, and suggested that engineers should give as much information as possible relating to these details. It seems to us that a great deal might be done to increase and multiply this knowledge by a system of question and answer. We have therefore to suggest that our readers will assist us in this matter—first, by asking questions; second, by answering questions. We, on our part, will send one shilling for every question that seems suitable for publication, and ten shillings for the best answer to the question. These questions may relate to any part of central-station work—buildings, equipment, organisation, finance, results, pay, distribution, and so on.

REVIEWS.

Steam-Boilers. By G. HALLIDAY, Whit.Sch. Edward Arnold. Price 7s. 6d.

This is one of the practical science manuals issued under the general editorship of Prof. R. Meldola. It is written by a man who has a double qualification for writing a good text-book. In the first place, his experience of practical work is good, and, in the second place, his teaching experience enables him to avoid those crudities of exposition which so often mar otherwise practical books. The combination has led to the production of the best elementary book on boilers we have seen. Commencing with a brief historical summary, the author proceeds to discuss seriatim, in a succession of chapters, the fundamental principles involved in the production of a good boiler. Heat values are given in British thermal units—that is, the unit is the amount of heat required to raise 1lb. of water 1deg. from the initial temperature, 62deg. F. The theoretic values of heat obtainable by combustion are discussed—thus, 1lb. of carbon burnt to form CO_2 gives 14,500 thermal units, and 1lb. of hydrogen burnt to form H_2O gives 62,032 thermal units. Having discussed the theoretic values, it naturally follows to discuss where the heat goes to, how much can be usefully employed, and how much is lost, but this, of course, necessitates an examination into the quantities of oxygen and of air required for perfect combustion. All these questions are well explained, though in one or two instances definitions are assumed rather than given, and leads to two excellent chapters on the evaporative power of fuel and the circulation of heat. We are glad to see the question of draught so carefully treated. It is a question too often treated merely by rule of thumb, and not scientifically. A superficial examination of this chapter would assist in getting rid of some of the misconceptions continually arising about the useful heat to be obtained from refuse destructors. Too many assume that the waste gases can be cooled down by usage to the temperature of the surrounding atmosphere, and forget that "to ensure the best possible draught through a chimney the temperature of the hot gas in the chimney should be nearly, but not quite, sufficient to melt lead." After these theoretic enquiries we come to the principles underlying the proper construction of boilers, then to questions relating to feed-water heaters, injectors, etc., and finally to technical descriptions of land and marine boilers, including, of course, water-tube boilers and boiler mountings. We must conclude this short notice as we commenced it, by saying that the more we examine the book the better we are pleased with it.

First Principles of Electricity and Magnetism. By C. H. W. BIGGS, Editor of the *Electrical Engineer*. Biggs and Co., 139-140, Salisbury-court, London, E C. 480 pp. Price 3s. 6d.

It is a sufficiently difficult task for anyone to *write* a book upon the elementary principles of this or that branch of knowledge so that it may be understood by the readers who are beginning to make a study of the subject: to *review* a work of this kind does not obviously entail the same labour, but if the author fails in his object there is a vast amount of unpleasantness for the conscientious reviewer in having to wade through a mass of worthless twaddle.

Consequently the present writer of this review determined first of all to experiment upon a real live student as a *corpus vile*, in order to secure a preliminary opinion from one of those for whom the book is mainly intended: and acting upon the youth's opinion he then tackled the book himself as far as opportunity allowed. The student's criticism was concise, if not elegant: "The book is not half bad, and I could understand it nearly all, thanks partly to the cricket and football analogies. Some of it is rather muddly, though; at least, I couldn't quite see what the author is driving at: and the illustrations in the book don't look any better than they ought to."

This provisional report made the writer investigate somewhat more closely the points that were "muddly," but it turned out that most of them were due to a little want of care and perspicacity on the part of the youth rather than the author of the book, and the only stumbling block of importance was the short section dealing with the question of "shunts." So far as that is concerned, the present writer himself confesses to finding it somewhat of an effort to ascertain just exactly what Mr. Biggs intends to convey; he isn't even sure yet whether he knows, and

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in any case the mode of treating the matter may well appear to confuse when we read such sentences (on opposite pages) as the following: "The shunting of a galvanometer always means the reduction of the pressure acting across its terminals." "By the introduction of a shunt across the terminals of the galvanometer we decrease the total resistance of the circuit, and E remaining constant, the current is increased."

Read in connection with the context, it is possible to see what the author has in his mind, but for students who are just beginning to grope their way into the mysteries of circuits, it is very important to express one's self with absolute clearness even at the expense of brevity. Heaven forfend, however, that a mild criticism of this kind should bring on more discussions a mile and a half long upon the nature of shunts in all their variousness. The matter is only mentioned because it seems to be about the only one worth drawing serious attention to from a critical point of point.

Speaking generally, Mr. Biggs's book gives promise of great usefulness: it bears the stamp of strong originality coupled, so far as a somewhat hasty perusal can show, with accuracy and clearness. It is quite a different work from his previous one in the same direction, although some of the good points in the latter are incorporated in the present issue. Among these ought to be mentioned the idea of "looping" lines of force instead of "cutting" them with a circuit. Mr. Biggs amends to some extent the phraseology employed, and speaks of "linking" or "encircling" a coil or lines of force, but this is merely to fall in line with what is, perhaps, now established use. "Cutting" lines of force, with its idea of motion, can hardly be said to apply in the case of a static transformer.

There are, of course, many small points and expressions in the book to which exception might be taken—thus, at the outset, it seems hardly correct to say that the "doing of work stops as soon as the causing acceleration stops," unless the term "acceleration" be considered to include both positive and negative forms. Again, the following sentence is not very well written: "The loss in transformation only means not transformed into the other form wanted." Extreme elegance of diction is, however, in some respects a disadvantage for a book of this kind, which aims, above all things, at simplicity: and, as a matter of fact, the author's "familiar lecture" style is to be commended rather than not. The only danger is that it may sometimes lead to misunderstanding, as in this sentence: "The retardation and the cooling are also the exact equivalent of the acceleration and the heating."

This does not by any means imply that

$$R + C = A + H,$$

although it might perhaps be so understood.

Each chapter is accompanied by a series of useful questions, with numerical answers at the end of the book: and numerous examples fully worked out are interspersed through the book.

Mr. Biggs does not cultivate a professorial dogmatism, but says quite frankly that he is ignorant of what causes such manifestations as those of lines of force (see p. 132), and to take a course like this will inspire much more confidence in the thinking student than an assertive assurance of entirely theoretical suppositions.

His section dealing with the principles and mode of action of electrical measuring instruments is very admirable and complete; the same may also be said essentially of the latter part of the book, in which he treats of magnetic circuits—the principles, etc., of dynamo-electric machinery—and their numerous applications. These pages are all well written from a point of view quite outside the ordinary text-book ideas, and should prove of great benefit and interest to students, whilst even the old stagers may advantageously run through them to get that fresh aspect of familiar matters which sometimes comes when we go back to A B C.

Speaking with absolute impartiality, the writer may conclude this brief notice by saying that if only for its original and refreshing modes of discussing the first principles of electricity and magnetism, Mr. Biggs's work ought to be read by all those who are just beginning their acquaintance with this fascinating branch of knowledge: and it may also be just as highly recommended for an up-to-date accuracy and clearness very seldom, if ever, found in text-books of the same order. There are, of course, misprints and small errors, as in all books, but it is no duty of a reviewer to notice these: and even the faults of diction do not strictly concern him. The present writer intends to show his selfish appreciation of this book by keeping the copy for himself and not handing it over to the student upon whom he experimented: but he feels rather in doubt as to whether this is flattering to the book or not, seeing that the youth might profit by a frequent perusal. A *modus vivendi* amounting to a lengthy loan of his copy to the junior will probably be arranged. L.

The Tutorial Trigonometry. By W. Briggs, M.A., etc., and G. H. Bryan, Sc.D., F.R.S. London: W. B. Clive. Price 3s. 6d.

Of all the branches of mathematical training, we think trigonometry is the most easily understood, and the most directly applicable, and the most interesting to the student. There is not much scope for originality of treatment, but for clearance of definition, for lucidity of arrangement, and for number of exercises carefully graduated, this book would be difficult to surpass. We are glad to see the old-time formulæ, sine $= \frac{\text{perp.}}{\text{hyp}}$., etc., giving way to sine $= \frac{\text{ordinate}}{\text{radius}}$; cosine $= \frac{\text{abscissa}}{\text{radius}}$, etc., in that it introduces thus early the idea of ordinates and abscissæ. The value of a book of this kind depends upon three or four properties: the description or explanatory matter must be clear and terse, the arrangement should be carefully graduated, the examples should be numerous, and also carefully graduated, while the type and illustrations should be easily read and understood. We are not at all certain that the modern method of employing a great variety of type is to be commended. The student has got to understand the whole argument, and not merely a few catch phrases. However, this is unimportant—the real matters are those previously alluded to, and in this book we find great care has been taken to make the explanations clear, and the examples numerous and graduated.

ON THE RELATIONS BETWEEN ARC CURVES AND CRATER RATIOS WITH CORED POSITIVE CARBONS.*

BY MRS. AYRTON.

When an arc is burning between a solid negative carbon and a positive of given diameter, the P.D. between the carbons varies according as the positive carbon is cored or solid.

When the Length of the Arc is Kept Constant.—(1) P.D. is in all cases higher with the solid than with the cored carbon; (2) with a solid carbon the P.D. continually diminishes as the current increases, with a cored carbon the P.D. either diminishes much less than with a solid carbon, or remains constant for all currents above a given value, or actually increases with the current after falling to a minimum.

With a Constant Current.—(1) The P.D. is always higher with solid carbons than with a cored positive carbon, but the difference between the two diminishes as the arc increases in length; (2) the rate of change of P.D. with change of length is constant with solid carbons, but diminishes as the length of the arc increases with a cored positive carbon; (3) this rate of change becomes smaller and more nearly constant for all lengths of arc as the value of the constant current increases; (4) the P.D. corresponding with length of arc 0 diminishes as the current increases with solid carbons, but increases with the current with a cored positive carbon.

These differences can all be accounted for on the hypothesis that with a given solid negative carbon and a positive

* Abstract of paper read before the British Association at Toronto.

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of a given diameter the P.D. required to send a given current through a fixed length of arc depends principally, if not entirely, on the nature of the surface of the crater being greater or less according as the carbon of which this surface is composed is harder or softer. By the term area of the crater is meant the area of the mouth of the crater, or, still more accurately, the plane area of that region of the end of the positive carbon which is sharply cut off from the rest by its peculiar brilliance and whiteness. The area of the soft carbon in the surface of the crater is taken to be the projection on the mouth of the crater of that area of the crater that is composed of soft carbon, and the proportion of soft carbon in the surface of the crater is measured by the ratio of the area of the soft carbon to the total area of the crater. This ratio for each current and length of arc will be called its "soft crater ratio." The ratio of the area of the hard carbon in the surface of the crater to the area of the crater will be called the "hard crater ratio."

Arcs of Constant Length.—The area of the crater is known to increase as the current increases. With a constant length of arc, therefore, when the current is very small the whole of the crater will be in the core; as the current increases some hard carbon will be embraced by the crater, and the P.D. will therefore by the hypothesis be higher than if the whole crater were of soft carbon. The larger the current the greater will be the area of the crater, and consequently the greater will be the amount of hard carbon in its surface; hence by the hypothesis the difference between the actual P.D. and what the P.D. would be if the whole carbon were as soft as the core must increase as the current increases, until in some cases the P.D. with the cored carbon, after reaching a minimum, would actually rise as the current increased, as it is found experimentally to do.

Constant Currents.—It has not hitherto been known how the area of the crater varied with the length of the arc. Hence a very good way of testing the accuracy of my hypothesis suggested itself. The hypothesis was used in conjunction with the curves connecting P.D. with length of arc for constant currents to determine what should be the form of the curves connecting the area of the crater with the length of the arc when the current was constant. If the result were the same as that obtained from the actual measurements of the crater, the presumption would be that the hypothesis was correct. The comparison was made with very satisfactory results, the form of the curves being exactly the same in both cases.

From the hypothesis and the curves connecting P.D. and length of arc for constant currents it was deduced that (1) when a cored positive carbon is used and a constant current is flowing, the area of the crater must increase as the length of the arc increases; (2) the change that takes place in the ratio of the soft carbon to the total amount of carbon in the surface of the crater with a given change of length must diminish as the arc increases in length; (3) the change that takes place in the ratio of the soft carbon to the total amount of carbon in the surface of the crater with a given change of length must be smaller, and the rate of change must become more nearly constant for all lengths of arc as the value of the constant current increases.

Remembering that the ratio of the area of soft carbon to the area of the crater is called the "soft crater ratio," these three conditions may be put thus: (1) with a cored positive carbon, and with a constant current flowing, the area of the crater must increase, and consequently the soft crater ratio must diminish as the length of the arc increases; (2) the change of soft crater ratio with change of length must diminish as the length of the arc increases; (3) the change of soft crater ratio with change of length must be the smaller and the rate of change must become the more nearly constant the larger the current.

To test the accuracy of these conclusions, and, therefore, of the hypothesis upon which they were founded, measurements of the crater made on the enlarged image of the arc in 1893 were used. It was found that straight line laws were obtained in two ways: (1) by plotting the P.D. for each length of arc with the corresponding area of the crater with various constant currents; (2) by plotting the current with the corresponding area of the crater with various constant lengths of arc. From these two sets of straight lines corrected areas of crater were obtained, from which the laws connecting the area of the crater and the soft crater ratio with the length of the arc could be seen more clearly than with the unconnected areas of crater.

These laws were found to be exactly what had been predicted. It was found that with a cored positive and solid negative carbon, and with a constant current flowing, (1) the area of the crater did increase, and consequently the soft crater ratio diminished as the length of the arc increased; (2) the change of soft crater ratio with a given change of length did diminish as the length of the arc increased; and (3) the change of soft crater ratio with a given change of length was smaller, and the rate of change was more nearly constant the larger the current.

From the parallel straight lines connecting the area of the crater with the current for constant lengths of arc three facts were deduced—viz.: (1) that with constant lengths of arc the area of the crater, minus a constant depending on the length of the arc, is proportional to the current; (2) that the change of area of crater with a given change of length of arc is independent of the value of the current flowing; (3) that the change of area of crater with a given change of current is independent of the length of the arc.

ON THE CONSTITUTION OF THE ELECTRIC SPARK.*

BY ARTHUR SCHUSTER, F.R.S.

If a Leyden jar is discharged through metal electrodes and the spectrum of the spark is examined, it is found that the metallic lines are not confined to the immediate neighbourhood of the poles, but are seen sometimes in the centre of the spark, several millimetres away from the electrodes from which they must have been projected with considerable velocity.

It has always seemed to me to be a problem of interest to measure the velocity of projection. A knowledge of it may teach us something concerning the mechanism of electric sparks, and in addition we may hope to obtain information on some important points in spectrum analysis which are at present under discussion. Thus, for instance, if the speed with which a molecule is pushed forward into the centre of the spark depends on molecular weight, it may separate from each other those lines of the spectrum which belong to different molecular combinations.

At various intervals during a number of years I had made unsuccessful attempts to deal with this problem when I became acquainted with the elegant method used by Prof. Dixon in some of his recent experiments, in which a photograph is taken on a film fixed to the rim of a rapidly-revolving wheel. On trial it was found that the molecular speed is sufficiently small to be measured by this method. The experiments were conducted by Mr. Gustav Hemsalech, to whose care and skill their success is largely due. Without entering into a detailed description of the apparatus, it will be sufficient to say that the photographs which I now submit to the section were taken on a film moving with a linear speed of about 80 $\frac{\text{metres}}{\text{second}}$ in a direction at right angles to the slit of the spectroscope. While the air lines appear perfectly straight, though slightly broadened, the metallic lines are inclined and curved. The spark was taken from five Leyden jars charged by means of a Voss machine, the distance between the electrodes being about 1cm. A single spark produces a good spectrum, reaching approximately from $\lambda = 5{,}000$ to $\lambda = 4{,}000$.

One of the photographs in which zinc poles were used shows that the velocity of the molecules is gradually diminishing as they move away from the pole. Close to it the speed seems very great, the average velocity up to a distance of about 1mm. being about 2,000 metres per second. At a distance of 4mm. the speed is reduced to something like 400.

In another experiment one pole was zinc while the other was bismuth. Some bismuth lines are decidedly more curved

* Abstract of paper read before the British Association at Toronto.

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than those of zinc, showing a smaller velocity, so that the line of bismuth which lies at 4,560 seems almost straight.

When the poles are moistened with a solution of calcium chloride interesting results are obtained, the calcium line at 4,226 being more inclined that H or K.

The experiments were made with comparatively rough appliances, but a more perfect apparatus is in course of construction, and the author hopes to continue the research in conjunction with Mr. Hemsalech.

ON A NEW METHOD OF DETERMINING THE SPECIFIC HEAT OF A LIQUID IN TERMS OF THE INTERNATIONAL ELECTRICAL UNITS.*

BY H. L. CALLENDAR, M A., F R.S., PROFESSOR OF PHYSICS, AND H. T. BARNES, M.A.SC., DEMONSTRATOR OF PHYSICS, OF MCGILL UNIVERSITY, MONTREAL.

In view of the probable adoption of the joule or watt-second as the absolute unit of heat, it becomes of special interest at the present time to make direct determinations of the natural thermal units in terms of the electrical standards now universally adopted.

In recent years the specific heat of water has been very carefully determined in this manner by Griffiths, and also by Schuster and Gannon. These observers employed the usual calorimetric method, in which a mass of water is heated through a carefully observed range of temperature by means of a measured quantity of electrical energy. Although their methods differed widely in points of detail, their results agreed to within one part in a thousand with each other. But, as Schuster points out, the result so obtained by the electrical method for the specific heat of water differs by more than one part in 350 from the result obtained by direct mechanical measurements of Joule, Rowland, and Miculescu.

Whatever the cause of this discrepancy, it seemed desirable to repeat the electrical comparison by an entirely different method, to avoid any possible source of constant error which may have remained unsuspected in the calorimetric method as usually practised.

The method which we have adopted consists in passing an electric current through a fine tube, through which a steady current of liquid is flowing. The electrical measurements required are the current and the difference of potential between the ends of the tube. The thermal measurements are the steady difference of temperature and the quantity of liquid flowing in a given time. The electrical measurements are all made on one potentiometer, preferably a Thomson-Varley slide-box, and present no difficulty, as it is easy to keep the current steady to one part in a thousand for an hour or more, and there is no change in the resistance of the circuit. The difference of temperature between the inflowing and outflowing liquid, which is also very nearly constant throughout the duration of the experiment, is measured by means of a differential platinum thermometer. The instruments used for this purpose, consisting of a compensated slide-wire resistance box and pair of thermometers, are the same as were exhibited by Prof. Callendar at the conversazione of the Royal Society in 1893, on which occasion the instruments were used for demonstrating the lowering of the melting point of ice under one atmosphere of pressure. Readings can be taken to the ten-thousandth part of a degree on a rise of temperature of 10deg. The current of liquid is kept steady by means of an automatic electromagnetic device, and the quantity flowing in a given time, the interval being also automatically recorded on an electric chronograph, is determined by weighing.

It will be observed that in this method, as compared with that usually employed, since the temperature distribution is exceedingly steady, it is not necessary to determine the thermal capacity of the calorimetric tube with any degree of accuracy. The rate of external loss of heat is also much more steady and more easily determined, and there is no question of lag of the thermometers. The external loss of heat, which is generally the largest and the most uncertain correction in all calorimetric experiments, can, in the present instance, be made extremely small and regular by the expedient of enclosing the calorimetric tube, etc., in a glass jacket, which is exhausted as perfectly as possible, and then hermetically sealed, so that the vacuum cannot suffer further change. The loss can also be measured and eliminated in a very simple manner. If observations are taken with different values of the electric and liquid currents, the values in each case being adjusted to give the same rise of temperature, it is clear that the temperature distribution, and therefore the external loss of heat, will be very nearly the same. The total loss can be reduced to 2 or 3 per cent. of the heat supply on a rise of temperature of 10deg. C., and the residual differences in any set of observations are but a small fraction of the total loss, and are easily corrected.

We have so far applied the method only to the cases of water and mercury, which present most interest. There is no difficulty, however, in extending the method to the case of other liquids. We have made special arrangements for applying the method to the determination of the variation of the specific heat with temperature, for which purpose it is peculiarly suited, and was, in fact, originally devised. The apparatus may be inspected at the McDonald Physics Building. The essential parts will also be exhibited at the meeting.

* Paper read at the British Association meeting at Toronto.

DOUGLAS.

REPORT OF THE COMMITTEE ON ELECTRIC TRACTION.

(Continued from page 442.)

The accumulators are carried under the seats, and are charged at the depôt, the charge being sufficient for a journey of 12 miles. There is one motor to each car which is capable of working up to 35 h.p. at a speed of 4¾ miles an hour. The power varies constantly according to the speed, gradient of road, and load on car. The average power exerted on a journey in a certain series of experiments was found to be 6·76 h.p., and on a return journey 6·88 h.p. One charge of power is sufficient for 36 miles, or for only six miles according to the condition of the batteries. Probably a double journey—that is, 12 miles—may be taken as a fair average. It is stated that the accumulator cars were considered unsatisfactory. They are very heavy, the weight being stated at nine tons, including accumulators; the vibration rapidly destroys the batteries, and at times the sulphuric acid gives out a disagreeable and objectionable smell. Complaints have been made that the acids have discoloured and destroyed the clothing of passengers, and claims made on account of damage sustained from this cause have been allowed. It is also stated that the acids have a very injurious effect on the cars themselves and destroy the woodwork, the ironwork, and the floors, and in consequence of the fumes from the acids, which discolour the paint, it is very difficult to keep the cars from looking shabby. The accumulator electric system is very far from being a success commercially. The following table contains the latest figures relating to working expenses that have been published:

Company.	Receipts per mile.	Expenses per mile.	Total miles.	Total receipts.	Total expenses.	Balance.
	d.	d.		£	£	£
Birmingham and Aston (steam)	16·95	10·14	334,500	23,621	14 130	9,490
Birmingham and Midland (steam)	16·05	12 73	418,814	28,024	22,226	5,798
Birmingham Central:						
Steam	15·76	9·11	1,273,342	83,699	48,348	35,351
Horse	9·49	8·67	705,059	27,888	25 494	2,394
Cable	11·86	5·43	743,805	36,744	16,830	19,914
Electric	15·70	18 43	138 925	9,093	10,828	Loss

The particulars submitted for the first two companies are for the year ending June 30, 1896; for the Central Company for the year ending June 30, 1895. The figures for the year ending June 30, 1896, are not available, owing to liquidation and sale of the company to a new company—the City of Birmingham Tramway Company. It is believed, however, that the receipts show a substantial increase upon the figures just submitted. It is also to be noted that the horse section includes a number of omnibuses, and, as a matter of fairness, it must be remarked that this company's accounts are not prepared in the same form

as those of the other two companies, some items of expense—such as rent and repairs of Corporation lines, payment for running powers, directors' fees, etc.—not being included in the expenses quoted above. Under these circumstances the figures cannot, therefore, be directly compared with those given for the other companies.

The number of accidents incidental to street traffic coming to the knowledge of the police department for the last two years is as follows :

	1895.		1896.
Steam trams (number of accidents	30	...	29
Electric trams ,, ,, ...	2	...	1
Cable trams ,, ,, ...	6	...	2
Other vehicles ,, ,, ...	387	...	501
Totals	425	...	533

Of the number of accidents in 1895, two fatal accidents are attributed to the steam tramways and 11 to other vehicles. With regard to fatal accidents during 1896, one occurred in connection with the steam trams, and 16 by "other vehicular traffic."

Approximately, the services on the cable route is at intervals of two minutes, and on the electric route at intervals of 15 minutes. On the horse and steam routes the intervals vary from four minutes to nine minutes. The Birmingham deputation do not recommend the accumulator system of electric traction.

In direct contradistinction to the experience of Birmingham with regard to the use of accumulators, it is especially interesting to observe that the directors of the Hanover tramway system have recently published a report, in which they narrate their experience with accumulators as the source of power for propelling their cars. In order to accurately gauge the value of their experiments, the following particulars of the system may not be out of place.

Hanover has a population of about 166,000, and in comparison with the population it has a greater mileage of tramways than any other town on the Continent. The present tramway company bought up the original company about four years ago, when it was paying 1½ per cent., and they are now paying 4 per cent., and their present concession from the Corporation has still an unexpired term extending from 35 to 40 years. There are about 67 miles of track, 33 miles of which are worked by electric traction and 34 miles by horses. The steepest grade is 1 in 18, and the quickest curve has a radius of 28ft. The pressure allowed is 500 volts, but in actual working 550 volts is attained. The company first commenced electric traction on the overhead system between two and three years ago, and so favourable has been their experience that they contemplate working all their systems by electric traction at an early date. The Corporation has hitherto been averse to allowing overhead wires in the central part of the town, where the streets are narrow and busy, and the traffic more or less congested. The company, therefore, nearly two years ago introduced the combined system, whereby the central portion of the route is worked by accumulators, and the other portion by the overhead system. As in Dresden, the accumulators are charged from the trolley wires while the cars are running. The distance now run by accumulators, although only 3¾ miles in the first instance, is now about 5½ miles. On the combined system about 60 cars have been running since May, 1896, fitted both with accumulators and overhead equipment. These cars cost about £850 each. They have no top seats, but are seated for 20 passengers inside and 16 are allowed to stand on the platforms. The accumulators are fixed under the seats ; the older type have 196 cells, but those more recently constructed have 208 cells, and each carries one 15-h.p. motor. The car body and truck weighs 4½ tons ; one 15-h.p. motor weighs 1 1-5th ton additional ; and the accumulators add a dead-weight of other 2½ tons ; bringing up the weight of the empty car, with only one small motor, to eight tons. Controllers of the usual type for regulating the speed of the cars by means of resistances, and for reversing the motion, are provided on the platform at each end, so that the driver can control the car by one handle. According to the experience of those who have travelled on the cars, the smell from the accumulators was quite perceptible, and was very disagreeable, and the speed of travelling from the accumulators did not seem any improvement over that made by horses. The company supplying the accumulators gave a guarantee that the cost of working per car mile would not exceed a given maximum, the tramway company only paying the net cost if less. The fares range from 1·2d. to 3·6d., according to distance. In the power station up till the last year there were three water-tube boilers, and two horizontal compound condensing engines, 250 h.p., each directly coupled to one dynamo running at 135 revolutions per minute. Each dynamo has an output of 400 amperes at 500 volts. The power has recently been doubled by putting down two more sets of the same description. The overhead electric installation and also the motors were supplied by Messrs. Siemens and Halske, Berlin. The poles in use are of the lattice type, strong and substantial, but very heavy in appearance. There are a few centre lattice poles with double bracket arms, with four electric lights hung from scrolls under the arms, over the bridge in Goethe-strasse. These poles are placed from 25 to 40 yards apart, the clear centre way between the two tracks at this point being 6ft. 9in. wide ; on other portions of the same street there are lattice poles with single arms ; at other places span wires fixed to poles on either side of the street, and where there are suitable buildings the span wires are fixed to them with rosettes. Instead of the trolley wheel, Siemens's sliding contact, as in Dresden, has been adopted. When converting to electric traction, new Haarman rails were put down, weighing 90lb. per yard, but 100lb. rails laid on a bed of concrete are now generally adopted. As previously stated, both overhead wires and accumulators have been used for a considerable time, and the managers of the tramway company claim that they are consequently in a favourable position to institute a reliable comparison. Taking everything into account, they pronounce decidedly in favour of the storage cell. The cost of maintenance has been ascertained and determined with great care and the utmost exactitude for the year 1896, and the average comes out at 40 marks per wagon per month, equivalent to 75 groschen per kilometre.

The estimate includes the cost of renewing the plates. Having regard to the expense involved in the maintenance of the overhead line and its accessories and appurtenances, as well as to other circumstances, the managers have come to the conclusion that the additional cost of accumulators does not exceed one groschen, or one-tenth of a penny per mile. Consequently, the managers have decided that the cars on the entire system shall, as soon as the requisite arrangements can be made, be propelled by secondary batteries. In view of the experience and testimony of Birmingham, the decision of the Hanover managers is certainly instructive. The evidence of Hanover, however, notwithstanding, the deputation is of opinion that electric motors supplied with current from portable accumulators placed in the car are in their present form so costly, as well as cumbrous and otherwise objectionable, that they are not to be recommended for adoption.

These observations, however, it must be distinctly understood, are merely intended to apply to the present time only. New systems are constantly being introduced, and many of the existing systems are undergoing rapid development and improvement. Many eminent and thoroughly practical engineers are busily engaged upon the intricate problems with a view to surmounting the difficulties now undoubtedly appurtenant to the system, and which heavily handicap it when placed in competition with other systems, and success may be achieved at no distant date as the result of the persistent enquiry which is being made. It may be, therefore, that before long some new discovery will be made or some new description of battery invented which will be successful in overcoming existing difficulties, but at the present time there is, unfortunately for the accumulator system, nothing of the kind in sight. A perusal of the opinions obtained from professional experts by the deputation during the course of their investigations will conclusively show that the accumulator system in any form is not looked upon with any degree of favour. Prof. Kennedy had the question submitted to him in most precise and unambiguous terms with regard to the accumulator system and his reply is terse and to the point—he does not think that the accumulator system of electric traction has as yet proved itself so successful that he could advise the Council to adopt it practically. He at the same time does not wish to express any doubt that there may not be some form which may prove itself entirely successful, and possibly some of the newer systems which have been lately brought before the public may prove themselves to be the systems of the future, but at present the adoption of any such system would certainly be of the nature of an experiment, and he was therefore not disposed to advise the Council to take the matter up.

The deputations representing the Corporations of Leeds, Glasgow, Sheffield, Birmingham, and Liverpool practically concur in the view entertained by the Douglas deputation with regard to the accumulator system being impracticable.

Accumulators and Overhead Conductors Combined.—With regard to the accumulators or storage batteries and overhead conductors worked in conjunction, as inspected at Dresden, this system, under existing conditions is not at all applicable to the promenades of Douglas. The arguments which have been advanced against the adoption of accumulators are equally pertinent to the combined system, especially as the distance to be traversed—approximately 1¾ miles—is comparatively short. The introduction of accumulators into a system partly worked by overhead wires is only at present commercially practicable upon those lines of tramways where the storage batteries are worked upon the level section of the route. Where the combined system is in operation it is usually adopted so as to allow the accumulator system to connect two outlying districts, the accumulator cars being used in the busier and more central thoroughfares. The question of gradients does not arise

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in connection with the routes along the Douglas promenades, as it does in many towns, the roadway from the Jubilee clock at the foot of Victoria-street, along the Loch Parade, the Harris Promenade, the Central Promenade, the Queen's Promenade, and Strathallan Promenade to Derby Castle Gates being practically level throughout. Indeed, if it is considered desirable or advantageous to adopt the system of accumulators on any part of the system, it would be equally desirable and advantageous to adopt it throughout the whole route, as a combined system of any kind would be quite unnecessary and serve no practical purpose.

Overhead Conductors and Underground Conduit Conductors Combined.—The remarks with regard to the foregoing combined system may also to some extent be applied to the system which embraces overhead conductors and underground conduit conductors worked in combination as inspected at Berlin. The underground conduit system is only used in such cases to connect outlying districts where overhead traction is permitted, and the conduit system is simply adopted in the busier and more central thoroughfares where the authorities will not permit overhead traction. It will be apparent that this joint system is not applicable to the route along the Douglas promenades, and it is consequently unnecessary to labour the question.

Surface Contact, or Closed Underground Conduit. — The deputation has ascertained that there are several descriptions of closed-conduit or surface-contact systems before the public, but beyond an isolated instance or two the systems do not appear to have made any progress beyond the elementary stage. A short length of what is known as the Johnson-Lundell system has been laid down in New York. The Electric-Magnetic Traction Company, through the patentee and the company's Glasgow agent, have exhibited and explained detailed drawings of their system to the Glasgow Corporation, the system having been tried for some months upon a short experimental line in Philadelphia; and the company has submitted a proposal to equip an experimental line in Glasgow, but so far as can be ascertained the system does not appear to have commended itself to the Glasgow Corporation. The Westinghouse Electric Company, Limited, of London, have exhibited a model of their system at the Crystal Palace. The Claret et Vuilleumier system has already been described in connection with the visit of the deputation to Paris. In addition to those named there are also systems known as the "Henry," the "Munsie Coles," the "Pringle," and the "Brain." A short experimental line of the latter system has been laid at the Helsby works of the Telegraph Manufacturing Company in England. Official descriptions of all these systems are available, being in the possession of the town clerk, should the members of the Council desire further information respecting them. The only system witnessed in actual operation by the deputation was the Claret et Vuilleumier, on the line laid down in the Place de la Republique in Paris. The advantages claimed for a closed-conduit system are the absence of overhead wires, with their unsightly and objectionable features, and the absence of the equally objectionable slot in the roadway, whilst some argue that the cost of depreciation is much less than in any other system of electric traction. One of the great disadvantages, and the principal objection against the general adoption of the closed-conduit system, is that the operative mechanism is placed beneath the streets. This reason alone is sufficient to indicate why no adequate progress has been made, and why the systems are looked upon with disfavour and with little hope of practical success attending experiments. Mechanism, when controlled by hand, is not in itself objectionable; but mechanism that is automatic in its action cannot be relied upon with any degree of certainty to perform its duties as and when required. It is generally acknowledged that the numerous devices used by the several inventors of the closed-conduit systems are exceedingly ingenious in their character, but when it is necessary, in order to work the system satisfactorily, to place these devices, more or less complicated, under the surface of the roadway, it is no wonder that considerable hesitation is experienced with regard to recommending or adopting them. The results attending any failure to act might be very serious. The same objection is applicable to all systems embodying the general principle of the closed conduit—viz., should a failure take place in the working of the mechanism, either the car would fail to start, or a dangerous pressure would be placed on the surface of the street. The latter contingency, and the possibility of danger to pedestrian and vehicular traffic, is quite sufficient to justify the deputation in declining to make any recommendation in favour of the adoption of a system which, taking everything into consideration, is but yet in its experimental stage.

Underground Conduit.—The underground conduit system of working consists of a channel constructed below the level of the street, in which the transmitters are placed, and it is generally recognised as the ideal system of electric traction, and, from a purely æsthetic standpoint, the most progressive with regard to improved locomotion will not be inclined to deny the proposition that it is of all systems the system to be greatly desired. With the intention of superseding the overhead wires, a great many conduit systems have from time to time been patented and experimented with more or less, with a view to adoption by municipal authorities or tramway companies, the undermentioned being amongst the most prominent and best known of these systems: the "Holroyd Smith" system, as in operation at Blackpool; the "Siemens and Halske" system, as in operation at Budapest and Berlin; the "Thomson-Houston" system, as in operation in Berlin and Brussels, and Lennox-avenue, New York; the "Love" system, as operated on short experimental lines in Chicago and Washington; the "Douty" system; the "Simplex" system, as inspected on the experimental line at Prescot; the "Petersen" double compartment system; the "Griffin" system; the "Bergwerks and Verein" system; the "Perkins" system; and the "Connett" system. The "Simplex" system has already been fully described, and official descriptions of the other systems have been obtained by the town clerk, and are available should the members of the Council desire to peruse them. Broadly speaking, the general principle is very similar, though details vary very much.

Upon fully considering the information obtained by the deputation, the Council will observe that the sole and certainly great advantage and strong recommendation possessed by the open-conduit system appears to be that the overhead wires and poles are removed. This is undoubtedly an important consideration. In crowded thoroughfares it is obviously an enormous advantage to have all wires underground, provided security and convenience can be fully and satisfactorily obtained. On the other hand, the principal objections which have been advanced from time to time against the conduit system may briefly be summarised as follows: (1) The great and exceptional expense which is involved in construction; (2) the expense involved in maintenance and keeping the system in a thorough state of efficiency; (3) the prolonged interference with the streets during the period occupied in construction and in effecting necessary repairs; (4) the difficulty of speedily locating any defect in the underground part of the system; (5) the difficulty and expense involved in carrying out work relating to the laying of gas and water mains, house drain connections, and main sewerage pipes; (6) the danger and inconvenience to traffic through the presence of a slot in the street, varying in width from 1in. to 2in.; (7) the difficulty of keeping the conduit clean; (8) the interference with the working through dirt, and mud, and road detritus getting into the slot; (9) the liability to stoppage through storms; (10) the great difficulty experienced in maintaining satisfactory insulation.

With regard to the first objection, it is impossible to disguise the fact—a fact which must be patent to all—that the conduit system is most expensive in construction. It may be fairly and legitimately argued that the matter of construction and the cost necessarily entailed thereby is a matter for consideration by the directors of the tramway company as being the parties most directly interested, and not for the Corporation or the ratepayers, who are but indirectly affected, and that consequently the argument as to cost is not applicable. In the first instance, the question of cost is one which more particularly affects the company, seeing that the obligation to provide the necessary capital rests upon the company, but the deputation would point out that the fact is important, as the cost of construction may eventually be a serious and very important matter to the ratepayers, seeing that upon the termination of the concession the undertaking has to be purchased at its "then value," and the capital to be provided to meet the "then value" of an underground conduit system would surely be considerably in excess of that to be provided for the system of overhead wires. It will have been observed that the question of comparative cost is one in relation to which much difference of opinion exists, and definite figures for purposes of reliable comparison have been somewhat difficult to obtain. Indeed, it is nearly impossible to ascertain with any degree of accuracy the cost of constructing the different systems, as the governing conditions vary extensively in each town, and although great care has been taken with a view to obtaining figures from reliable sources, none of the figures obtained are likely to prove an accurate estimate of the cost of carrying out work of a similar character in the Isle of Man, or even England, principally on account of the very different prices paid for labour, and also for materials. In Budapest, for instance, the ordinary wage of a labourer is only about 2d. per hour, and of a rail-layer 3d. or 3½d. The committee of the Birmingham City Council, in reporting upon the matter, pertinently and suggestively remark that there seems to be an effort to magnify the cost of one system and to minimise that of the other. One engineer, who is an undoubted authority on the matter, states that the cost of the conduit is four or five times greater than that of an overhead wire; whilst another engineer of equal reputation and experience says that the difference in cost between a conduit and a well-constructed overhead wire is but small. Both agree, however, that when once constructed one is worked as cheaply as the other so far as cost of electricity, labour, etc., is concerned, but the eminent experts again widely differ as to the cost of maintenance and

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keeping the conduit cleaned out. The Birmingham committee strongly incline to the belief that these differences of opinion as to the cost arise in a large degree from different works being included, and they think rough general statements of this kind can be of but comparatively little value. The comparative capital expenditure of the two companies incurred in setting up installations of each kind can, it is urged, only be compared when proper weight is accorded to the predominating elements of locality, prices, cost of concessions, commissions, patent royalties, nature of contracts, and modes of payment, whether in "cash" or "paper," and many other considerations and sources of expense which may be included in one case and excluded in the other. A fair and reliable comparison can only be made by obtaining the actual cost of the works in the streets belonging to a conduit, and comparing this with the actual cost of an overhead wire with its poles, span wires or brackets, and other necessary apparatus, but omitting all questions of ordinary tramway rails and paving, generating stations and machinery, underground feeders, and other items such as are common to both systems. And again the prices taken in such an estimate should only be such as a corporation or a substantial company could get the work done for by competent contractors who are paid for their work on a cash basis. Taken in other ways, it seems possible to make the difference between the costs of the two systems appear as great or as little as may be desired. It will be remembered that the deputation was informed by Baron von Reibnitz at Dresden, that the cost of constructing the conduit was from £4 to £4. 10s. per yard run, equivalent to approximately £7,000 to £8,000 (erroneously printed £700 to £800 on p. 85 of the descriptive report) per mile, as against £1. 3s. to £1. 12s. for overhead per yard run, equivalent to approximately £2 000 to £2,800 per mile. Where rosettes are allowed the cost was stated to be about 14s. per yard run, equivalent to approximately £1,232 per mile. These amounts, however, it must be particularly observed, only includes the conduits or poles, wires, etc., and nothing whatever is included for the cost of laying down the paving or rails in either case. Again, in Berlin the tramway company state that the cost per mile of overhead traction is about £2,400, as against about £6,450 for underground which does not include any concrete work. From another source the deputation was informed that the cost of overhead line per mile was about £1,600 as against £8,000 per mile for underground. Herr von Siemens, again an undoubted eminent authority, estimates the difference in cost of construction at £4,000 to £5,000 per mile of double line. The Union Company, equally eminent and authoritative, state that the cost of constructing the conduit system is four times greater than the cost attending the overhead system. Mr. Martin, of the firm of Ludwig Loewe and Co., Berlin, stated positively that the conduit system had invariably been found to be four or five times more costly in construction, and was certainly more costly to maintain and keep in a thorough state of efficiency. In Brussels the cost of the overhead line is stated to be £1,400 per mile for the line proper, and £1,150 per mile for the electric apparatus, making £2,550 per mile, or inclusive of engines, cars, etc., but no buildings, £5,410 per mile. The cost of construction of the conduit was given as £19,600 per mile of double line, including everything. The total cost of the overhead installation at Bristol is given as about £50,000. At Prescot the deputation was informed that when the "Simplex" system was once in working order, it was anticipated that the cost would not be more than that entailed by overhead construction. The estimate given was £6,000 per mile of single track. In the report recently issued by the City Council of Liverpool it is stated that the cost per mile for track material, electrical equipment, and labour on the overhead trolley system would be £5,822, and on the slotted system £9,648. According to the official documents issued in relation to the Budapest conduit tramway, the cost is given as £14,750 per mile of single track. It may be stated that the cost of labour is cheaper on the Continent than in England. The consensus of opinion undoubtedly shows that the conduit system costs considerably more to construct than the overhead system, and that consequently from the point of view of economical advantages the underground system does not by any means command the suffrages or recommendation of the deputation.

To be continued.)

ELECTRIC LIGHTING FOR WESTON-SUPER-MARE.

The following is the report of the engineer, Mr. W. C. C. Hawtayne, adopted by the committee of the Weston-super-Mare Urban District Council :

In accordance with instructions, I have gone carefully into the question of the most suitable manner for you to carry out the electric lighting powers conferred upon you by the Board of Trade in the year 1891, and have now the honour to report to you as follows :

Progress of Municipal Electricity Supply.—The whole question as to the advisability of the Council retaining their powers in their own hands and carrying out an electricity supply scheme for Weston-super-Mare at the earliest possible moment has been so ably put before you by your vice-chairman, Mr. Councillor Clark, and so fully appreciated by the Council, that there is no necessity for my touching on this point. I would, however, draw your attention to the way in which companies and syndicates are being formed to acquire powers for electricity supply even in the smallest towns, and as a set-off against this, the almost feverish haste with which municipalities that allowed companies to "take the risk" are now buying out these companies, even at very high figures, and that although in the early days of electric lighting nearly every town was worked by a company, yet at the present time more than 70 per cent. of the total number of provisional orders granted by the Board of Trade are now in the hands of municipal authorities. I have given this matter the fullest possible consideration, and after seeing the requirements and the probable progress of the undertaking at Weston-super-Mare, I am confident that you will do well to at once proceed with the work.

Capacity of the Undertaking and Probable Development.—I understand that when the question of electric lighting was before you some two or three years ago, a canvass of the town resulted in your obtaining promises that about 4,500 lamps of 10 c.p. would be taken up immediately within the "compulsory area," but as several other would-be consumers whose premises lie outside this area have now signified their intention of adopting the light—among others, the proprietor of the Grand Atlantic Hotel, who expects to instal about 300 16-c.p. lamps—I have no doubt that the number that will be taken up within a comparatively short period at Weston-super-Mare will be something like 8,000 of 8 c.p. or 10 c.p., and I do not consider that it would be wise to put down a station to deal with a smaller number than this. I should say, from my experience of other places, that the demand in two or three years' time is likely to be quite double the above amount, so that the station to be put down should be one capable of ready enlargement and the system of mains to be adopted should be one that may easily be added to and extended without the necessity of again disturbing the footways and roadways. I understand that you are naturally desirous of lighting the sea-front by electricity, and it is perhaps scarcely necessary for me to say that a system of electric lighting extended along the full length of your promenade would give an effect second to none in the kingdom, and I think the Council would do well to erect arc lamps along the entire front from Madeira Cove to Severn-road—the termination of the present lighting—or even to the sanatorium, and to adapt the present lamps from Madeira Cove to Anchor Head for incandescent electric lamps, as had been done at Brighton and other places. This would mean the erection of 30 arc lamps, and the adaptation of five small lamps—and in these days, when seaside places are vieing with one another in making their towns as attractive as possible to the public, there is no doubt that this fine display of lighting would prove an enormous attraction. Returning to the question of private lighting ; of the 8,000 lamps estimated to be taken up within a comparatively short period, you may safely reckon that, at the most, not more than 4,000 will ever be alight at one time, and I consider, therefore, that works should be established capable of dealing with this number of lights, plus the whole of the lamps on the promenade, and the lights in the other streets dealt with further on in my report, the mains being made sufficiently large in the first case for double the number of "private" lights.

System to be Adopted.—There are two principal systems on which electricity is now supplied for undertakings of this nature. They are known as (1) the high-tension alternating system ; (2) the low-tension direct-current system. The former is the more suitable for a scattered district, or a district in which the principal load is situated at a considerable distance from the generating station, but the Board of Trade having quite recently given permission to raise the pressure of low-tension supply from 250 volts to 500 volts, it is now possible profitably to employ this system over a far more extended area than was the case two or three years ago. The low-tension direct-current system has so many advantages, among which is that of being able to store electricity during certain portions of the day, for use during other hours or in cases of emergency, and another, its applicability to motive power and for traction purposes, that I consider it best suited for Weston-super-Mare. I have estimated the cost of the necessary works, allowing for a battery of storage cells from which you would be able to supply electricity during the light hours of the day, when the demand would be small, without having to pay for any attendance at the station. This you will see is likely to be of great advantage, especially during the early days of the undertaking.

Refuse Destruction.—Having been asked by the Council to take into consideration the question of the utilisation of house refuse as a means of generating steam to drive the plant at the

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electricity supply station, I have made estimates as to the cost of such a system, and the probable financial result to the Council of its adoption, and I would say at once that as far as the electricity supply works is concerned, there is no doubt that such a means of obtaining steam would be quite satisfactory, but in fairness to the undertaking, and in order to secure accuracy in the annual returns made to the Board of Trade, any expense connected with the refuse destructor over and above the cost of steam raising for electricity supply, should in my opinion be charged to the department responsible for the sanitation of the town, and the combined works should be placed at some central point, for all advantages would be entirely minimised if by combining the electricity supply station with the refuse destructor it became necessary to move the supply station to any considerable distance from the centre of the district. The figures in connection with this part of the scheme are given farther on.

Site.—The selection of the system to be adopted depends a good deal not only on the district to be served, but also the possibility of obtaining a suitable site for the works. I spent several days at Weston-super-Mare looking for such a spot, my object being to get as nearly as possible in the centre of the district, where the principal load is to be expected. The Council will readily understand that the farther one gets away from the centre, the greater is the cost of the mains, and the losses in the mains. I understand that the Great Western Railway Company are prepared to lease a portion of their land, adjoining the cattle market, to the Council for the purposes of this undertaking, at a small annual rental, and further, that they will construct a siding for coal at a small cost, and although the cost of the mains from this place to the compulsory area would be about £1,300 more than from the town yard site with which I deal below, yet, in view of the fact that any future development of the town will take place in this direction, and also that should a destructor be erected it could be placed well back on this site without any possibility of annoyance to the neighbouring householders, I am of opinion that the Council will do well to establish their works here, if a satisfactory agreement can be made with the railway company. There will be a distinct saving in the cost of delivery of materials to the works if this site be adopted, and this will somewhat reduce the estimate of capital expenditure. Owing to its central position, I could not help being struck with the suitability of your present town yard. I find that a great part of the space is at present used for the storage of drain pipes, and other things that might possibly be more closely stored, or even removed to some other site in possession of the town, and again, a space is occupied by a rather crude shed in which the steam-roller stands. I would suggest to the Council that this site is too valuable to be so little used as at present. I consider that an electricity supply station could easily be put here, and probably still allow ample room for stable and other accommodation, and if the negotiations with the railway company should fall through, and no other site can be acquired in the neighbourhood, I would urge the Council to adopt this one. The supply station could equally well be placed at any other point close to the compulsory area without materially affecting the cost of the undertaking, but if it has to be erected close to the statutory hospital or the waterworks—these two being the only other available sites for the combined schemes, so far as I can judge—the extra expenditure on mains will be very heavy, and in my opinion entirely unwarranted, but for your satisfaction I append Scheme 4, which shows the estimated cost of such a combination.

Area to be Lighted.—The compulsory area has already been defined, but in view of the fact that the proprietor of the Grand Atlantic Hotel and others wish to become customers, and also on account of the probability of lighting the sea-front, I would advise carrying the mains through a large extended area. I have estimated for mains running the entire length of Oxford-street and St. James-street, and in order to light the sea-front I propose instead of running a cable along the parade simply for the public lighting, and which would be of no use for any other purpose, to carry the ordinary mains, suitable both for public and private lighting, right along by the line of houses in Beach-road from Severn-road to Regent-street, picking up the lamps from there to the fountain and running on with the main coming from West-street, through Knightstone-road to Birnbeck-road, tapping off at intervals to pick up the lamps along the sea-front, which would be connected alternately in groups, so that any group could be switched on or off if desired, and in case of a breakdown two consecutive lamps would not be out at one time. Such a system of mains is naturally more expensive than one purely for the promenade lighting, but I am convinced that the Council will be wise to provide them at once, as there is very little doubt that they will eventually be required throughout these roads, and when laid they will probably yield a handsome return for the capital expended, and largely increase the earning powers of the station.

Public Lighting in addition to Promenade Lamps.—I find that along the streets traversed by the mains, there are at the present time—

43 small lamps, each costing £3. 3s. 9d. per annum ...	£137	1	3
14 large lamps, each costing £9. 2s. 6d. per annum ...	127	15	0
1 lamp outside post office, costing £4 per annum	4	0	0
	£268	16	3

I propose that all these should be adapted for electric light to the material benefit of the town, both with regard to the higher efficiency and decreased cost of the lighting. Many towns in the kingdom are following the plan of connecting their public lamps wherever mains are laid for general supply. The figures in connection with this are given farther on.

Maximum Load.—The maximum load at the supply station will be: Private lighting—8,000 8-c.p. lamps, of which not more than 4,000 are alight at one time, 120,000 watts. Public lighting: promenade lamps, 15,000 watts; other lamps, 7,000—total, 142,000 watts; say 150,000 watts, or 150 kw.; add for reserve plant 50 kw.—total, 200 kw.; together with a battery of storage cells.

COST OF THE UNDERTAKING.

Scheme 1.—Without destructor.—Site, Town Yard.

Buildings and foundations	£3,000
Generating plant—boilers, steam dynamos, accumulators, switchboard, steam and exhaust pipes, economiser, overhead traveller, etc.	9,900
Private lighting mains and feeders	5,600
Promenade lighting and mains, including adaptation of other lamps	3,300
Legal and expert services and contingencies	1,500
	£23,300

Scheme 2.—Without destructor.—Site, Great Western Railway.

Works as set out in Scheme 1	£23,300
Add for extra mains and feeders	1,300
	£24,600

Scheme 3.—With destructor.—Site, Great Western Railway.

Works as set out in Scheme 2	£24,600
Add for refuse destructor	2,000
	£26 600

Scheme 4.—With destructor.—Site, Statutory Hospital.

Works as set out in Scheme 3	£26,600
Extra for mains and feeders	4,000
	£30 600

Annual Output.—I have assumed that with regard to the hours of burning the public lamps will be supplied as at present, the only alteration being in the amount of light given, which, of course, is far greater under the system suggested. For instance, the 35 large lamps along the promenade are at present of about 60 c.p., reduced during certain hours to 12 c.p. These would be replaced by lamps of about 1,500 c.p., reduced to 30 c.p., and the promenade lamps from Ellenborough-park to Severn-road would also be of about 1,500 c.p., instead of as at present, about 12 c.p. The total number of these arc lamps will be 30. The lamps from Madeira Cove to Anchor Head would be of 25 c.p., as against 12 c.p. In the other streets there would be two or three times as much light as at present. The total annual output for public lighting will be about 24,000 Board of Trade units. Each of the 8,000 "private" lamps first connected to the mains may be estimated to consume 18 Board of Trade units per annum, showing a total consumption of 144,000 Board of Trade units. Add for public lighting as above, 24,000 Board of Trade units. Total annual output, 168,000 Board of Trade units.

Gross Revenue.—By the terms of your provisional order the maximum price that can be charged to the consumer is 8d. per Board of Trade unit, but I would recommend that you should not charge more than (at the rate of) 6d. per Board of Trade unit, now generally reckoned as the equivalent of gas at 3s. per 1,000 cubic feet. At this rate the revenue would be:

8,000 lamps, consuming 18 units at 6d.	£3,600	0	0
Promenade lighting, as per present gas bill	302	16	0
Other public lighting	268	16	3
	£4,171	12	3

This is on the assumption that the Council pay nothing more to the electricity supply works for the enormously improved lighting than they pay at present for gas lighting:

WORKING COSTS.

Scheme 1.—Without destructor.—Site, Town Yard.

Materials—Coal at 6lb. per unit, 450 tons at 12s. 6d.	£281	5	0
Water at 60lb. per unit, 1,008,000 gallons at 6d. per 1,000 gallons	25	4	0
Oil, waste, etc., at one-tenth per unit	70	0	0
Carbons and lamp renewals	36	0	0
	412	9	0
Labour and supervision—engineer and workmen	700	0	0
Rates, taxes, insurance, office expenses, and collection	300	0	0
Repairs and maintenance	615	0	0
Say, £2,030.	£2,027	9	0

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Scheme 2.—Without destructor.—Site, Great Western Railway.—Practically the same as above, the saving in coal cartage balancing the "repairs and maintenance" on £1,300 extra of mains.

Scheme 3.—With destructor.—Site, Great Western Railway.

Materials—coal to deal with periods of heavy load, £80; other materials as in Schemes 1 and 2, £131. 4s.	£211	4	0
Labour and supervision, as in Schemes 1 and 2, £700; add extra labour handling refuse, £130	830	0	0
Rates, taxes, etc., as above	300	0	0
Repairs and maintenance, as above, £615; add 5 per cent. on £2,000 spent on destructor, £100	715	0	0
Say, £2,060.	£2,056	4	0

Scheme 4.—With destructor.—Site Statutory Hospital.

Working costs as in Scheme 3	£2 060	0	0
Maintenance on £4,000 extra mains	60	0	0
Add for extra coal cartage	10	0	0
	£2,130	0	0

PROFIT AND LOSS ACCOUNT.

Scheme 1.—Without destructor.—Site, Town Yard.

Gross revenue	£4,170	0	0
Works costs	2,030	0	0
Gross profit	£2,140	0	0
Repayment of capital and interest at 5¼ per cent. on £23,300	1,222	10	0
Profit available for reduction of rates or other purposes	£917	10	0

Scheme 2.—Without destructor.—Site, Great Western Railway.

Gross revenue	£4,170	0	0
Works costs	2,030	0	0
Gross profit	£2,140	0	0
Repayment of capital and interest at 5¼ per cent. on £24,600	1,291	10	0
Profit available for reduction of rates or other purposes	£848	10	0

Scheme 3.—With destructor.—Site, Great Western Railway.

Gross revenue	£4,170	0	0
Works costs	2,060	0	0
Gross profit	£2,110	0	0
Repayment of capital and interest—5¼ per cent. on £24,600, £1,291. 10s.; 8 per cent. on £2,000 for destructor borrowed for 15 years, £160	1,451	10	0
Profit available for reduction of rates or other purposes	£658	10	0

Scheme 4.—With destructor.—Site, Statutory Hospital.

Gross revenue	£4,170	0	0
Works costs	2,130	0	0
Gross profit	£2,040	0	0
Repayment of capital and interest as above, £1,451. 10s.; repayment of £4,000 extra of mains at 5¼ per cent., £210	1,661	0	0
Profit available for reduction of rates or other purposes	£379	0	0

Refuse Destructor.—Returning again to the subject of refuse destruction, this method of getting rid of town refuse has been in operation for many years, and its advantages, from a sanitary point of view, cannot be overestimated. The addition of such a system to the electricity supply works will naturally increase the cost of such works, and the amount to be set aside annually for "redemption." From the figures given above, the Council will see that with or without a destructor the undertaking is financially sound, and it will be for them to decide whether they will sacrifice a portion of the profit on the electricity supply works for the satisfaction of being able to dispose of their house refuse in a perfectly sanitary way. For my own part, I have no doubt that such a scheme would be of great advantage to Weston-super-Mare, and although it will naturally cost more than the present system of disposing of the town refuse, yet at the same time a certain amount will be saved in cartage if the Great Western Railway site is adopted, and so the increase will not be very great. If the Council approve the erection of a destructor, but consider it undesirable to erect it on the G.W.R. site—or should the railway company offer objection to the scheme—then in order to get full value out of the refuse one of the two following alternatives must, to my mind, be adopted: either (1) a combined destructor and electricity supply works must be placed at the statutory hospital or at the waterworks; or (2) the destructor, when required, must be erected not in combination with the electricity supply works at all, but in combination with the waterworks as a means of generating steam for pumping purposes, care being taken that the refuse tip is well isolated from the water by such easy means as may be suggested by your surveyor. In fact, I am of opinion that the latter alternative would prove very satisfactory. The demand at the waterworks being uniform and the plant not subject to the sudden fluctuations of load which obtain in a lighting station, and your surveyor will probably confirm my opinion that the cost of coal and cartage, which at the present time must be a considerable expense to the waterworks, will be saved if the waste heat from a destructor is utilised.

Conclusion.—In framing the above report and drawing up the estimates for construction, working, etc., I have been largely guided by the ascertained results of other similar undertakings, and have under-estimated rather than over-estimated the profitable nature of the business. I have dealt entirely with the supply of electricity for "lighting," and have said nothing about its many other possible applications. I understand that there is a proposal on foot to establish tramways at Weston-super-Mare, and I have no doubt that the tramway company would be prepared to negotiate with the Council for running their trams by means of electricity. There is nothing novel in such a scheme: it is what is being done by nearly every traction and lighting undertaking in the kingdom, and the type of machinery I have estimated for is not only suitable, but the most suitable for such a purpose, and by its employment the supply works would make a large additional profit during those hours of the day when, under ordinary circumstances, they would not be earning much. Cooking and heating by means of electricity are stepping hard on the heels of other methods, and the Council will bear in mind that additional sources of profit might well be obtained by the supply of electricity for these and other purposes. From the figures given above I think the Council will see that were the undertaking once started and in full working order, a substantial profit would undoubtedly be realised, and I would advise them to at once invite tenders for the work, and at the same time to make application to the Local Government Board for powers to borrow the necessary capital, as in order to secure the station being at work by the end of next summer, when the winter load is beginning to come on, it will be necessary to proceed with as little delay as possible. I think also that a start should be made this year in order to show the Board of Trade that the Council are in earnest over the matter, and that the Board of Trade need not entertain the proposals of any company or syndicate seeking to establish works in the town.

ST. PANCRAS VESTRY.

We give herewith the interim revenue account and balance-sheet of the working of the St. Pancras electric lighting undertaking for the six months ending June, 30, 1897. The report accompanying these accounts was given in our last issue:

INTERIM REVENUE ACCOUNT.

Dr. To Generation of Electricity.				£	s.	d
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on works	£2,544	3	10			
Oil, waste, water, and engine-room stores	329	2	5			
Wages at generating stations	1,325	16	10			
Sundry petty expenses	41	19	7			
Repairs and maintenance, as follows: buildings, £129. 5s. 6d.; engines, boilers, etc., £431. 16s. 7d.; dynamos, exciters, accumulators, etc., £144. 12s. 3d.; other machinery, instruments, and tools, £82. 15s. 11d.	788	10	3			
				5,029	12	11
To Distribution of Electricity.						
Wages and other remuneration to linesmen, fitters, labourers	262	17	4			
Repairs, maintenance, and renewals of mains of all classes, including materials and labour	1,508	15	5			
Repairs, maintenance, and renewals of meters, switches, fuses, and other apparatus on consumers' premises	167	3	1			
Water, etc., at sub-stations	6	3	4			
				1,944	19	2
To Public Lamps.						
Carbons	41	7	9			
Attending	168	14	9			
Repairs	36	14	2			
				246	16	8
To Royalties, etc.						
Licenses for mains laid on Crown property, etc.				10	13	6

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To Rents, Rates, and Taxes.			
Rents payable	55 1 2		
Rates and taxes	207 7 3		
		262 8 5	
To Management Expenses.			
Salaries—viz., engineer's department and clerical staff	871 18 10		
Stationery and printing	175 1 10		
General establishment charges	148 6 11		
		1,195 7 7	
To Law and Parliamentary Charges.			
Law expenses		6 18 8	
To Special Charges.			
Insurances, etc.	65 1 0		
Expenses, fixing meters, etc., on consumers' premises	15 1 4		
Expenses obtaining loans	50 2 0		
Amount disallowed by London County Council in connection with the opening Regent's Park station	136 15 0		
		266 19 4	
Total expenditure		8,963 16 3	
Balance carried to net revenue account		5,356 18 7	
		£14,320 14 10	
Cr.		£ s. d.	
Sale of current per B.T.U. per meter at 6d., £10,284. 19s. 6d.; ditto at 5d., £374. 9s. 7d.; ditto at 3d., £1,793. 12s. 6d.		12,453 1 7	
Public lighting		1,744 15 0	
Work done on consumers' premises		6 10 0	
Sale of reports, etc.		0 13 0	
Fees for testing installations		4 0 0	
Rents receivable		11 15 3	
Proportion (estimated) of office expenses chargeable to the lighting (gas) department		100 0 0	
		£14,320 14 10	

GENERAL BALANCE-SHEET.

Liabilities.	£ s. d.
Capital account—Amount received per loans	162,485 0 0
On loan from bankers	35,136 17 4
Sundry creditors	4,527 6 6
Interest accrued on loans	1,617 2 11
Net revenue account	499 14 5
	£204,266 1 2
Assets.	£ s. d.
Capital account—amount expended for work	191,314 1 6
Stores in hand at June 30, 1897—coal, £137. 15s. 9d.; oils, waste, etc., £106. 17s. 2d.; general, £4,943. 13s. 5d.	5,188 6 4
Sundry debtors for current supplied to June 30, 1897, £6,927. 19s. 9d.; less deposits, £120	6,807 19 9
Cash in hand	70 17 10
Repayment of instalment in advance—Regent's Park account	728 11 6
King's-road account	156 4 3
	£204,266 1 2

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Azuaga (Spain).—Tenders are required by November 3 for the lighting of the town; the system to consist of 250 lamps of 10 c.p. The estimate amounts to £264 per annum.

Russia.—The Municipal Authorities of Novorossisk, South Russia, are inviting tenders for the concession for the construction and working of an electric tramway, and for the electric lighting of the town. Tenders by November 1.

Ploesti (Roumania).—Tenders are invited for lease of lighting the town by electricity for a period of 40 years, also for power transmission purposes. Particulars may be obtained on application to the Municipal Authorities at Ploesti. Tenders by Nov. 27.

Southampton.—The Corporation invite tenders for the supply and erection of various engines, alternators, motor-alternator, rectifiers, high-tension switchboards, continuous-current generators, balancing and volt-raising transformers, low-tension switchboards, and a battery of accumulators and accessories, particulars of which appear in our advertising columns. Tenders by October 18.

Sydney (New South Wales).—Tenders are required by October 18, at noon, at the General Post Office, for supplies to the Telegraph, Telephone, and Post Office Departments, including iron, copper, and insulated wire, insulators, nails, screws, nuts, bolts, electric batteries with all accessories and chemicals, diaphragms, arc lamps, incandescent lights, 11,000ft. carbon for arc lamps, and various other appliances.

Singapore.—The Municipal Commissioners of the town of Singapore, Straits Settlement, invite proposals for the lighting of the public street lamps for five years from January 1, 1899. Tenderers may submit proposals for lighting by gas or oil, or partly with one illuminant and partly with the other. Further particulars may be obtained on application to Mr. C. C. Lindsay, M.I.C.E., 167, St. Vincent-street, Glasgow, or to Mr. J. Polglase, secretary to the Municipal Commissioners of Singapore, Singapore. Tenders may be sent either to Mr. Lindsay, up to November 30 next, or to the Secretary up to December 31.

Queensland (Australia).—The Municipal Council of Ipswich, Queensland, is inviting tenders for the supply and erection of the following electric lighting plant, etc.: tubular boilers, pipes, pumps and heaters, alternators and exciters, switchboard, high and low tension mains, junction boxes, transformers, etc. Specifications and all particulars as to conditions, etc., may be obtained from Messrs. Gordon and Gotch, St. Bride-street, Ludgate-circus, London, E.C., and tenders have to be forwarded to the town clerk (Mr. Albion Hayne), Council Chambers, Ipswich, Queensland. Tenders by November 15.

Glasgow.—The City Council invite tenders for the electrical equipment of the Springburn and Mitchell-street route of the Corporation tramways. Specification, with form of tender and plan of route, can be obtained on application to Mr. John Young, general manager, 88, Renfield-street, Glasgow. Intending contractors must remit to the General Manager the sum of £10, by bank draft, payable to Glasgow Corporation Tramways, and this sum will be returned to them on receipt of a bona fide tender, together with the plan of route. Sealed tenders, marked "Springburn and Mitchell-street Route, Tender for Electrical Equipment," to be lodged with Mr. J. D. Marwick, town clerk, City Chambers, Glasgow, by 10 a.m. on October 20.

Belize (British Honduras).—Tenders are invited by the District Board of Belize for the lighting by electricity of the town of Belize. The system decided upon is that known as the three-wire or neutral-wire system, and comprises boilers, engines, dynamos, accumulators, copper mains, flexible leads, iron lamp standards, switches, fuses, lamps (glow), and lamps (arc), meters, etc. Full particulars of the requirements of the Board can be obtained on application to Mr. A. R. M. Simkins, M.I.E.E., care of F. Otto, Esq., Tower-chambers, Moorgate-street, London, E.C. (Telegraphic address, Helios, London). Tenders should be addressed and should reach Mr. Simkins by October 20, and should be enclosed in a sealed package, marked "Tender for Electric Lighting."

Hull.—The Corporation are advertising for tenders for the electrical equipment of their tramways, to the extent of about nine miles double track and half mile single track. It will be open to contractors to submit tenders for various systems, and the contract, which will not be divided, will include engines and generators, switchboards, feeders, poles, brackets, trolley wire, rail bonding, and all accessories, also the first instalment of cars (15 motorcars and five trailers). It is expected that the specification, lithographed plans of the routes, and other particulars will be ready for issue early in September, and copies, when ready, may be obtained from Mr. A. E. White, city engineer, Town Hall, Hull, by persons proposing to tender, upon payment of a deposit of £10, which will be refunded upon receipt of a bona fide tender and return of the papers and plans supplied. Cheques to be made payable to Mr. Thos. G. Milner, city treasurer. Tenders, endorsed "Tender for Tramway Equipment," are to be addressed to the Chairman of the Works Committee, and delivered at the Town Clerk's Office, Hull, before noon on November 5.

Madras.—Tenders are invited for the utilisation of water flowing from the Periyár Lake for purposes other than irrigation and not incompatible with the use of the water for drinking. The irrigating season extends over nine to ten months, during which time the discharge is likely to be from 1,100 to about 500 cubic feet a second, according to the demands for irrigation and the available quantity in the lake. Subject to the risk of interruption by accident or drought, supply can be given throughout the irrigation season. No supply can be guaranteed at other times, but, so long as water is available, the Government will be prepared to issue it in such daily quantities as may seem to it advisable with reference to the time which is likely to elapse before the supply is replenished by the setting in of the rains. The fall from the tunnel to the foot of the hills is approximately 900ft., and the distance measured along the course of the stream about 6,800ft. One cubic foot per second falling 900ft. is estimated to produce over 60 effective horse-power. Intending lessees should state the quantity of water required in cubic feet per second and the annual rent offered for each cubic foot per second. No rent will be charged for the first year from the date of the concession; for the second year the charge will be one-fifth, and an additional charge of one-fifth will be made every year until the full rent is reached. The whole or part of the concession may be surrendered on a year's notice being given. Lessees will construct at their own expense, on plans to be approved by Government, all the weirs and other works required to divert the water from the river below the tunnel. For further information, application may be made to the Chief Engineer for Irrigation, Madras, by whom tenders will be received up to July 1, 1898.

RESULTS OF TENDERS.

London, E.C.—Messrs. Keller, Grabowski, and Co. have received the following tenders for works in connection with an installation of electric light at 3A and 5, Cannon-street, and 8, Watling-street:

Warburg, Dymond, and Co.	£175 0 0
Laing, Wharton, and Down	136 8 0
L. Alwyn	130 0 0
Bolding and Son, Limited	125 0 0
C. Larkins and Co. (accepted)	124 0 0

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Leeds.—The Corporation have accepted the tender of Mr. T. H. Churton, Leeds, at £1,325, for the erection of an electric light installation in Kirkgate Market—two 30-b.h.p. gas-engines, two dynamos, and 40 enclosed arc lamps and necessary wiring, etc.

Llandudno.—The following tenders for the erection of electric lighting buildings have been received by the Electric Lighting Committee:

S. Warburton, Manchester	£5,503	2	0
E. Roberts, Manchester	6,391	0	0
Gled Hill and Thomas, Halifax	7,859	10	8
R. L. Roberts, Llandudno	4,976	12	0

London, S.W.—The following tenders have been received by the Chelsea Electricity Supply Company, Limited, for the erection of a sub-station at Slaidburn-street, Chelsea:

G. Wade	£1,556
Holliday and Greenwood	1,327
Lole and Lightfoot	1,297
C. F. Kearley	1,296
Collis and Co. (accepted)	1,267

Kingston.—The following tenders have been received by the Council for the extension of the electric light buildings:

J. H. Jarvis, Surbiton (accepted)	£2,057
Rayner and Winckworth, Kingston	2,248
W. Cunliffe, Kingston	2 290
E. Wells, Kingston	2,315
W. Johnson and Co., Wandsworth	2,465
J. Smith and Son, South Norwood	2,532
Holloway Bros., Battersea	2,650
Kirk and Kirk, Westminster	2,697

BUSINESS NOTES.

Eccles.—We hear that the Local Government Board have sanctioned the electric lighting scheme for Eccles.

St. Just Churchtown.—The question of lighting this town and parish by electricity is being discussed by the District Council.

Poplar.—The committee have received Mr. F. J. Warden-Stevens's report on electric lighting and power, water, and steam supply.

Austria.—The Estimates for 1898 contain an item for the Austrian portion of a direct telegraphic line between Budapest and London.

Lewes.—The Corporation have appointed Mr. F. J. Warden-Stevens consulting engineer to advise and report on the lighting of the borough.

Aberdeen.—Much satisfaction has been expressed at the intimation that the Gas and Electric Lighting Committee were looking out for a sub-electric station in the west-end.

Removal.—Mr. W. C. C. Hawtayne, of Mansion House-chambers, 20, Bucklersbury, E C., announces that he has removed his offices to the second floor of the same building.

Doncaster.—The Town Council resolved on the 6th inst. to apply to the Board of Trade for a provisional order authorising the Town Council to supply electricity for public and private purposes in the borough.

Cork.—The Cork Electric Tramways and Lighting Company have given notice of an application to be made by them under the Cork Electric Tramways Order, 1897, for the consent of the Corporation for doubling portions of their line.

Royal Electric Company of Montreal.—Messrs. Coates, Son, and Co. are authorised to invite holders of the Company's 4½ per cent. debentures to send their bonds in for additional stamping, in accordance with the requirements of the Commissioners of Inland Revenue.

Appointments Vacant.—As seen by our advertising columns, there are various openings just now for electrical engineers, etc., in England. The Continental papers continue to contain numerous announcements of vacancies for engineers, fitters, drivers, and managers.

Prize Competition.—In view of the progress which has been made in electric lighting during the last decade, Mr. Ellis Lever, of Colwyn Bay and Liverpool, has renewed his offer of a prize of £1 000 for the production of an approved efficient portable electric safety-lamp for miners.

Aldershot.—At a special meeting the District Council have resolved to apply to the Board of Trade for a provisional order under the Electric Lighting Acts, 1882 to 1890, authorising the Council to supply electricity for any public purposes within the district of the Council.

Chichester.—At a special meeting of the Chichester Corporation, held on October 4, a resolution to take the necessary steps to procure a provisional order for lighting the city with electricity was carried after a long discussion, the Mayor giving his casting vote in favour of the resolution.

Harefield.—The Parish Council have requested the Telephone Company to put their wires underground through the village from the bottom of the hill (known as Church Hill) to the end of Watt's Common, on the Rickmansworth road. The Council do not grant the erection of poles through the village.

Edinburgh.—The City Council have passed a resolution approving of the installation of the electric light at Portobello. The expenditure is stated as £16,000, and if power was taken from Dewar-place for Portobello, new machinery which would cost £5,000 was required. This would be a total of at least £20,000.

Glasgow.—At a meeting of the Watching and Lighting Committee of the Corporation, a sub-committee was appointed to confer with the Tramways and Electricity Committees with regard to a proposal to light the new electric car route to Springburn.

Hull.—The Corporation Works Committee having advertised for tenders for the electrical equipment for the trams, and also for wood, and other materials for paving the streets, hope that early in the new year they would be in a position to get started. It is the committee's intention to hasten the work as much as possible.

Anglo-American Telegraph Company, Limited.—The directors have resolved, after placing £6,000 to the credit of the renewal fund, to declare an interim dividend for the quarter ended September 30 of 14s. per cent. on the ordinary stock and £1. 8s. per cent. on the preferred stock, less tax, payable on November 1.

Dundee.—The Tramway Committee of the Town Council have received the engineer's report with regard to the introduction of electric motor power was submitted. The cost is estimated for giving a complete electric service at £58,502. Mr. Mackinson, the city engineer, estimates the proposed widening of the streets at £19,100.

Greenock.—The Mearns street engineering class, which was so successful last year, is about to be resumed, and will again be taught by Mr. Walter Jamieson, consulting engineer to Messrs. Ramsay and Co, electric light contractors, Glasgow. The students will have the privilege of utilising the 60 h.p installation at Prospecthill, belonging to the Corporation.

Worcester.—At the meeting of the City Council this week it will be proposed to increase the salary of Mr. Murray, electrical engineer, from £250 to £350 per annum. Mrs. Hadley, of Teme House, has issued a writ against the Corporation claiming an injunction and damages in consequence of the vibration and noise alleged to be caused by the generating station at Powick.

Halifax.—During the last three or four weeks the roadways in Horton-street, Wards-end, and King Cross-lane, Halifax, have been broken up in consequence of the work of laying the tram-lines being commenced. The Tramways Committee have great hopes that before long the railway company will give them power to carry the lines along the railway bridge to the station entrance.

Nantwich.—The minutes of the Sanitary, Water, and Lighting Committee stated that a letter had been received from the Edson's Electric Lighting Incorporation intimating that it would be necessary for the Council to take steps forthwith to secure a provisional order if it were intended to proceed with the installation of the electric light. It was decided to recommend the Council not to proceed with the application this year.

Eastern Telegraph Company.—The directors of the Eastern Telegraph Company, Limited, announce the payment, on October 14 next, of interest of 3s. per share, less income tax, being at the rate of 6 per cent. per annum on the preference shares for the quarter ended September 30; and the usual interim dividend of 2s. 6d. per share on the ordinary shares, free of income tax, in respect of profits for the quarter ended June 30.

Chorley.—The electric supply company have written to the Town Council stating that, in consequence of the Corporation's intention to apply for powers under the Electric Lighting Acts, they would probably withdraw their intention to apply for a provisional order for powers to supply the borough. A resolution has been passed by the Council authorising an application to Parliament for powers to adopt the Electric Lighting Acts.

Wimbledon.—After some years' discussion, the Wimbledon District Council have finally decided upon an electric lighting scheme for the whole of the parish. The necessary public arc lamps will be provided, and 5,000 incandescent globes for private consumers, at an estimated total cost of £32,000. Application for a loan to cover the amount will be made to the Local Government Board. Mr. Arthur H. Preece has been appointed engineer.

Brussels.—A correspondent of the *Daily Chronicle* says an untoward incident in connection with the recently-completed underground electric tram installation at Brussels has revealed a new source of danger to the unsuspecting pedestrian. A female domestic in the King's Palace, when in the act of crossing the road, placed her foot on the tramline, and received so serious a shock as to necessitate her transport to the nearest house for medical treatment.

Bolton.—A special meeting of the Town Council is announced for the 27th inst., when a resolution will be submitted directing application to be made to the Board of Trade for a provisional order or license under the Electric Lighting Acts, 1882 and 1888, authorising the Corporation to supply electricity for public and private purposes to the townships of Astley Bridge, Turton, Horwich, Heaton, Smithills, Darcy Lever, Breightmet, Lostock, Deane, Over Hulton, Middle Hulton, Tonge, and Great Lever.

Rotherham.—The Electric Light Sub-Committee will present the following report at the monthly meeting of the Town Council this week: "The sub-committee recommend that Prof. Kennedy be asked to report upon a scheme for the electric lighting within the borough upon the terms contained in his letter." The committee recommend that the report be adopted, and that a plan submitted showing the area of the proposed electric light supply and streets to be lighted in the first instance be approved and adopted.

Carnarvon.—The Gas Committee have reported to the Town Council that having further considered the intended application by the Great Western Electric Light and Power Company for a provisional order empowering them to supply electricity within the borough, they recommended the Council to refuse consent, and

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to take steps to oppose the application. It was explained that the opposition suggested was not opposition in Parliament, but at the local enquiry which would have to be held. The report was adopted.

Tipton.—Referring to electric lighting, the Clerk said at last week's meeting of the District Council that a meeting of the sub-committee to discuss the Electric Lighting Acts had been convened, and that on October 6 a meeting of representatives of local authorities would be held at the Town Hall, Wednesbury. A special meeting of their own Council would take place a month hence. A letter had been received from the Midland Electric Corporation, Limited, stating their proposed operations, and asking for an interview.

Finchley.—The Sanitary Committee have received from the Postmaster-General a letter stating, in connection with the proposed telegraphic communication between Finchley and Southgate police stations, that the cost of laying underground a line of telegraphs along Woodhouse-lane, Summers-lane, North-road, Short-lane, and Squires-lane was prohibitive. The committee's recommendation, that a reply should be sent intimating that the Council would not consent to the construction of overhead wires, has been agreed to by the District Council.

Mines Drainage Commission.—The annual meeting of this Commission was held at the Drainage Offices, Dudley, on the 6th inst. The Chairman, in moving the adoption of the annual reports of the engineers, remarked that he did not know whether there was a probability of there being an electric supply for the district. He felt, however, that such a supply would be of great value to the Commission, as it would enable them to put down in the little "swags" small pumping stations, the engines at which would be automatically worked by electricity.

Bradford.—In view of the fact that the Bradford City Council at its next meeting will have to consider a recommendation of the Tramways Committee to adopt the electric overhead system for the tramways to Bolton and Horton, the members of the Council visited Leeds on the 5th inst. for the purpose of seeing the system in operation there. After the inspection of the works a luncheon was served at the Queen's Hotel, when the Lord Mayor of Leeds (Sir James Kitson, Bart., M.P.) and several of the members of the Leeds City Council and prominent officials were entertained.

Belfast.—The monthly meeting of the Belfast Corporation was held on 1st inst. The report of the Lighting Committee was adopted. The report stated that the Local Government Board's sanction has been received to the Council's application for a loan of £65,000 for building plant and cables for new electric station. It was said that on account of some labour difficulties on the other side of the Channel, the new station would not be ready as soon as had been expected. Consumers have been requested to be as easy as possible in their use of electric light during the winter months.

Rathmines.—A question having been asked at the Council as to the delay in proceeding with the completion of the electric tramlines along Kenilworth-road, the Engineer stated that the weight of the rails in the specification submitted by the tramway company to the Board of Trade was 92lb., whereas the rails that the company had commenced to lay down weighed only 72lb. When he was apprised of the deficiency he served notice on the company, and the work was temporarily suspended, but he understood that it would shortly be resumed again with rails of the proper weight.

Dublin.—The question of the electric lighting of the city came before the Corporation on the 4th inst. A report had been made out by the Electric Lighting Committee, but it did not appear on the paper, the reason why being, as explained by the town clerk, because it did not reach his office in time. It was proposed that the report should be carefully discussed at a special meeting. The report recommends the raising of £20,000 to renovate all the cables, and the raising of £100,000 to carry out a new system for the entire city under the direction of a skilled consulting electrical engineer.

Bolton.—At a meeting of the Gas and Electricity Committee on the 1st inst., it was decided after a warm discussion, in which there was some opposition, that it be a recommendation that a separate committee, to be called the Electric and Power Committee, be formed for the management and control of the electrical undertaking of the Corporation, and that the resolution be placed before the General Purposes Committee for further consideration. The electrical engineer was instructed to prepare a report and estimate of cost of extensions of plant and mains which will be required during the lighting season of 1898.

Southgate.—The Tottenham and Edmonton Gas Company intend to apply to Parliament in the next session for an Act authorising them to raise further capital with which to meet the growing demands of the district. The directors have stated to the Council their willingness to incorporate in the Act obligations with regard to the supply of electricity if they could arrange conditions mutually satisfactory to the Council and themselves. The directors would be glad to meet the Council and lay before them the provisions of the proposed Bill, and especially to consult them on the question of electric light. The matter is now before a committee of the Council.

Lee.—On the question of laying telephone mains in Woolwich-road the Charlton Committee have reported to the Lee District Board of Works that a correspondence had been carried on between Mr. Gaine, the solicitor to the Telephone Company, and the clerk to the Lee District Board, and as a result thereof the committee recommended that the company be informed that if and when it is in a position to satisfy the Board that it has the license of the Postmaster-General and the London County Council, the Board will be prepared to consider the question of the granting of its consent for the laying of underground telephone mains in the Woolwich-road, Charlton.

Chester.—The church of St. Paul's, Boughton, was lighted throughout by electricity for the first time on Sunday. It is to be hoped that other churches will ere long follow suit. The present installation at Boughton Church consists of 64 26-c.p. incandescent lamps, the lighting of the body of the church being effected by six five-light electroliers. In the chancel are four polished brass brackets, which effectively illuminate both the pulpit and the choir seats. The work has been designed and carried out by Messrs. Rooper and Robins, electrical engineers, Chester, the same firm who recently installed the electric light in the town hall and public market.

Commutator Segments.—There appears to still exist a certain prejudice against the use of micanite segments on account of the oozing of the cement. Messrs. Bergtheil and Young claim to have developed a process which enables them to guarantee that the segments do not ooze or slip. They further claim that the mica is also softened, causing it to wear away equally with the copper, and that they are superior to those made of raw mica in the ordinary way. The firm offers as a test to send anyone applying a sample set of segments for any standard railway motor or small dynamo, free of charge. The original plates are 18in. by 36in. in size, but the segments are also supplied cut to pattern.

Dudley.—The Public Works Committee's report to be submitted at the meeting of the Town Council this week states that the sub-committee appointed to confer with the representatives of the British Electric Traction Company, with reference to the proposed new tramway scheme, reported fully the result of their negotiations; but they did not deem it in the interest of the borough to at present publish any details, as negotiations were incomplete. The sub-committee had obtained the best expert evidence, and had also ascertained from different corporations in the United Kingdom their terms with regard to the supply of electric power, and in their negotiations were acting upon this evidence.

Aston.—The Highways and Buildings Committee of the District Council will report at the meeting this week that they have had under consideration the desirability of the Council applying for a provisional order enabling them to electrically light the district, and having regard to the fact that already there are notices by three separate companies seeking similar powers, the committee think it desirable that the Council should have sole control, and recommend that they be empoerwed to take such steps and employ such provisional assistance as may be necessary for this purpose. The estimated cost of an unopposed order will be about £300, which sum includes the deposit required to be made by the Board of Trade.

Peterborough.—At the monthly meeting of the Council this week the following notices of motion stood upon the agenda: "That the resolution of the Council passed on March 30 last, by which the further consideration of the subject of electric lighting was deferred for 12 months, be now rescinded, and that the Council do now make application to the Board of Trade for extension of time for completing works prescribed by the provisional order." In the event of the resolution of the Council deferring the consideration of electric lighting for 12 months being rescinded, it will be proposed that the Council forthwith proceed to take the necessary steps for the sale of the provisional order on the best terms that can be obtained.

West Hartlepool.—At the last monthly meeting of the West Hartlepool Town Council it was reported that Major Marindin had paid a visit to West Hartlepool to inspect the electric tramway lines in Church-street, and had refused to grant the company permission to run in Church-street until the company had made peace with the Corporation respecting the poles in Church-street. The poles were not of the class desired by the Corporation in the principal street. Arrangements would no doubt shortly be made for more ornamental poles to be erected. The matter was left in the hands of the Works Committee. Permission sought by the Telephone Company to erect more poles in the town was objected to. It was ultimately decided to send the matter to a committee.

Social.—The officials, staff, premiums, and workmen of Messrs. Ernest Scott and Mountain, Limited, electrical and general engineers, Close Works, Newcastle, assembled together at the White Hart Hotel on Saturday evening last, October 2, for the purpose of presenting to Mr. George Rolf (head of the electrical department) a testimonial on the occasion of his marriage. Presentations were made by Mr. G. Turner on behalf of the officials and staff, consisting of a silver salver and biscuit jar, and by Mr. Lock on behalf of the workmen, consisting of a very handsome smokers' companion. Mr. M. B. Mountain occupied the chair, supported by Mr. Chas Curtis and others, and a very enjoyable evening was spent—songs, recitations, etc., being rendered by several friends.

Leith.—At a meeting of Leith Town Council last week a notice of motion referring to the tramway question was tabled. The gist of it was that in the event of the Council not coming to or getting the Edinburgh Tramway Company—that is, the company working the Leith lines—to come to terms whereby the company would cable from Pilrig to the foot of Leith-walk and work the remainder of the system in Leith by electric traction, the electricity to be supplied by the Corporation, that the tramway company be offered £55,000 for their whole undertaking. The resolution also suggested that there should be extensions and three circular routes in the burgh, and also penny and halfpenny fares. The meeting of the 6th inst., after much discussion, agreed to remit the whole matter to the Electric Lighting and Tramways Committees for early report.

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Birkenhead.—In answer to a question raised at the monthly meeting of the Birkenhead Town Council, held on the 6th inst., it was stated that the committee had held several meetings. They had first of all considered the various means of tramway traction, and they came to the conclusion that electric traction was the best for tramways, and that of the various systems the overhead trolley system was the best, so far as present experience pointed. The question last under discussion was whether such a system should be carried out by entering into an agreement with some company, or whether the municipality of Birkenhead should take in hand both the traction of the tramways and the working of them, and he thought they had arrived at the opinion that the Council itself should take up the work entirely.

Kingston.—The Town Council have obtained the sanction of the Local Government Board to the borrowing of £17,994 for electric lighting, the sum of £2 006 not having been sanctioned because it had been excluded from the previous sanction. The Town Clerk submitted his reply to the Council, pointing out that the full details of the items making up such balance of £2,006 had been furnished, and asking, therefore, that the amount should be sanctioned. The committee confirmed the reply, and had requested the Finance Committee to make arrangements for the borrowing of £10,000 on account for such sanctioned loan. Upon the approval of the minutes being moved, it was said that it was important the work of extending the electric buildings should be proceeded with without delay, otherwise its cost would be greatly increased. The motion was carried.

Isle of Man Tramways.—The meeting of shareholders of the Isle of Man Tramways and Electric Power Company was held on the 30th ult. at Douglas, Mr. A. Bruce (chairman) presiding. It was unanimously resolved to increase the capital of the company, now standing at £175,000, by the issue of £25,000 preference shares and £100,000 as separate share capital, for the construction of a new electric section from Laxey to Ramsey, a distance of nine miles. It was elicited that the bulk of the new capital had been readily taken up by the directors and shareholders. The directors have declared interim dividends at the rate of 6½ per cent. per annum on the preference shares and 7½ per cent. per annum on the ordinary shares for the six months ended June 30 last. The dividends were payable on the 7th inst. to those shareholders standing registered on the company's books on the 30th ult.

Exeter.—The Electric Lighting Committee having reported to the City Council that some large transformers were required to meet the recent rapid increase in the demand, it has been resolved that a 20-kw. transformer be obtained from the British Thomson-Houston Company, Limited. The courtesy of the gas company's officials in having met the committee in an important matter was acknowledged by the Council. Through various commercial difficulties, the person who tendered for the supply of the electric light poles had not been able to comply with the contract, and the citizens were glad to recognise the courtesy of the gas company in meeting the Council. Very satisfactory arrangements had been made whereby the streets would be lighted, although September 29 found them without the electric light poles. A new cable is being laid in consequence of the increased demand for electric light.

Henley.—The Electric Lighting Committee have reported to the Town Council that the Local Government Board had sanctioned the borrowing of £14,880 for the purposes of electric lighting, and stating that the Board had excluded the sum of £120 from their sanction required for motors. The borough and electrical engineers had prepared a report respecting the adoption of the maximum demand system of charging for electric light, and the committee recommended that the system be adopted, and that all customers desirous of claiming the abatement, after the consumption of their highest demand for an average of one hour per day in the summer half-year and two hours per day in the winter half-year, be provided with maximum demand indicators and be charged half price—viz., 2½d. per Board of Trade unit—on the extra consumption. The recommendation has been confirmed.

Luton.—At a recent meeting the Town Council adopted a report which includes the acquisition of a large piece of ground. During the debate it was said that if they decided to go in for electric lighting and erected the station there, it would save the Council some thousands of pounds because of its central position, or half the cost of the cables. The Mayor said the surveyor was most anxious that the site should be acquired, assuring them that a saving would be effected by giving him ample space for all his requirements. It would economise the time of men and horses, and would in every way recoup the town for the outlay. The site was also admirably suited for an electric lighting station, and was offered to them when all other enquiries had failed. The Electric Lighting Committee were very anxious that their work should be proceeded with, and that the expert should have a site on which to base his report.

Penzance.—At the last fortnightly meeting of the Town Council the following report was adopted: "The Lighting Committee recommend that the surveyor be instructed to call on the owner of the streets now nearly completed on the Leskinnick estate to provide the necessary means of lighting such streets. A further communication having been received from the Imperial Electric Light Company on the subject of the application of the company for the consent of the Council, as the local authority, to the grant to them of a provisional order under the Electric Lighting Acts, 1882 to 1890, and the committee having had an interview with the company's representative in support of the same, recommend that the matter be referred to a committee of the whole Council for consideration." The Mayor said what the Council had to do was to protect their rights, and it was not necessary that they should launch out with any scheme for lighting by electricity.

St. Albans.—The question as to whether St. Albans should be lighted with electricity has been before the Council for several weeks, and at a special meeting held last week a report from the Urban Committee recommending that application should be made to the Board of Trade for a provisional order was adopted. The discussion which took place on the report showed that it is the intention of the Council to obtain the order in the interests of the ratepayers, so as to prevent the monopoly passing into the hands of a private company. The Corporation will not under any circumstances attempt to put down an installation, but will lease their powers under the order to a company, offers of a definite character having already been made. It was pointed out that in the event of the application being granted the agreement to allow a private company to proceed under the powers of the order would contain clauses which would enable the Corporation to purchase at a fair price in a given number of years.

Brierley Hill.—A letter was read at the Brierley Hill District Council meeting on Monday from the British Electric Traction Company asking the Council to forego the clause in the agreement which compels the company to take a portion of the electricity from Brierley Hill if the latter authority ever succeed in obtaining powers to supply electricity. The Chairman said it appeared to him that Dudley were getting all the plums and Brierley Hill were getting nothing. The longest length of line went through Brierley Hill, and they were entitled to some consideration. He had been informed that Dudley were getting £150 a year for the right of going through the town. He certainly thought Brierley Hill should have some of the benefit. The company also intimated that if the clause was withdrawn, steps would be taken almost immediately to construct generating plant. If the clause was persisted in, it would take three or four years before they could commence the work. It was decided to retain the clause in the agreement.

Perth.—At a meeting of the special committee on electric lighting a report was read by Mr. Thomas Barton (Blackburn) as to the introduction into Perth of a system of electric lighting and the erection of refuse destructor. After considerable discussion it was resolved that the meeting proceed with their enquiries, and ascertain the most suitable site for a station in Perth. At a previous meeting of the same committee a letter was read which had been sent by the clerk to Messrs. William Robertson and Co. (London) with reference to a threatened application by the Imperial Electric Light and Power Company, Limited, to the Board of Trade for a provisional order to supply electricity within the burgh, also a reply received from Messrs. William Robertson and Co., in which they suggested that in order to defeat this application the Town Council should themselves apply for a provisional order. The committee agreed to report the present state of matters to an informal meeting of the Council (in committee) to ascertain the views of the latter.

Worcester.—At the monthly meeting of the City Council on the 5th inst., a lengthy discussion took place upon the motion to raise the salary of the electrical engineer, Mr. Murray, from £250 to £350. It was contended by the mover of the resolution that the engineer was very much underpaid, he being in charge of works which had cost £60,000, and upon which another £10,000 were now being expended. The station was not a simple one, being worked by steam and water. In opposition it was said that increase in capital and business did not constitute a reason for increase in his salary, seeing that at present the works did not show any profit. It was said that Mr. Murray had saved the Council the costs of a consulting engineer, as he had charge of the new extensions. Finally, an amendment deferring the matter till the Council had had a report on the circumstances of a breakdown which recently occurred was carried by 17 votes against 16. During the course of the debate it was said that there was nothing likely to come out of an enquiry upon the boiler tubes accident referred to which would reflect upon Mr. Murray's professional skill and competence.

Hammersmith.—The Vestry have received a report from the Electric Lighting Committee, in which they said: "We have approved the action taken by the Exhibition Committee, acting as an Emergency Committee, upon an application made by Mr. Price, contractor of the Central London Railway Company, for the supply of electric current for their works at Shepherd's Bush, when the engineers reported that in order to supply the current it would be necessary to obtain and fix a special transformer for the purposes at an estimated cost of £40, for which the applicant was prepared to pay a rental, and they gave instructions for the work to be carried out. Having received a report from the engineer that it would be necessary to order four transformers and five primary current meters, we recommend that the same be purchased at the contract price." The report has been agreed to—The slate for the switchboard for the electric power station has in some of the slabs as many as 300 holes, varying in size from §in. to 3in. Both the drilling and shaping of these slabs was executed by Messrs. Congdon and Powell with their special electrical planes, shapers, and drills, designed by Mr. W. J. Fryer, of Sloane-square. The same firm have also recently manufactured the slate for the switchboards at Wandsworth, Hampstead, and Torquay.

Bradford.—The Gas and Electricity Supply Committee of the Bradford City Council have received an application from several residents in the neighbourhood of Toller-lane, Manningham, for an extension of the supply of electricity to that locality, in order that

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it may be utilised for electric light installation in private houses. It transpired that nearly a mile of cable would have to be used to fulfil the requirements, involving an initial outlay, at the rate of about £1 per yard, of a sum approaching £2,000. It was eventually decided to make arrangements for a canvass in the district to ascertain the number of persons willing to become consumers, with a view to considering whether or not the expenditure were likely to be justified. The committee next proceeded to discuss a proposal to readjust the price charged for the supply of the electric current in favour of consumers. The Corporation have hitherto charged 5d. per unit, but it was suggested that a reduction to 4½d. might be adopted without seriously affecting the profits of the department, and that an increased consumption would probably be the result. A sub-committee was appointed to make enquiries as to the rate charged by other municipal bodies, and report generally upon the feasibility of the proposal. It was understood that the contemplated reduction had no reference to the price charged for motive power, which will remain at 2½d. per unit.

Montrose.—The Town Council will meet on the 14th inst. to confirm the following report, which was adopted at their last meeting: "The committee having fully considered (1) the notes of their deputation, consisting of the Provost, Bailie Stone, and Mr. Hall, and their enquiries at Shrewsbury, Kingston-upon-Thames, and Charing Cross and Strand, as also at Edmundson's, Limited; (2) draft agreement between Edmundson's Electricity Corporation, Limited and the Town Council; and (3) the relative draft deed of transfer of provisional order, all herewith submitted, agree to recommend the Town Council to enter into the above agreement, and to take steps for formally passing a resolution to the effect that the Town Council, as the local authority of this burgh, to apply to the Board of Trade, under the provisions of the Electric Lighting Act, for a provisional order authorising them to supply electricity for any public or private purposes within the area of the burgh, to be confirmed by Act of Parliament in the ensuing session; and that the town clerk do take the necessary steps to carry the resolution into effect. The committee's only difficulty in recommending that the agreement with Edmundson's be ratified was the fear that the first cost would be over-stated; and, in order to safeguard the Council against this, your committee, after the experience gained by the deputation's visit to Shrewsbury, Kingston, etc., considered it necessary to have a clause added to the agreement providing for a reference on this point. The committee think this clause should keep the Council safe; but if the Council think otherwise, then the only alternative is for the Council to take out the order itself, and proceed with the carrying out of the work, as, failing its doing so, Edmundson's will at once proceed to do so, in which case the result will be that the Council would in a few years' time find itself in the same position as Shrewsbury, where the Corporation is now finding itself compelled to negotiate for the acquisition of the undertaking at a price very much beyond the cost."

Treeton.—Part of the lamps of the electric lighting installation were used for the first time on Saturday, October 2. Messrs. John Dewhurst and Son, of Sheffield, are the contractors for the work of installation, which is now practically complete. The dynamo is a series-wound dynamo of the most modern construction, specially adapted for street-lighting, with an output of 1,300 volts and 10 to 15 amperes. There are 21 arc lamps of 2,000 c.p. The main cable consists of best quality copper cable, highly insulated throughout, and suspended from galvanised wires. The work has been carried out under the superintendence of Mr. W. H. Barwell, engineer (representing the Parish Council), and Mr. Denner, electrician to Messrs. Dewhurst and Son. The total cost will be about £650, which has been raised by loan. This appears to be the first village lighted by electricity and allowed to take its power from a colliery. The scheme was prepared by Mr. William Baxter, a member of the Council and manager of Treeton Colliery, when it was submitted to the County Council of the West Riding. The solicitor to that body stated that as this was the first application for sanction to an electric lighting scheme for a village, and as there appeared to be a doubt whether this mode of lighting could be adopted by a Parish Council under the Lighting Act of 1833, the Parish Council was advised to apply in the first place to the Local Government Board. This was done, and after a voluminous correspondence the Board decided that the Parish Council could provide the necessary plant for distribution, but could not themselves generate the electricity. An arrangement was therefore entered into with the Rothervale Collieries, Limited, for the supply of power, etc., for a term of years. Tenders were also obtained for the required plant for distribution. On March 26 of the present year a local enquiry was held before Colonel Albert C. Smith, B.E., on behalf of the Local Government Board. Mr. Trevor Edwards attended on behalf of the County Council. The evidence given was unanimous in support of the electric lighting scheme. Finally the consent of the Local Government Board and the County Council was received, and the contracts let.

Liverpool Overhead Railway.—On October 2 a number of engineers and others connected in some way with the work of erecting the new generating station for the Liverpool Overhead Railway met together at the Alexandra Hotel, at the invitation of Messrs. Holme and King, the contractors, for the purpose of visiting the generating station and of examining the new extension. Here a lunch was partaken of, Colonel A. H. Holme being in the chair. The original equipment of the generating station consisted of six double-flue Lancashire boilers, 30ft. long by 8ft. diameter, fitted with Vicars's stokers, with a steam pressure of 120lb. The engines were four in number, of the horizontal compound-condensing type, built by Messrs. Musgrave and Sons, of Bolton. Each engine developed 400 i.h.p. at 100 revolutions per minute, with 120lb. boiler pressure. Each of these engines drives an Elwell-Parker dynamo, 500 amperes, 500 volts, of the double-limb type, with magnetic circuit above and below the armature. The efficiency of these dynamos and engines is about 85 per cent. at full load. The current from these dynamos was controlled by a switchboard which has recently been replaced by a more extensive one to suit the requirements of the larger station. The recent addition to the generating station consists of two engines built by Messrs. Hick, Hargreaves, and Co., of Bolton, and two new dynamos and switchboard, built by Messrs. T. Parker, of Wolverhampton. The two new engines are Corliss valve engines, each of the horizontal surface-condensing type, having cylinders 15½in., 31in. by 3ft. stroke, each intended to give 400 i.h.p. as an economical load when running at 100 revolutions per minute, with a boiler pressure of 120lb. per square inch. The flywheels are 14ft. in diameter, and are grooved for 19 ropes, each 1¼in. diameter. The condensing apparatus is a separate plant, having its own air and circulating pumps. The output of each dynamo is 500 volts, 500 amperes, at a speed of 420 revolutions a minute. The armatures are so arranged as to be interchangeable, identical in the matter of external dimensions with the original ones. The magnets, however, instead of being of the double horseshoe type, as in the original machines, are of a single horseshoe with the poles at the top. This results in an increase of efficiency, the shunt resistance being now 100 ohms, as against 75, thus making an electrical efficiency of 98 per cent. The loss in hysteresis, eddy currents, etc., amounts to 6,000 watts, so that the commercial efficiency at full load will be 95·7 per cent. The dynamos are rope-driven by 19¼in. ropes, the rope pulley running between two bearings and the pulley shaft being connected to the armature by a coupling, so that the armature can be changed without disturbing the ropes. The total weight of the machine is 24½ tons. The main switchboard looks a complicated piece of mechanism to the eye of the uninitiated, but to those who constructed and to those who operate it, it is a beautifully simple contrivance for the control and direction of the enormous electrical force generated at the station. All these extensions and connections had to be accomplished without interfering for a moment with the working of the generating station.

Leicester.—The report relating to the electric lighting undertaking was adopted by the quarterly meeting of the Town Council. Alderman Lennard stated that they had exercised the whole of their borrowing powers, but they had a balance in hand not paid away of £3,071. 2s. 4d The total receipts showed an increase of £732, and the expenditure an increase of only £148. He wanted the Council to take in that fact—that their expenditure had only gone up about 10¼ per cent., while their output had gone up 75 per cent. They had to incur the whole of their annual expenses before the whole of the machinery was being used, but now it was being practically used—or would be this winter—up to its fullest capacity. The main increase was that of £64 for oil, waste, and engine stores, the total increase being £148. The output during the half-year was 102,830 units at 5d., and this was the first balance they presented at the reduced charge. Last January they began to charge only 5d. instead of 6d., which meant a difference of revenue to the department of £428. The revenue had been for "current" £2,142, as against £1,467; rental of meters, £76, against £50; and profits on the fittings' department, £183. The profit and loss account showed that after bringing forward the balance from the revenue account of £999, the interest and sinking fund absorb the whole of it, and £215. Had they not reduced the price to the consumers they would have had a balance on this half-year—a net profit after paying all expenses—of over £200. The total net loss up to the end of June was therefore £1,819, and possibly some might be reminding themselves that the end of 1897 would be the end of the first three years with regard to which he expressed the opinion of that committee that they would make both ends meet. Well, the present half-year was going in the same way as the last half-year; they were doubling their output as against the previous half-year, while their expenses would only go up a trifle. And they quite anticipated, by doubling their output, they would have a net profit, after paying their sinking fund, of some £1,300 or £1,400. That would nearly wipe out the loss standing in the balance-sheet, and had it not been for the reduction of 1d. they would have had a handsome surplus in hand, because a penny reduction of the whole of this year meant £1,300. At the end of the year they would probably be £300 or £400 to the bad, but they would have £4,000 or £5,000 put on one side as a sinking fund, besides having given a concession to the consumers of £1,300 or £1,400 in the way of reduction. He also stated that the electric lighting plant was now being used to its fullest capacity, and the committee had been obliged to realise that it would not be sufficient, and consequently they had had to hire additional plant, and with that they would find it difficult to get through the winter. Now they were not able to take any more orders from would-be customers for this winter.—Colonel Coke, Local Government Board inspector, has held an enquiry into an application by the Town Council to borrow £33,719 for electric lighting purposes. There was no opposition to this application. Mr. Colson, the engineer, said this sum was necessary to meet the increased demand for the light.

Liverpool.—A meeting of the Lighting Committee of the Corporation was held at the Municipal Offices, Dale-street, on the 1st inst. The committee was informed that owing to the great quantity of applications for the supply of electricity extensions of the main into Chatham-street, Bedford-street, Falkner-street, Scotland-road, Aigburth-drive, Bentley-road, and Whitechapel were necessary. These extensions were sanctioned by the com-

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mittee, and will be proceeded with at once. The engineer reported upon the necessity also of proceeding with the trunk main to Lord-street and Whitechapel consequent upon the anticipated demands for electric light having been largely exceeded. This work, which will cost about £2,500, it was intended to defer until next year, but as a result of the engineer's statement the committee authorised it to be gone on with at once. The superintendent of lighting presented a report relative to incandescent lighting in the city, and with a view to arranging for the better illumination of the streets in the recently added areas, recommended the extension of the present system at an outlay of about £1,500. The committee approved the report, and decided to apply to the Council for a supplementary estimate to enable them to carry out the recommendation contained in the report. A special meeting of the Central Markets Sub-Committee has been held to inspect the arrangements now completed for lighting the market by electricity. A comparison was made between the present system of illumination by gas and the new method of electrical lighting by the numerous arc lamps fitted in the respective avenues. The effect of the new light was most marked, and will no doubt be fully appreciated by the stallholders and the general public. The preliminary test was declared quite satisfactory; and the light was used for the first time for public use on the 2nd inst.—The Liverpool District Lighting Company has materially assisted the Crosby District Council to obtain a provisional order under the Electric Lighting Act of 1896. The company immediately set about laying extensive mains, which will distribute the electric current through Great Crosby, Blundellsands, Waterloo, and Seaforth. The company's area of supply covered by the above provisional order is six miles long. In January, 1888, the number of 16-c.p. incandescent lamps supplied by the company was 997, and at the present time the supply is equivalent to over 14,000 16-c.p. lamps. The system of supply that will be used is low tension, direct current, at an E.M.F. of 220. The plant at present fixed is capable of supplying 1,000 lamps at one time, but the buildings are large enough for plant for about 7,000 lamps, and land has been acquired for further extensions when required. The current was turned on on the 1st inst. for 200 consumers, and it is expected that the number will rapidly increase when its benefits become more widely known. The reductions granted in the hours of working on the tramways and in the fares have reference merely to the present system of horse haulage, and are not intended in any way to take effect with respect to the electric system when it comes into operation. The fares and hours of labour of the men will then come up for revision again by the Tramways Committee. So far as both the subjects referred to are concerned, it is proposed that they shall come into operation immediately they have been sanctioned by the Council.—At the monthly meeting of the City Council, held on the 6th inst., the following resolution was carried by 30 votes to 12: "That the Special Tramways Committee be requested to reconsider the offer of the Simplex Electric Tramway Conduit Syndicate, Limited, to lay and equip, at their own cost, an experimental line of tramway, and that they be authorised to accept such offer if they deem it desirable to do so." The Council decided to place at the disposal of the Lighting Committee the sum of £56,000, to be spent on capital account for electric lighting purposes.

Hastings.—The Town Council have adopted the borough engineer's report, embodying the investigations of the Tramway Committee on the different modes of traction employed in several cities in England and on the Continent, from which we quote: The committee have had information placed before them dealing thoroughly with the systems in use in the following cities and towns: Brussels, Hanover, Hamburg, Berlin, Dresden, Budapest, Vienna, Milan, Genoa, Paris, Rouen, Elberfeld, Reimscheid, Liège, Blackpool, Bristol, Birmingham, Walsall, Wednesbury, Edinburgh, Dover, and many cities in America. The whole of the towns and cities before mentioned on the Continent have well-equipped tramway systems, mostly worked by electricity, a few having sections of their systems still worked by horse or steam traction. This method is, however, being done away with in favour of electricity. The gauge of the track in most cases is the standard one of 4ft. 8½in., the rails varying from 70lb. to 100lb. per yard run, the space between rails and for a distance of 18in. on each side being in most cases laid with stone pitchers. As a general rule, tramways cost more to construct and maintain in this country than is the case abroad. The systems applied to tramway traction are very numerous, but they may be classed under the following heads: (1) overhead traction by means of wires, suspended either from columns or arches, the current being taken from the cables to motors under the cars; (2) conduit systems, where the cables are contained in conduits under the surface of the road; (3) the Serpollet system of steam traction; (4) the compressed-air system; (5) gas cars; (6) the cable system; (7) the accumulator system; and (8) horse traction. With reference to overhead traction, this possesses numerous advantages which are not possessed by any other system at present in use. It is far cheaper in first cost, cheaper to maintain, and works on the whole far more satisfactorily than any other method of traction at present adopted. In most of the Continental cities this system is the one generally adopted. In some cases disapproval has been expressed at the unsightly appearance of the overhead wires; this has soon been overcome, and if the columns are made ornamental they may be made to improve the appearance of a street instead of detracting from it. The interference with the general traffic is less than by any other system, and what is perhaps of the utmost importance, the roads are not interfered with in consequence of derangement of electric current. Any necessary repairs can be effected with the minimum of trouble, delay, and expense, and the lines can be constructed much quicker, and with less interference with the surface of the streets and the traffic than by any other system. The various open and closed conduit systems are many, no less than 19 different systems being either partially in use or having been invented. The only systems which have been put to real practical test are: the Holroyd Smith system (Blackpool), the Siemens and Halske (Budapest), the Thomson-Houston (New York), and the Love system (Chicago and Washington). The disadvantages of the conduit systems, *inter alia*, are that they are very expensive in first cost, and far more costly to maintain than the overhead system. They necessitate prolonged interference with the streets during construction and repair. There is great difficulty in locating any defect in the underground part of the system. They render the carrying out of sewerage works difficult and expensive, and there is the great disadvantage of the presence of a slot in the conduit in the centre of the track, varying from §in. to 2in.; also the difficulty of keeping the conduit clean and maintaining efficient insulation. The Serpollet system of steam traction is in many respects a great improvement on the old form of steam traction, but its disadvantages compared with electricity must be apparent. With regard to the compressed-air system, as used in Paris, it is not satisfactory, being very expensive, and not adapted for steep gradients. The only place apparently where gas cars are used is Blackpool, and there only in an experimental stage. Smells arise from it, and it is not apparently in any way so reliable as electricity. The cable system is used in several towns in England, and it has certain advantages, but these advantages disappear when compared with electric traction. The advantage of the accumulator system appears to be that by the use of accumulators the necessity of either overhead wires or the objectionable slot of the conduit system is obviated. At present, however, this system cannot be looked upon as satisfactory, owing to the great extra weight of the cars, the accumulators alone weighing as much as three tons; the great expense of maintenance, the constant recharging which is necessary, and the objectionable smells of the acids used, with the possibility of injury to passengers' clothing, with consequent claims for such damage. The comparative ineffectiveness of this system, when compared with other forms of electric traction, even when ascending but slight gradients, is such as to render its use on steep gradients almost prohibitive. Most of the Continental towns find that the cost of working a double line of track is cheaper than a single line, but the decision of this question must be dependent entirely on the available width of road and the nature of the district to be traversed. The risk of accidents to the general public through the overhead system is less than that occasioned by almost any other system of traction, as the speed of the cars can be so perfectly regulated as to allow them to be stopped within a distance of less than the length of the car. Accidents through a wire breaking are comparatively few, as the Board of Trade limit the current for working an overhead system to 500 volts, which current is not fatal to human life, and the speed is limited by the Board of Trade to eight miles per hour. With reference to the means adopted for constructing these lines, it has been found from experience that it is preferable for the municipality to construct them themselves, it being evident that money can be borrowed by municipalities at a cheaper rate than can be the case with public companies. The conclusions which may be arrived at from the information contained in the reports which the committee have obtained are: (1) That overhead electric traction is the system which is most suitable for a town like Hastings; (2) that it could be worked in connection with a system of electric street-lighting; and (3) that it would be an advantage for the Corporation to construct the lines and lease them on certain terms.

TRAFFIC RECEIPTS.

Bristol Tramways.—The traffic returns for the week ended October 1 were £2,712. 13s. 10d., compared with £2,203. 19s. 5d. for the corresponding period of last year, being an increase of £508. 14s. 5d.

Birmingham Tramways.—The traffic receipts for the week ending October 2 were £4,038. 18s. 8d., as compared with £3,414. 7s. 7d. in the corresponding week in 1896, being an increase of £624. 11s. 1d.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended October 3 amounted to £1,350, as compared with £1,184 in the corresponding week of the previous year, being an increase of £166.

City and South London Railway.—The returns for the week ended October 3 were £926, compared with £903 for the corresponding period of last year, being a decrease of £23. The total receipts for the half-year 1897 amounted to £12,620, compared with £12,715 for the corresponding period last year, being a decrease of £95.

South Staffordshire Tramways.—The traffic returns for the week ending October 1 were £748. 17s., as compared with £627. 15s. 11d. in the corresponding week of the previous year. The aggregate receipts so far this year were £24,833. 2s. 9d., as compared with £24,211. 14s. 6d. in the corresponding period in 1896.

D.S.D. Tramways, Dublin.—The traffic receipts for the week ending October 1 were £594. 0s. 3d., as compared with £517. 14s. 9d. in the corresponding week in the previous year, being an increase of £16. 18s. 0d. The number of passengers carried was 89,358 in 1897 and 77,324 in 1896. The aggregate returns up to date are £10,301. 3s. 8d., as compared with

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£11,049 last year, being a decrease of £747. 19s. 8d. The mileage open is the same as last year—viz., eight miles. There are now 319 cars running, against 256 in 1896. The number of miles travelled being 24,259 (27,460 in the same period of 1896).

PROVISIONAL PATENTS, 1897.

SEPTEMBER 27.

22100. Improvements in electric trolleys for electrically-driven railway vehicles. William Henderson Russell, 89, Chancery-lane, London.

22117. Improvements in oval lamps for incandescent lighting. William Gordon Potter, 899, Fulham-road, London.

SEPTEMBER 28.

22203. Process of and apparatus for electrically treating ore. Alfred Julius Boult, 111, Hatton-garden, London. (Francis H. Soden, United States.) (Complete specification.)

22206. Machine for making storage battery plugs. Carroll Potter, 111, Hatton-garden, London. (Complete specification.)

22215. Improvements in alternating-current meters. The British Thomson-Houston Company, Limited, 70, Chancery lane, London. (Robert Shand, United States.) (Complete specification.)

22216. Improvements in or relating to electric recording watt-meters. The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. (William H. Pratt, United States.) (Complete specification.)

22217. Improvements in shielding devices for electric meters. The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. (Elihu Thomson, United States.) (Complete specification.)

22218. Improvements in electric measuring instruments. The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. (Elihu Thomson, United States.) (Complete specification.)

22236. Improvements in porous diaphragms for electrolytic apparatus. James Douglas Darling and Charles Leland Harrison, 24, Southampton-buildings, Chancery-lane, London. (Complete specification.)

22240. Improvements in electric arc lamps. James Brockie, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

22250. Improvements in or relating to the prevention of sparking at a controller resulting from breaking a contact. William Phillips Thompson, 6, Lord-street, Liverpool. (Thorsten von Zweigbergk, United States.) (Complete specification.)

22251. Improvements in safety fuses for electric devices. William Phillips Thompson, 6 Lord-street, Liverpool. (George Harris Goodhue and Ferdinand Austin Hart, United States.)

SEPTEMBER 29.

22276. Improvements in electrical propulsion of barges and boats on canals and rivers. Henry William Handcock and Alfred Herbert Dykes, 5 Victoria-street, London.

22311. An improved system of conveying electrical currents through engines, carriages, trucks, and other railway vehicles. Frederick Arthur Pyke, 13, Abbey-grove, Bolton.

22331. Improvements in telephony. Charles Adams-Randall, 63, Chancery-lane, London.

22332. Improvements in telegraphy. Charles Adams-Randall, 63, Chancery-lane, London.

23339. Improved electric motorcar switch. Otto Claude Immisch, 52, Chancery-lane, London.

22360. Improvements in multiple-contact telephone transmitters and the battery circuit connections relating thereto. Charles Adams-Randall, 63, Chancery-lane, London.

22365. An improved method of suspending or attaching electric or other motors to self-propelled vehicles. Henry Emmett Gamble and William Malcolm Binnie, 42, Holland Park-avenue, London.

22375. Apparatus for effecting silent electrical discharges. Sir Felix Louis Ortt, 4, South street, Finsbury, London.

SEPTEMBER 30.

22444. Improvements in machinery or apparatus for transmitting motion from electric motors to other machinery. Joseph Whitworth Hulse, 46, Lincoln's-inn-fields, London.

OCTOBER 1.

22521. Improvements in electric furnaces. William Smith Horry, 111, Hatton-garden, London. (Complete specification.)

22549. Improvements in single-liquid voltaic batteries. George Frederick William Morris, 6, Lord-street, Liverpool. (Samuel Bash, Argentine Republic.)

OCTOBER 2.

22633. Improvements in or relating to electrical connecting boards. Alfred Whalley, 111, Hatton-garden, London.

22610. A new or improved compound or material applicable for electrical or heat non-conducting or insulating purposes. Hawthorn John Brown, Otto Robert Heinrich Schmidt, and Alexander Mackenzie, 27, Southampton-buildings, Chancery-lane, London.

22613. Apparatus for controlling electric currents and for actuating mechanical devices by variation of electric potential. Joseph Tavener, 22, Davies-street, London.

22627. Improvements in alternating arc lamps. Bernard Mervyn Drake and John Marshall Gorham, 66, Victoria-street, Westminster, London.

22629. Improvements in the insulation of electrical conductors. Henry Edmunds, 47, Lincoln's-inn-fields, London.

22638. Improvements in plates for heating by electricity. La Société Bouvier Frères, 46, Lincoln's-inn-fields, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, March 20, 1897, being date of application in France.)

SPECIFICATIONS PUBLISHED.

1896.

7649. Electric cables. Edmunds. (Amended.)

20513. Electromotors especially applicable to motor carriages and other vehicles. Vaughan-Sherrin.

20520. Apparatus suitable for punching paper for telegraphic purposes. Gibson.

21879. Electric furnace or oven. Timme.

22465. Electric measuring instruments. Wright.

22746. Automatic switches for controlling electric lamps. Davy.

25345. Communicating electrical energy to vehicles and apparatus for that purpose. Siemens Bros. and Co., Limited, and Taylor.

1897.

17144. Flexibly insulated conductors and methods of and apparatus for making the same, and other continuously coated extended lengths of material. Kelman.

18095. Method of and means for operating alternate-current motors. The Thomson-Houston Company, Limited. (Steinmetz.)

18276. Electric lamps for miners' use. Lake. (Siedentopf.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	11-11½
Brush Company, Ordinary	3	1-1½
—— Non. Cum., 6 per cent. Pref.	2	1⅝-1¾
—— 4½ per cent. Debenture Stock	100	103-107
—— 4½ per cent. 2nd Debenture Stock	100	96-100
Callender's Cable Company, Debentures	100	108-113
—— Ordinary	5	7-8
Central London Railway, Ordinary	10	9⅞-10⅛
——	6	5⅞-6⅛
Charing Cross and Strand	5	12-13
Chelsea Electricity Company	5	10½-10⅝
—— 4½ per cent. Debentures	100	110-113
City of London, Ordinary	10	25-26
—— 6 per cent. Cumulative Pref.	10	17-18
—— 5 per cent. Debenture Stock	100	131-136
City and South London Railway, Consolidated Ordinary	100	69-71
—— 4 per cent. Debenture Stock	100	138-140
—— 5 per cent. Pref. Shares	10	15⅛ 15⅝
County of London and Brush Provincial Co., Ordinary	10	12⅞-13⅛
—— 6 per cent. Cum. Pref.	10	15⅛-16
—— 4½ per cent. 2nd Debenture Stock	10	15-15⅛
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1⅛ 2
—— 5 per cent. Debentures	—	89-94
Edison and Swan United Ordinary	3	2⅛-2⅜
—— 5 per cent. Debentures	5	4-5
Electric Construction, Limited	2	2-2⅛
—— 7 per cent. Cumulative Pref.	2	3⅛-3⅜
Elmore's Copper Depositing	1	⅞-1
Elmore's Wire Company	2	1⅛-1⅜
W. T. Henley's Telegraph Works, Ordinary	10	19-20
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	109-114
House-to-House Company, Ordinary	5	9-9½
—— 7 per cent. Preference	5	10⅞-11⅛
India Rubber and Gutta Percha Works	10	21½-22½
—— 4½ per cent. Debentures	100	103-107
Kensington and Knightsbridge Ordinary	5	13½-14½
—— 6 per cent. Pref.	5	6-6½ xd
London Electric Supply	5	1⅛-2
Metropolitan Electric Supply	10	18-19
—— 4½ per cent. First Mortgage Debenture Stock	100	118-122
National Telephone, Ordinary	5	6⅝-6¾
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	15-17
—— 5 per cent. Non. Cum. Third Pref.	5	6-6½
—— 3½ per cent. Deb. Stock	100	105-110
Notting Hill Company	10	15-16
Oriental, Limited, £1 shares	1	1⅛-2
—— £5 Shares	5	8-8½
—— £4½ shares	4½	7⅛-7⅜
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	103-105 xd
St. James's and Pall Mall, Ordinary	5	16-17
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	36-39
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	8	12⅜-12½
Westminster Electric Supply, Ordinary	5	14½-15⅛
Yorkshire House-to-House	5	8-8½

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NOTES.

Appointment.—Dr. Frank Clowes has been appointed chemist to the London County Council in the place of Mr. W. J. Dibdin, who has resigned. There were 42 applications for the post, and the salary is £700 a year.

The Institution of Junior Engineers.—The annual general meeting of the institution will be held on Friday October 22, at the Westminster Palace Hotel at 8 p.m. The report of the council will be received, the officers elected, and other business transacted.

Animal Electricity.—We have received a copy of a book, entitled "Lectures on Physiology," which contains the first series of lectures on animal electricity delivered by Dr. Waller at the Royal Institution during the spring of 1897. The book is published by Messrs. Longmans and Co. at 5s. net.

A Novel Clock.—An electric clock of a new design has just been erected on the south-east side of Piccadilly-circus. Electric lamps are fixed along the moving hands, and there are electric stars fixed at each figure. The clock is worked on the Synchronome Syndicate's system in conjunction with a number of other clocks.

The Proposed Icelandic Cable.—Following on a note which appeared in our issue of October 1, we now learn that the Icelandic Parliament has resolved to subsidise a submarine telegraph cable connecting Iceland with Scotland *vid* the Faroe Islands. A Danish company has secured the undertaking, and Denmark will contribute towards the cost.

Electrician Killed by Electricity.—At the end of last month, two electricians, working at Tatroz (Switzerland) after the regulation time, were struck by a discharge of electricity, which killed one of them outright and wounded the other one in his hand and his knees. The schoolmaster of Tatroz, who went to render assistance, nearly became a victim to his devotion, for the current hurled him backwards more than 6ft. The wounded man is reported to be out of danger.

Applied Mechanics.—This is the title of a new treatise for the use of students who have time to work experimental, numerical, and graphical exercises. The author is Mr. John Perry, M.E., D.Sc., etc., who is the professor of mechanics and mathematics in the Royal College of Science, South Kensington; a vice-president of the Physical Society, and a vice-president of the Institution of Electrical Engineers. Messrs. Cassell and Co. are the publishers, and the price of the book is 9s.

The World's Telegraph System.—The total length of the world's telegraph system has now reached 4,908,921 miles, exclusive of 180,440 miles of submarine cables. Of this, Europe has 1,764,790 miles; Asia, 310,685 miles; Africa, 99,419 miles; Australia, 217,479 miles; and America, 2,516,548 miles. United States Consul Germain, who sends these figures to the State Department from Zürich, says they show that notwithstanding the steady increase in the building of telegraph lines all over Europe, America leads the world, and has almost double the European mileage.

Electric Trains for Speed.—The *Chicago Tribune* says: "The project of an electric elevated railroad between Chicago and New York with running time of trains about nine hours would appear ridiculous were it not for the endorsement given it by electricians of high standing. The General Electric Company has offered to sign a contract to equip the road and guarantee a speed of 200 miles an hour by the use of the Tesla alternating current. Experiments in Massachusetts on the Old Colony Railroad demonstrate in convincing manner the merit of the alternating current when properly applied."

Swiss Railway Nationalisation.—Having adopted the preamble, as we announced in a previous issue, the National Council has now adopted, by 98 against 29 votes, the Bill authorising the Swiss Confederation to repurchase the five principal railways, according to the terms of the concessions, at the dates on which the latter determine, in 1903 as regards four of the lines, and in 1906 for the St. Gothard railway. Reuter says that the project will be submitted in February to the popular vote, as the referendum is sure to be demanded.

The Price of the Time.—The Mayor of Pontarlier, a town in France near the Swiss frontier, has issued a notice to persons desirous of subscribing for the electrically-regulated time of the town to send in their requests at once. The subscription is for a minimum of five years, and will commence on January 1, 1898, the remaining months of the present year not being counted. The subscription is fixed at 10s. a year payable in advance. The town pays for the establishment of the wires up to the house of the subscriber, but the latter has to pay for all interior installation. The cost of installing one clock varies with the size of it, but in no case does it exceed about 18s.

Electric Traction in Hawaii.—There are people who still hope to see the trams in Hawaii worked by electricity, but the local authorities seem to be waiting for an angel of enlightenment. The Chairman of the Hawaiian Tramways Company said at the annual meeting last week that at present the directors could not recommend any conversion of the system of working from horses to electricity, unless some inducement was offered to them by the local authorities. Should any inducement be held out to them at the forthcoming meeting of the Legislature, the matter would immediately receive the serious attention of the Board. We are afraid the Hawaiian authorities have this in common with some English bodies, that they are uncommonly slow to move.

Waterloo and City Railway.—It is satisfactory to note that such rapid progress continues to be made with this undertaking that it is hoped it will be ready for opening in the early part of January. The driving of the last of the station twin tunnels in the City is completed, while at the Waterloo end the whole of the work is practically completed, and the permanent way has been laid from the terminus to the working shaft in the river in one tunnel. The contractors for the electrical part of the undertaking are now at work in the tunnels where the rails have been laid, fixing the conductors and making the necessary connections. The erection of the generating station is well advanced, the shaft being nearly completed, while the boilers are ready for delivery, and everything is in readiness for the installation of the engines and dynamos.

A Monster Generator.—A three-phase alternating-current dynamo of somewhat unusual dimensions has just been constructed for the Edison Electric Illuminating Company, of Brooklyn, N.Y. This machine is of the revolving field type, with 40 poles and a normal output of 1,500 kw. when running at 75 revolutions. It is wound for an output of 2,000 kw. at 6,600 volts, and the armature windings are mounted upon the stationary part of the machine. These windings form one of the most interesting features of the construction of this class of machine, the method of coil construction and insulation being especially adapted to high-voltage work. The casting of the lower half of the armature has a span of 25ft. The vertical outside diameter of the armature frame is 31ft. 2in., and

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the length along the shaft 51in. The weight of the revolving field is 59,000lb., and the total weight 163,000lb.

The Liquefaction of Fluor.—At the Academy of Sciences in Paris on Tuesday, M. Moissan, a leading member of that body, read a paper written jointly by him and by Prof. Dewar. It related a long series of experiments carried on in London with the instruments devised and constructed by Prof. Dewar for the liquefaction of fluor. The refractory power of this extraordinary liquid has been accurately determined. Although it has been submitted to a temperature of – 210 C., it has retained its liquidity, whereas almost every chemical affinity of the most active of all known gases has disappeared under this intense cold. An exception must be made, indeed, for hydrogen and turpentine oil, which, even at that temperature, combine with fluor, and are incandescent.

Fire-Alarms.—A useful suggestion is made by a correspondent to the *Times* as regards communication with fire-brigade stations. Under the present system, to give an alarm of fire it is necessary to break the glass of one of the street posts, or call points, pull a bell knob, and wait until the engines arrive to direct them to the outbreak. This, although an expeditious way of summoning help, involves loss of time in ascertaining where the outbreak is, and the suggestion is that the system should be made a telephonic one if the telephone in the post can be made to speak so loudly that anyone near the post can hear it clearly without having to put a telephone to his ear, or, in fact, to do anything. It would undoubtedly be a vast improvement on the present system for many and obvious reasons, and, as far as we can gather, the subject is receiving attention at the hands of high officials, who are impressed by the importance of it.

Accumulator Traction.—An acquisition has been made by the Saxony Government railways of an accumulator railway wagon. The accumulators are carried on springs between the two axles underneath the body of the car, and there are two motors of 35 h.p. each. Some interesting trials took place a short time ago at Dresden in the presence of the Minister of Finance and several high officials of the Government railways of various countries, the route taken being from Dresden to Klotzsche. The accumulator wagon has a weight of 27 tons, and in the first trial a composite carriage was attached to it, making the total weight 40 tons. The gradient was 1 in 55, and a distance of 4⅓ miles was traversed in 19 minutes, which would give a mean of 13·7 miles per hour and would allow of about 22 miles on the level. In the second trial the passenger coach was taken off and three fully-loaded freight vans were substituted, making a total weight of 78 tons, and even this great weight was moved quite easily.

The Glasgow Telephones.—The enquiry which has been held at Glasgow into the defects of the local telephone service has been very lengthy. The proceedings at the last sitting consisted solely of speeches by counsel. On behalf of the dissatisfied subscribers, Mr. Ure, Q.C., M.P., pointed out, as showing the extent of the evil, that 2,700 subscribers out of a total of 4,183 had lodged complaints. For the Corporation, Mr. Salvesen declared that the present service was wholly insufficient, and urged the national importance of the enquiry, inasmuch as Glasgow's position was that of other cities, and if Glasgow obtained a license other cities would follow the same course. The company should have substituted overhead metallic circuit for the present single wires, or else have adopted the course pursued in London of utilising underground railway tunnels for an underground metallic circuit. Mr. Asher, Q.C., M.P., for the company, described the complaints as "idiosyncrasies." He attributed the defects of the present system entirely to the Corporation having refused underground wayleaves.

Underground Tunnelling.—A good deal of fuss was created in the papers a few days ago about a slight subsidence in Queen Victoria-street, which caused cracks to appear in the building known as Mansion House-chambers. The precautionary measure of barricading the building until the extent of the mischief could be ascertained was construed by most of the newspapers as an outward and visible sign of an alarming condition of things within. As the Waterloo and City Railway are tunnelling near the spot it was very easy for some individuals to put two and two together and make eight out of them, and one correspondent viewed with considerable discomfiture the state of London buildings when there would be innumerable electric railways burrowing in all directions underground. They evidently forget that subsidences arise from other causes besides electric railway tunnels. London soil is not particularly favourable for foundations, and when in addition to that enormously heavy buildings are erected on land which for centuries carried a brook known as Wall brook—though it has long been enclosed—one must expect cracks and other signs of settlement.

Science and Witchcraft.—When one considers the extraordinary effect some of our nineteenth-century inventions have had upon the ignorant savage in different parts of the world, one is led to wonder what Mr. Rider Haggard's intrepid explorers in "She" and "King Solomon's Mines" might not have accomplished had they been able to include in their outfit a Röntgen ray apparatus. With such magic appurtenances they might even have overcome the prejudices of the old lady who so unkindly shut the door on them in King Solomon's treasure-house, and might have returned triumphantly to England and settled down to a quiet and virtuous life of electrical company promotion. If those treasures are still there, we offer Mr. Haggard the suggestion for a new novel concerning them in which the principal recovery agent shall be the Röntgen rays; and we hope that another author has not purloined those hoards. At any rate we can say this, on the authority of the *Cape Argus*, that the natives really are amazed at this grim photography. A Kaffir patient having had his finger photographed to show the position of a foreign substance, was so struck by the result that he immediately put it down to witchcraft.

Uniformity in Regulations.—The Public Works Department of the Government of India have published the draft of the rules which it is proposed to make in exercise of the power conferred by Section 4 of the Electricity Act, 1887, and in supersession of the rules issued under the notification of May 3, 1889. To all intents and purposes they are word for word the same as the regulations issued by the Board of Trade in England, which is an exceedingly satisfactory arrangement, because it is always advisable to have as much uniformity in this respect as is possible. There are a few cases where the Indian rules differ from the English. For instance, one clause gives power to the local government to instruct the district magistrate, or, in a Presidency town, the commissioner of police, as to the roads or public place in which overhead electric wires are not to be allowed. Another clause fixes 33deg. F. as the maximum temperature which may be raised in the conductor by the working current. This is 3deg. higher than in England—a difference due, no doubt, to climatic conditions. Another clause enacts that only one side of a street may be occupied by aerial lines, except with the approval of the local government and of the telegraph authority. These are practically the only variations on the English rules.

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The Telegraph in Ceylon.—From the report of Mr. E. O. Walker, superintendent of post office, telegraphs, and electrician in Ceylon, we learn that the lines were increased by 46 miles of line and 154·21 miles of wire in 1896, but reduced by dismantlements and by transfers to the telephone system in Colombo by 30·75 miles of posts and 8·75 miles of wire. The net lengths are now 1,020·59 miles of posts, 1,878·55 miles of wire, and 217 miles of cable. Of the miles of wire, 1,497·68 are departmental, 376·42 miles for railway purposes, and 4·45 miles for the Batticaloa Customs. The extensions carried out during the year were departmental wires from Colombo to Gampola and to Kalutara, respectively 80·21 and 27·5 miles in length; a line from Gampola to Nuwara Eliya (21 miles) and from Batticaloa to Kalmunai (25 miles). A bell circuit of 0·5 mile in length was erected for the railway. The departmental wire, partly hung upon cocoanut trees and partly upon posts on the road between Galle and Matara, was transferred to the new railway posts. The extensions to be carried out in 1897 are from Puttalam to Mannar, Avisawella to Yatityantota, Haputale or Ratnapura to Balangoda.

The Siemens Jubilee.—This is a year of jubilees, and even the electrical profession is not left out. Messrs. Siemens and Halske on Tuesday celebrated the fiftieth anniversary of the establishment of their firm at Berlin. The event has caused a very great amount of interest, and congratulations were presented at the celebration meeting by deputations from the Berlin, Charlottenburg, Vienna, St. Petersburg, and London branches, and a number of presents were offered, including a portrait of Herr Werner Siemens, painted by Koner. Herr Carl Siemens read a deed establishing a fund of a million marks for the benefit of the workmen and officers of the firm, and providing for the appointment of a committee of officials to consider the best means of employing the money. Herr Wilhelm Siemens delivered a speech, dwelling upon the two guiding principles of the firm—scientific research and perfection of work. Congratulations were also presented by Herr Delbrueck, Minister of State, on behalf of the Association for the Promotion of Industry, and by Privy Councillor Herz on behalf of the Berlin mercantile community. Mr. Alexander Siemens has attended these functions to represent the English firm of Siemens Bros. and Co., and his absence from this country for this purpose explains the continued doubt as to his recent statements to an interviewer on the engineers' strike.

New Tunnellings in Prospect.—The proposal to construct a railway from St. Laurent to Geneva for the purpose of obviating the loss to French transit which would result from the completion of the Simplon Tunnel is being actively taken up. The Council of the Vosges, of which MM. Méline, the Prime Minister, and Boucher, Minister of Commerce, are both members, recently passed a resolution in favour of the new line, and the example has been followed by other departmental councils. The projected line would only be 30 miles long, but it would include 4½ miles of tunnels, of which the longest would be that of the Col de la Faucille, 2¼ miles, and several viaducts. The estimated cost is only £1,440,000, but it is computed that the St. Gothard Tunnel has caused an annual loss to France of £1,600,000, which figure, of course, will be increased by the Simplon Tunnel. The St. Laurent du Jura to Geneva line would permit of reductions of carriage rates on goods from Paris, Dieppe, and Havre, varying from 3fr. 60c. to 16fr. 40c. per ton, or even 33fr. 05c. by express. Fares from the same places to Geneva would be reduced 13fr. 55c. first class, 9fr. 15c. second, and 5fr. 95c. third class. Goods from England, Belgium, Calais, Dunkirk, Boulogne, etc., would be carried at from 12fr. 40c. to 28fr. 95c. per ton cheaper according to what they were, while fares would be reduced 21fr. 40c., 14fr. 45c., and 9fr. 40c. according to class.

Siamese Progress.—Western Europe has been greatl interested lately in the visits of the King of Siam, and electrical engineers will be pleased to learn that the electrical prospects of Siam are of a most hopeful and encouraging nature. The King's palace, some of the temples, and the principal streets of Bangkok are already lighted by electricity, and an American engineer has formed a syndicate and taken over the management of the work from the Government department which had been carrying it on. He has obtained from the Government a contract to last for 20 years, with a monopoly of electric lighting in Bangkok. The present capital is £6,000 in 100 shares, 50 of which are held by American citizens, 41 by British subjects, five by Germans, and four by Siamese. It is probable, however, that the capital will be increased to four or five times its present amount, and the syndicate converted into a limited liability company, registered as British. The consular report for the district of Bangkok shows that in 1896 the exports amounted to £3,036,291 and the imports to £2,104,432, there being an increase under both heads on the previous year. By far the greater portion of the trade is done through the three British ports of Hong Kong, Singapore, and Bombay, and it is very satisfactory to learn that the finances of the country are being placed on a sounder basis by an English financial adviser, with European assistants.

Municipal Elections and Trams.—The question of municipalising electric undertakings seems to be as important in America as it is in England, judging by the fact that it forms one of the "planks" in the platform of Mr. George, who is a candidate for municipal honours in New York. To any municipal councillors among our readers we commend the following extract of a terse report in the *Times* of Mr. George's speech, as affording an excellent comparison between the way such matters as elections are dealt with in America and in England.: "In a brief speech Mr. George said that he was cheated out of the election of 1886 and Mr. Hewitt was counted in—a calumny which he has suppressed for 11 years. The platform drawn up by Mr. George reaffirms the Chicago platform—of which he the day before repudiated the chief principle, Silverism—hails Mr. Bryan as future leader, upbraids Tammany for disowning Chicago, advocates the municipal acquisition of street railways, gas and electric plants, telephones and telegraphs, omitting to say whether they should be paid for, proposes the reassumption of the wealth which justly belongs to all by equitable scientific taxation, and so redistributing the confiscated property as to enhance the prosperity of individuals while benefiting the community." There is a comprehensiveness and vigour about these remarks which reminds us somewhat of the full-blooded orations of our old friend Mr. John Burns, but we could have wished that Mr. George was not in favour of municipalising street railways.

The Engineering Crisis.—The only change we have to record this week in the position of affairs is the growing uneasiness in the labour camp. Two appeals for financial help have already been made—one to Australia and the other to the general public of this country. The employers have given no sign, and still maintain the same attitude of determination not to give way. Comparing both sides impartially, one is led to the conclusion that the end of the strike is not very distant, and that the men are on the losing side. There is already a strong feeling among the

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men that a ballot should be taken of the whole of the men now idle with a view of ascertaining their opinions repecting the advisability of approaching the masters and effecting some sort of compromise. This feeling is being held in check as much as possible by the leaders, but once having appeared it is sure to spread. The fourteenth distribution of strike pay to the 70,000 men now on strike or locked out throughout the United Kingdom took place on Saturday. The total sum disbursed was estimated at £35,000. The Executive Council of the Engineers' Society have decided to increase the weekly levy to be paid by the engineers still at work, which already amounts to 4s. The latest returns with respect to the number of them now idle are as follows: engineers, 31,000; allied workers, 20,000; non-unionists, 8,000; labourers, 11,000—total, 70,000. On Saturday the Engineers' Society received £875 towards the lock-out fund, including a grant of £300 from the Amalgamated Society of Carpenters and Joiners, and £500 from the Stonemasons' Society.

Royal College of Science.—The session of the Royal College of Science was opened last week, when an address was delivered by Prof. Roberts-Austen, C.B., who referred to the part taken by his Royal Highness the Prince Consort in establishing the School of Mines, out of which the Royal College of Science had grown. At the opening ceremony on May 12, 1851, at the museum in Jermyn-street, where the School of Mines found a home, the Prince Consort had used the following words: "I rejoice in the proof thus afforded of the general and still increasing interest taken in scientific pursuits, while science herself, by the sub-division into the various and distinct fields of her study, aims daily more and more at the attainment of useful and practical results. In this view it is impossible to estimate too highly the advantages to be derived from an institution like this, intended to direct the researches of science and to apply their results to the development of the immense mineral riches granted by the bounty of Providence to our isles and their numerous Colonial dependencies." Having taken this as his text, Prof. Austen passed in review the position of technical teaching in the fifties, and indicated the nature of the work done by the distinguished body of men, including Playfair, Hofmann, Huxley, Tyndall, Percy Smith, and others, who had gathered round Sir Henry de la Beche, and he showed that the great success of the students in all parts of the world had been attained by recognising that the main duty of the professors had been, not to train specialists, but to give men such all-round training as should enable them to deal successfully with any problems they might encounter in life.

Wireless Telegraphy.—The Post Office authorities are continuing daily the experiments in wireless telegraphy at Dover, and varying results are obtained, according to atmospheric conditions. Mr. Preece does not personally conduct the experiments, but he goes down occasionally to witness them and compare results, and advise as to future operations. The English authorities are endeavouring to obtain as satisfactory results as those achieved by Marconi, but up to the present time they do not appear to have been so successful. The receiving apparatus is sent out every morning on a trolley, so that it can be transferred to different parts of the coast. Strict secrecy is maintained in regard to the instruments, and when the experiments are concluded at the end of the day the apparatus is brought back to Fort Burgoyne and carefully guarded. The experiments are now being made within a radius of three miles of the fort. Hitherto they have been confined to two miles with the most successful results, messages being freely and distinctly transmitted. At the three miles' radius it is stated the results are not nearly so satisfactory. In order to transmit to a greater distance, the height of the vertical wire is to be increased. The pole at Fort Burgoyne is already a considerable height, but the use of the flying kite has been reverted to in order to test at greater heights. According to the *National Zeitung*, much better results have been obtained at Berlin. It is stated that the experiments which Prof. Slaby, with the assistance of military balloon detachments, has been conducting for some days, have proved extraordinarily successful. In spite of unusually adverse atmospherical conditions, messages were successfully conveyed between two stations over 13 miles apart as the crow flies.

The London Telephone Service.—The state of the telephone service in the Metropolis is calling for very serious consideration, and we are glad to see that the right people are taking it up. We have recorded in previous issues the course which the City Commissioners of Sewers have adopted of refusing to sanction the laying of underground wires for the company unless an improved service at a reduced cost is provided, and we observe now that the London County Council are following suit, though in a more ponderous way. At the instance of Mr. J. W. Benn, they have instructed the Highways Committee to report to the Council what steps can be taken to investigate the present position of the telephone service of the Metropolis. Mr. Benn argued rightly that the telephone did not occupy the same position of usefulness in London that it did in other places, while the charges for the privilege were considerably in excess of those paid elsewhere; and he suggested that the London County Council should either follow the course adopted by the Commissioners of Sewers, or else institute a municipal telephone service, which Sir Alexander Binnie estimated could profitably be done at about half the rent now paid. It is to be hoped that the Highways Committee will not "deliberate" too long, and that they will suggest some tangible method of relieving the telephone subscribers of the incubus of the monopoly from which they are at present suffering. Their position is the reverse of enviable, for, in the words of the *Financial Times*, "St. Martin's-le-Grand receives representations and protests with a stare of contemptuous indifference; complaints in the House of Commons serve merely as an opportunity for Ministerial snubs; and now we can do no more than faintly trust Mr. Benn and the London County Council."

An Electric Delivery Wagon.—A firm in Chicago seems to have done what English firms have not been able to do yet, and that is to turn out a successful and satisfactory delivery wagon driven by electricity. The *Electrical Age* publishes an illustration of a light and neat-looking wagon, together with some interesting particulars evidently supplied by the manufacturing company. The electrical equipment consists of 44 storage batteries of 100 amperes per hour capacity each, weighing only 13lb. each, and connected with a 3½-h p. motor, iron-clad and waterproof, of the four-pole pattern. The charging apparatus is very simple, and consists of an automatic stationary rheostat, which is equipped with meters indicating the proper volume of current and the number of amperes stored in the vehicle batteries. These have an apparatus which automatically disconnects them from the charging circuit when fully charged. The plugs of the connections, and the binding posts of the batteries, and the rheostat are correspondingly marked positive (+) and negative (−), so that no possible error can be made in placing them. The guiding lever is at the driver's left hand, and a smaller lever at the seat on the right reverses the machinery. The wheels bear on frictionless ball-bearing axles, and have 3in. pneumatic tyres. One of the wheels

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carries an odometer, and this has proved that as great a distance as 64 miles has, under favourable circumstances, been run with one charging of the batteries. The batteries occupy very little space, and they can therefore be so placed as not to injure the appearance of the vehicle. The manager of a large commercial house in Chicago says that from the odometer record they have found that the electricity costs about ½d. per mile. The wagons register from 30 to 42 miles a day each, and even then the batteries are not half empty at night.

The Future of the Motor Trade.—It will soon be the anniversary of the emancipation of motorcars and the triumphal progress to Brighton, and therefore it is in the fitness of things that we should hear of Mr. Harry Lawson at this period. He has been interviewed by a representative of the *Financial News*, and we are glad to learn that he was, "as usual, breezy and enthusiastic." We came to the same conclusion on perusing the questions and answers. "Progress and permanence of the motor trade?" he said. "Why, look at the motors every day in the streets—motor-vans, electric cabs, and all the rest of them! Everything that has been promised is being carried out, and with extraordinary rapidity. Between the first 'Puffing Billy' motor of George Stephenson and the second motor, 'The Rocket,' there was a period of 15 years, and 'The Rocket' is actually more simple than one of the motorcars of the present day. A motorcar requires months to build, and it is only by getting works thoroughly equipped upon the interchangeable system and making in large quantities, all of which takes time, that we shall be able to make them cheaply and rapidly. Every week we are now delivering actual English-made motors." Motor-vans, electric cabs, and all the rest of them! We should be inclined to put the electric cabs first, but anyone not in the habit of visiting London would perhaps have visions of roads blocked by motors, interspersed with a few dejected horses and disused cabs. From what we can see of the future of the motor-car industry—and Mr. Harry Lawson is not the only prophet—electricity will play an enormous part, but it is rather early to talk about a "triumph all along the line" now. Money can do a great deal, but it has its limits, and it cannot invent the best way to drive an electric omnibus. That is only accomplished by a severe course of trials and failures, but electricity and perseverance must win in the end.

The Ventilation of Underground Railway Tunnels.—We are now in possession of the report of the committee appointed by the Board of Trade to enquire into the system of ventilation of tunnels on the Metropolitan Railway. This, together with the proceedings of the committee and the minutes of evidence, has been issued as a Blue-book, and the result is—as one might expect—an expression of opinion in favour of electricity. That the ventilation of these tunnels is bad, anyone who has the misfortune to find it convenient to travel by them can testify only too strongly, but we need not enter into the reasons why it is so bad. It was at one time thought that an extensive system of fans would solve the difficulty, and so, perhaps, it would, but the cost is said to be considerable. The other alternative was the provision of additional openings, which also has the demerit of great expense. So the committee propose to compromise, having regard to the probable adoption of electrical traction in the near future, which they consider the most satisfactory mode of dealing with the ventilation of the Metropolitan tunnels. They say that they are prepared to recommend, as a temporary measure, that the construction of the additional openings, proposed by the Metropolitan Bill of last year, which would be found useful even when the line is worked electrically, should be allowed, but only upon the condition that, unless electric traction be adopted, or some satisfactory artificial ventilation be introduced within three years after the passing of the Act authorising those openings, it shall be made incumbent upon the company to close them if called upon to do so by some competent authority to be named by Parliament. There is considerable objection to these ventilating openings on the part of the local authorities on the grounds of public health and depreciation of property, and no doubt these objections will have considerable weight in favour of electric traction being adopted, but there is unfortunately not much immediate prospect of more comfortable conditions of travel on the underground railway.

Experimental Alternators.—The outfitting of laboratories with electrical apparatus for technical education is now a question of a mean between what is actually required and what the funds can afford. It is always the professor's aim in designing his laboratory outfit to arrange for his electrical machinery to have as many applications as possible. We remember that when Dr. Fleming selected the alternators for the University College he chose a combination of two direct-current motors with two small alternators, and arranged that the armatures of the alternators could be mechanically coupled up to give any desired difference of phase. Prof. Henry S. Carhart has recently described before the American Association for the Advancement of Science a different method of obtaining the same result. In this case only one machine is required, and the difference of phase is obtained by having a different number of poles in the armature to that of the field-magnet system. The field magnet is made to revolve, and is built up of two steel castings which have five poles. The castings are of the claw type, as used by several of our English makers, in which a single exciting coil is required. The field magnet hence has 10 poles and the armature is arranged with 12. Prof. Carhart gives the following dimensions of the machine: diameter of the armature pole faces, 10¼in.; length of faces parallel to shaft, 1½in.; width of polar faces, 1½in.; pitch of poles on armature, 2·68in.; depth of poles, ½in.; net cross-section of pole in square inches, 5·4in. The armature poles were wound with 40 turns of No. 16 wire. The double air-gap is ½in., and the field coil contains 1,012 turns of No. 16 double cotton-covered wire. The armature coils were wound in reverse order from pole to pole in the usual way. The ends of each armature coil are brought out so that they can be connected in any desired manner, and as the phase difference between the chasing coils is 30deg, or one-twelfth of a period, a large period of phase differenee can be arranged by alternators in the armature connections. If consecutive coils are connected in series, and the E.M.F. of the one coil is represented by E, the following values are obtained: with two coils 1·93 E, with three coils 2·73 E, with four coils 3·46 E, and with six coils 3·86 E. These are calculated values, but the author gives results which show that the observed values do not differ appreciably. With 2,000 ampere-turns on the field coil the following voltages were obtained with different methods of connection: the two-phase mesh connection, 79 volts; the two-phase star, 112 volts; the three-phase mesh, 69 volts; and the three-phase star, 121 volts. The alternator is arranged to be driven by a motor from a power circuit, so that an even driving force can be obtained, and owing to its small diameter a wide range of frequency can be employed. For laboratory purposes a machine as described above is much handier for obtaining a difference of phase than any method requiring alteration in mechanical coupling.

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BRADFORD ELECTRICITY WORKS EXTENSIONS.

The opening of new electric lighting works at Bradford is a new sign of the growth of municipal enterprise. Bradford took the lead in such matters, and other towns gained encouragement to proceed in municipal electricity works from the success of the Bradford undertaking. Mr. A. H. Gibbings has been responsible for the design of the electrical equipment of these new works, of which Mr. Thomas Barker has acted as architect. The contract for the buildings shown in Fig. 1 was carried out by Messrs. John Moulson and Sons, of Bradford.

The new works are situated at the corner of Valley-road and Lionel-street. The buildings are plainly but substantially built in local stone in the Renaissance style, adapted to the purpose for which the building is required. The works are in one block, and may be divided into office buildings, fronting Valley-road; engine and dynamo rooms placed behind the offices; and a boiler-house, running parallel with Lionel-street. On the ground floor of the former are the general offices for clerks and draughtsmen, lavatories, etc., opening out of a spacious entrance hall with tiled floor. A staircase leads up to the first floor, on which are a large committee-room (40ft. by 20ft., with windows overlooking the engine and dynamo room, so that the generating plant may be seen at work) and the electrical engineer's private office. The basement is utilised for the condensing plant, comprising surface condensers and electrically-driven air-pumps and centrifugal circulating pumps. The exhaust steam-pipes from the engines are brought under the floor of engine-house. All the floors of office building are of fireproof construction, built up of steel joists and cement concrete, and covered with wood parquetting. The dynamo and engine room (Fig. 2) is 85ft. long, 61ft. wide, and 28ft. high to the steel roof, which is in one span and boarded with pitch pine. Accommodation is provided for 12 engines and dynamos. A 12-ton travelling crane runs the whole length of engine-house, and is supported by a cornice with arches and pilasters. The architraves and imposts of the latter are of specially designed glazed moulded bricks of a Rockingham brown colour. The whole of the engine-house walls are lined with white glazed bricks above a dado of brown and buff glazed bricks. The floor, which is tiled, is supported on concrete arches and steel joists, beneath which is a basement for easy access to engine-beds, electric cables, exhaust-pipes, etc. All the switching arrangements are controlled from a platform which runs across one end of the engine-house. Owing to the nature of the strata in the valley bottom it has been necessary to carry the walls of the building some 10ft. below the natural surface of the ground, and to lay broad footings of cement concrete to get a stable foundation. In the engine-house, also, the whole area is covered with a thick layer of concrete on which the engine foundations are built, to ensure an equal distribution of weight and an absence of vibration. The boiler-house (Fig. 3) is 105ft. long, 48ft. wide, and 23ft. high to the steel lattice girders which carry the roof. The latter is provided with large louvred ventilators for carrying away escaping steam, and sky-lights for giving light. Accommodation is provided for seven steam-boilers of the marine type, made by Messrs. John Brown and Co., Limited, Sheffield, and fitted with Ellis and Eaves's system of induced draught, and also for the electrically-driven feed pumps.

In order that the coaling arrangements may be expeditiously carried out, and with as little labour as possible, the coal-carts enter by special entrance gates in Valley-road, and, after being weighed at the weigh-house, pass up a slight incline to a roadway running alongside the boiler-house, from which the coal may be easily tipped through the large doorways direct into the extensive bunkers below.

For condensing purposes a cooling reservoir has been constructed near the beck, some 90 yards distant from the works. The water, controlled by a sluice, can be drawn from the beck through a settling-tank into the reservoir. The latter is constructed of brickwork in cement, concrete, and masonry. Efficient cooling of the condensing water is attained by the architect's system of guide walls, by which the water is given time to part with its heat by travelling a maximum distance before returning to the condenser. From the reservoir the water travels in large cast-iron pipes to a well—built of brickwork in cement and concrete—near the engine-house, whence it is drawn by the circulating pumps to the surface condenser, from which it returns in open cast-iron troughs to the reservoir.

Steam Generating Plant.

The boilers and accessories were supplied by Messrs. John Brown and Co., of Sheffield. These boilers can be seen in position in Fig. 3. They are of the marine type, fitted with Ellis and Eaves's induced-draught apparatus, each providing steam for 600 i.h.p. when working on a consumption of 20lb. of water per indicated horse-power, and capable of providing 800 i.h.p. when forced. They are made in accordance with Lloyds's rules and regulations for a working pressure of 200lb. per square inch. The motive power for working the induced-draught apparatus is provided by two electric motors developing 21 b.h.p. each, supplied by Messrs. Ernest Scott and Mountain, Newcastle-on-Tyne. The electrically-driven feed pump is also by the same firm.

Steam and Exhaust Pipes.

The main steam-pipes are 10in. diameter. They traverse three sides of the engine-house and one side of the boiler-house, forming a complete ring. The straight pipes are of

FIG. 1.—The New Electricity Works, Bradford.

mild steel, lap welded, and fitted with special stamped steel flanges, male and female, on the faces. The tee and cross pipes, from which the connections to engines and boilers are taken, are of cast iron of the highest quality. The 10in. mild-steel bends at the corners of the rings are a special feature, being of large dimensions to give to the expansion. The valves for the steam-pipes are of Messrs. Hopkinson's make. The exhaust-pipes vary from 20in. to 14in. diameter, and are all fixed underneath the floor, with the exception of the large breeches pipe and the two 14in. copper bends connecting to the engines. Every joint has been arranged so as to be easily accessible in case of leakage. The valves for the exhaust-pipes were made by Messrs. Fletcher Bros., of Ashton-under-Lyne. The steam-pipes in the engine-house are supported by hangers from cast-iron brackets fixed to the walls. Those at the office end are of very ornamental design. The pipes in the boiler-house are hung from the roof girders, and arrangements have been made so as to give freedom of expansion in all directions. The pipes are of the following radial thickness respectively:

10in.	bore steel pipe	$\frac{3}{8}$in.
6in.	„ „	$\frac{1}{4}$in.
4in.	„ „	$\frac{5}{16}$in.
10in.	„ cast-iron tees	1in.
6in.	„ copper pipe	$\frac{1}{8}$in.
4in.	„ „	$\frac{1}{6}$in.

The whole of the pipework has been supplied and erected

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complete in a very satisfactory manner by Mr. John Spencer, of the Globe Tube Works, Wednesbury, from the designs and to the specification of Mr. Gibbings.

A surface-condensing plant has been installed, including air and circulating pumps driven by electric motors supplied by Messrs. Rosling and Appleby, Bradford. This plant is capable of condensing 30,000lb. of steam per hour at a temperature of 200deg. F.

Generating Plant.

At present two sets of engines and dynamos have been fixed, but these will be added to shortly. The engines are of the Willans patent central-valve triple-expansion type, having three cranks at 120deg. apart. Each engine is capable of developing 600 i.h.p. when running at 300 revolutions per minute with a steam pressure of 180lb. per square inch at the stop-valve. The cranks run in a bath of oil, which automatically lubricates all the working parts. The range of speed is capable of being regulated by hand gear on the governor between 270 and 300 revolutions per minute.

Dynamos.

The two dynamos were supplied by Messrs. Siemens Bros. and Co., and are of the six-pole type. These machines are worthy of special note, as being the largest direct-current machines manufactured in the country. Their general appearance can be seen in Fig. 2, while a more detailed illustration will be found in our issue of December 4, 1896. As there were one or two mistakes in the description given to us at that date, we may again detail the general features of the dynamos. They are coupled directly to the engines, the output of each set being 750 amperes at 500 volts at a speed of 300 revolutions per minute. The armatures are built on the Siemens drum principle, with stranded bar conductors. In this instance the diameter of the armature is nearly twice the length of the pole-pieces. The commutator has 211 segments, and there are two sets of brushes placed at 60deg. angular distance apart,

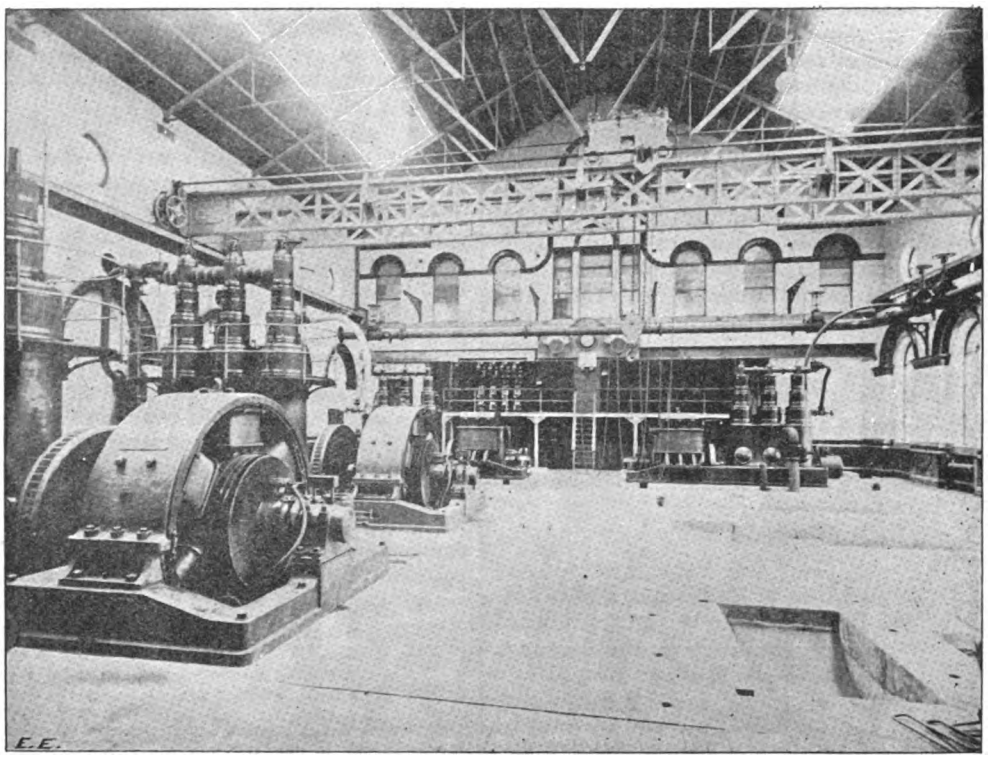

FIG. 2.—The Engine-Room at Bradford.

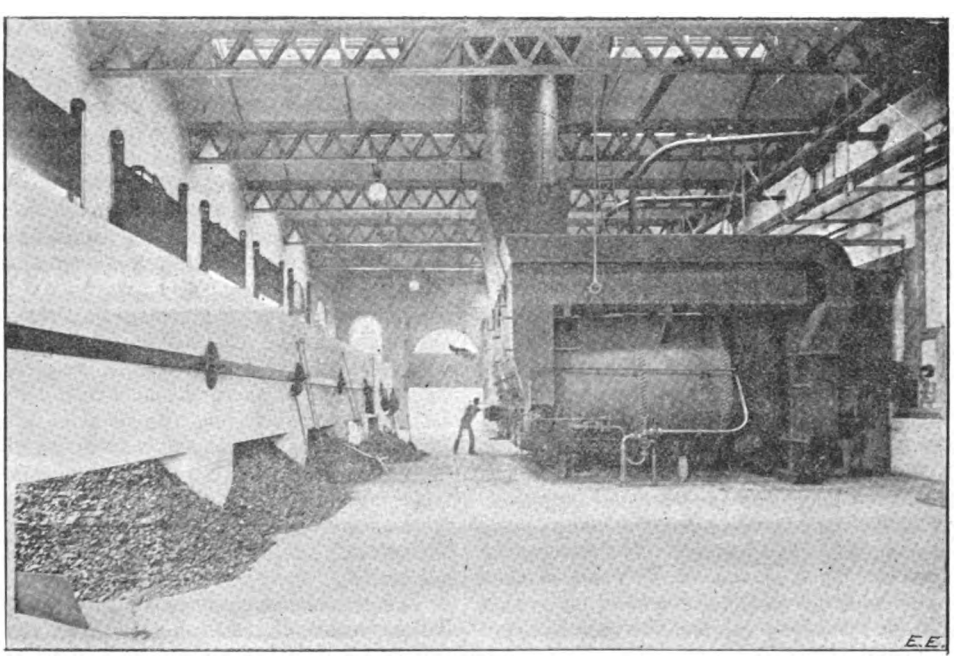

FIG. 3.—The Boiler-House, Bradford.

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each set consisting of three brushes. The armature resistance from brush to brush is less than one-hundredth of an ohm. The weight of the complete armature is 6½ tons. There are six field magnets, arranged equidistant inside a heavy cast-steel ring, which forms the common yoke, and is 8ft. in diameter over all. The pole-pieces are rather more than 2ft. across, and the wire is wound on iron formers with wooden flanges. All six magnet coils are connected in series, and have a total resistance of 41 ohms. They are connected in shunt to the armature, with regulating switch and resistance in series. The complete ring of magnets weighs 11 tons, bringing up the weight of the whole dynamo, inclusive of bed-plate, to rather over 21 tons. Advantage was taken of there being two similar machines before delivery by the firm to test them by the Hopkinson method, when the following total efficiencies for the double conversion were measured: at quarter-load, 90½ per cent.; at half-load, 94¼ per cent.; at full load, 95½ per cent. This gives, assuming that the two machines are equally efficient, as we have a right to do, that the commercial efficiency $\frac{\text{E.H.P.}}{\text{I.H.P.}}$ for each machine is 97·73 per cent. At half-load this efficiency falls to 97·08 per cent., and at quarter full load to 95·13 per cent. These are wonderfully high figures, and we know of no multipolar dynamos to compare with them.

Switchboards.

This part of the new plant was manufactured and supplied by Mr. G. A. Steinthal, of Bradford. The switchboard, which can be seen in the distance in Fig. 2, is worked from a platform elevated some 6ft. 6in. from the floor-line. The switch-gear and fuses are all placed above this platform on 10 slate panels, each 6ft. 4in. high and 1ft. 6in. broad. The panels are made of 1½in. polished slate, and are screwed to wood frames. Ten similarly spaced panels, also 1ft. 6in. wide, but only 3ft. high, are placed below the platform to hold the electricity meters required for the various circuits. Fig. 4 shows two views of the equipment of one of the upper panels, which contain the following instruments and apparatus suitable for handling 600 amperes at 250 volts; one Lord Kelvin's ampere-gauge; one two-way knife switch; one Siemens magnetic cut-out; one shunt-regulating switch-gear, including a carbon-tipped two-way switch and resistance; and two fuse blocks. There are two panels with this outfit, and two with arrangements for dealing with 750 amperes at 500 volts. In these a single-way switch is used, and a Kelvin electrostatic voltmeter is added. Only four of the 10 panels are fitted up at present, and the other slabs will be equipped as the corresponding machinery is laid down.

Fig. 5 shows the details of the under-panels, containing the Thomson-Houston recording wattmeters. The positive and negative 'bus bars, which pass along the back of the switchboard, are each 3in. wide and 1in. thick. They are some 30ft. long, and are supported from the frames, as shown in the illustration. The middle, or neutral, 'bus bar is of the same width, but only ½in. thick.

Cables.

The new station at present is used for feeding the distributing switchboards at the old station. The cables connecting these works to the old electricity works in Bolton-road were supplied by the British Insulated Wire Company, of Prescot. The distance to be traversed is 1,030 yards, and five cables have been laid, each of 1·5 square inch sectional area. The cable used is insulated by hemp paper impregnated with resin oil. The insulation is protected by a lead sheathing ⅛in. thick, and the whole cable is then armoured by two ribbons of steel tape wound on so that they break joint. A three-core pilot cable has also been laid alongside the above mains.

The estimated cost of the new work described above is as follows, and it must be borne in mind that the buildings are arranged to hold much more plant than has been now installed: buildings, £11,500; condensing reservoir, £220; machinery, including engines (two 600 i.h.p.), £4,400; dynamos (two 600 e.h.p.), £2,650; feed pump, £175; boilers (two), £3,000; weighing machine, £100; steam-pipes, valves, etc., £1,135; condensing plant, £1,500; electric lighting of building, £50; batteries, £750; new switchboard, £500; cable (for extensions), £4,000; travelling crane, £320; cables (for change to three-wire system), £9,700. Total, £40,000.

The Opening Ceremony.

The Mayor of Bradford opened these new works on Friday last. He was presented with a gold key for the opening ceremony by Mr. W. E. Aykroyd, the deputy chairman of the Gas and Electricity Committee. When the company had passed into the building, the Mayor made a speech referring to his past connection with the undertaking. He remarked that at the laying of the corner-stones of that building 16 or 17 months ago he expressed the belief that before 12 months had passed the use of electric motors by persons wanting small power or power of an intermittent character would be 10 times as great as it then was. The requirements then amounted to about 50 h.p. at the outside, and to-day the demand in connection with motors was 642 h.p. He had seen much larger stations than that which he was about to open, but its arrangements were so complete, perfect, and up-to-date that under any conditions the work would be done as cheaply as, if not more cheaply than, at any other station.

After Mr. Aykroyd had started the first engine, the company adjourned to the town hall for luncheon, after which the usual congratulatory speeches were made. In the course of his response to the toast of the electrical engineer, Mr. A. H. Gibbings read the following verse, composed for the occasion by his father, Mr. R. Gibbings:

> The rebel light that rends the clouds to smite
> The trembling earth on homestead, turret, tree,
> That shakes with storm the hours of peaceful night
> And racks the heaven with dread artillery:—
> The wild, weird spirit of tempestuous skies
> Has stoop'd to man, subservient to his use,
> To wield a Titan's strength, to bind and loose,
> To move his lumbering wheels, in dark disguise,
> To give him speech o'er continent and sea,
> Or, like another sun whose glorious light
> Is flashed in full-orbed stars, to turn his night
> To day; and so henceforth, perchance to be
> His latest, crowning servitor sublime
> Through all the rolling mystery of Time.

The following sketch of the inception and working down to the present time of the Bradford electricity supply undertaking will be of interest to our readers: The Bradford Corporation were the first public body in the kingdom to adopt electricity as an illuminant. This was brought about in the year 1888, in consequence of notices being received from promoters of various companies of their intention to apply for powers to commence operations in the borough, the Corporation very wisely, as subsequent events confirmed, resolving to take the initiative and keep out the companies by themselves applying for powers, though even those most in favour of taking this step were none too sanguine as to the success of the results, seeing that they had no similar municipal undertaking to which they could turn for guidance in launching the new venture. Alderman F. Priestman, at this time chairman of the committee controlling the gas supply, which, by the way, was also in the hands of the Corporation throughout the greater part of the borough, took an active part in bringing the electric lighting scheme to a successful issue, and through his energetic efforts, and those of other members of his committee, a start was made with a capital outlay of £20,000, and in September, 1889, the works were opened for the supply of current to the public. The system adopted was the two-wire continuous-current system.

The generating plant consisted of three Lancashire steel boilers, each of 180 i.h.p.; three steam-engines of the inverted vertical type, each of 150 i.h.p., and working at 120lb. steam pressure, two being supplied by Messrs. Willans and Robinson, Thames Ditton, and one by Messrs. Marshall, Sons, and Co., Gainsborough. These engines were direct-coupled to Messrs. Siemens Bros. and Co.'s dynamos, developing 120 e.h.p. (90 kw.) each. About 10 miles of cables were put down, including four feeders, and this work was entrusted to Messrs. Siemens Bros. and Co., who were also the manufacturers. This firm also

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supplied the necessary electrical instruments and apparatus for controlling and regulating the electricity supply.

The small number of consumers connected to the mains at this time only necessitated the plant being run for a few hours before midnight, as there were no motors in use to demand a day load. Nevertheless, steady progress was made during the first few months, and so satisfied were the consumers with the light and the price charged for the current (5d. per unit), that others soon began to appreciate its advantages, and in 1890 applications for light were so numerous that the works had to be extended at a cost of an additional £30,000. A portion of this extension consisted of a secondary battery of 70 cells, each of 1,000 ampere-hours capacity, which was an efficient reserve power for use during the night, and further improved the steadiness of the supply, besides proving a source of great economy in the working of the station.

By the end of the year 1891 the number of consumers had increased considerably, as may be gathered from the fact that over 10 miles of additional mains had been laid, and the number of units sold amounted to 239,361, the total cost per unit sold being 2·47d. As showing the excellence of this result it may be said that the cost per unit sold for the previous year (1890) amounted to 4·10d. The supply was now uninterrupted throughout the 24 hours, and it may be mentioned that a few electric motors had been connected during the year, and in consideration of the fact that the station had only been running two years, the prospects for the near future were very satisfactory to contemplate. In 1892 further additions to the generating plant became necessary, and the year's working realised the handsome profit of £1,385. Thus the concern began to be looked upon less as an experiment and more as a practical and profitable addition to the Municipality's many important undertakings. In the year 1893 Dr. Hopkinson's three-wire system of distribution was resolved upon, and in all subsequent extensions of mains a third wire was laid. The sum of £30,000 was required for the further necessary extensions, and borrowing powers were obtained for this sum, and the £50,000 already expended, thus bringing the total capital of the undertaking to £80,000. A substantial increase in the net profits was the result of this year's working, the sum of £1,805 being set aside. The year 1884 was a still further successful one for the undertaking, and extensions to the plant had again become necessary. On the advice of the engineer the committee adopted the marine type of boiler, its quick steam-raising qualities being considered of very material advantage in the case of a sudden call upon the station through dull or foggy weather intervening, and orders were placed for two boilers fitted with Ellis and Eaves's system of induced draught and two Willans-Siemens sets of 300 i.h.p. each. In the year 1895, the full capacity of the plant was 18 per cent. below the maximum possible demand, and the committee saw that the interests of the electricity department would be seriously handicapped in the event of the breakdown of any engine or dynamo, as there was no stand-by plant to rely upon in case of emergency. The committee therefore determined, in consideration of the report of the engineer, to build a new station in a situation more suited to future extensions than that of the present one, and a favourable site having been chosen, borrowing powers were obtained for another £40,000, and work upon the new station was proceeded with in the early part of 1896, as there was little time to be lost if the committee were to adequately cope with the growing demand for the supply.

In the meantime, the committee had not been idle in other directions, and during the summer all the consumers who were being supplied at a pressure of 115 volts were changed over to the double pressure of 230 volts, the Board of Trade having sanctioned the increase of pressure up to a maximum of 300 volts. Meanwhile the contractors were progressing with the new station, and on May 27, 1896, two foundation stones were laid by the chairman and deputy chairman respectively (Councillors W. C. Dixon and Thos. Speight). It was an interesting function, most

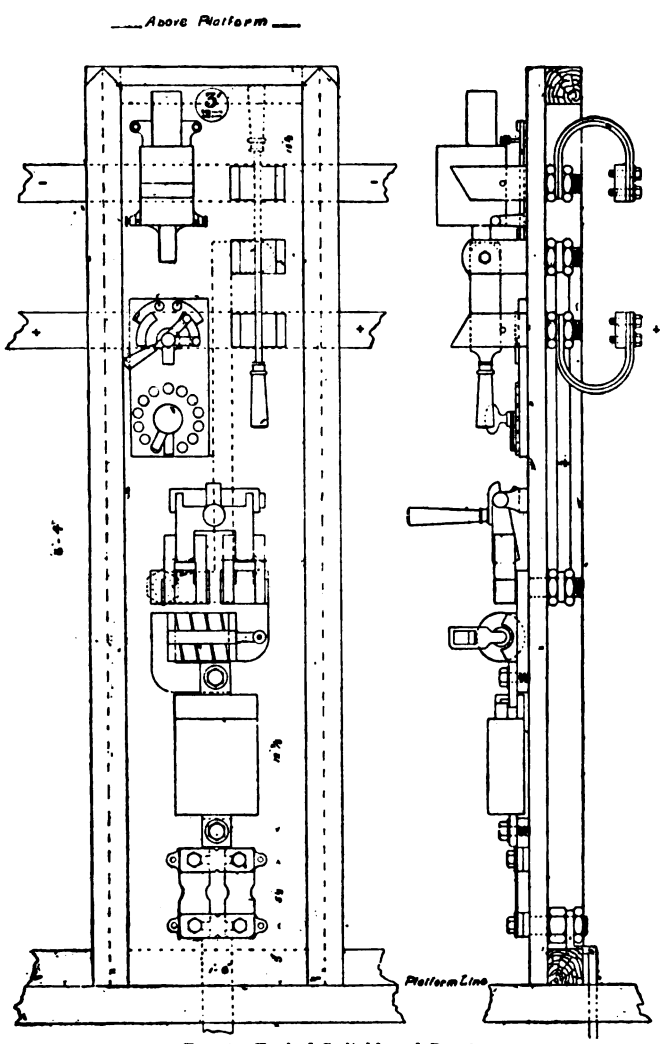

FIG. 4.—Typical Switchboard Panel.

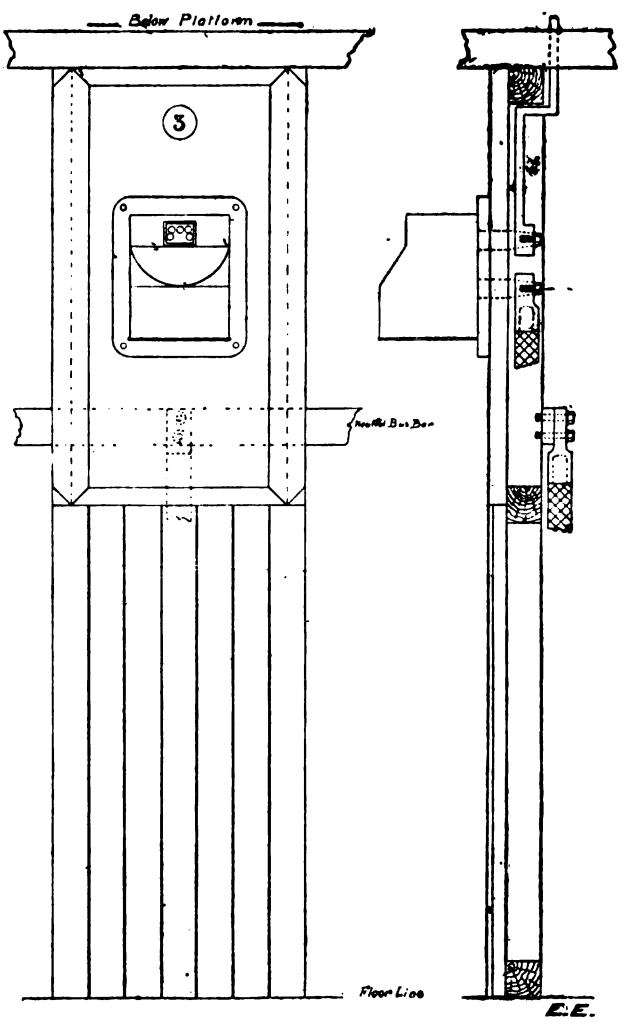

FIG. 5.—Meter Panel, placed under the Switch Gallery.

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of the members of the Council being present, and the laudatory speeches and the enthusiasm displayed were sufficient in themselves to show the importance with which the electricity department had come to be regarded in the borough. This was indeed an eventful year in the history of the electricity department. It was decided to reduce the price charged for motive power to half the price for lighting—namely, 2½d.—and this was to come into force from January 1, 1897. But the enterprise of the department did not stop here, as at the end of the year the engineer's scheme for the free supply of lamps to consumers came into operation, and the town is to be congratulated upon the fact that it was the first, either on the Continent, in America, or the United Kingdom, to adopt such an innovation. The advantages to be derived from this scheme were incalculable, as the Corporation were enabled to supply to their consumers the best and most efficient lamps on the market, besides cheapening the cost of the supply.

How fully consumers appreciate the enterprise which the department has shown in this direction will be apparent from the following fact: The number of accounts outstanding at the end of August, 1896—that is, at the end of the first two months after the expiration of the half-yearly meter readings—were represented by £1,000 on a gross income of £6,000, or 16⅔ per cent. At the present time—that is, at the end of August, 1897, the corresponding period to last year—the outstanding accounts are under £660 on a gross income of over £8,600, or under 8 per cent., and these outstanding accounts represent electricity used for other purposes than lighting. It cannot be gainsaid, therefore, that consumers have been encouraged by this innovation to settle their accounts promptly. The committee were also fully alive to the importance of having a day load to provide for, in order to enhance the utility and success of the department, and were successful in accomplishing their object by deciding to let out on hire motors and arc lamps. The results fully justified the step taken, as in less than six months' time over 40 additional electric motors were connected to the supply, bringing up the demand for motive power during the daytime to an equivalent of 300 h.p., and there was an equal demand for arc lamps. The combined horse-power of all the motors connected to the supply up to the present time reaches a total of 642.

The following figures show the financial results for the year ended in 1896:

Total capital expended	£105,275
Total revenue	16,195
Percentage of gross profit to capital, per cent.	11·39

The total revenue was allocated as follows:

Total revenue		£16,195
Interest	£2,301	
Depreciation	3,000	
Sinking fund	2,803	
Working costs	6,143	
		14,247
Net profit		£1,948

Cost per Unit.

Working costs	1·03d.
Management expenses, including rent, rates, and taxes	0·78d.
Interest, depreciation, and sinking fund	2·39d.
Total costs	4·20d.
Average price obtained per unit	4·66d.

The amount set aside for depreciation and redemption of capital—namely, £8,104—was 7·69 per cent. upon the total outlay. The above figures are conclusive evidence of the commercial success of the department, and this success has been undoubtedly attained in great measure by the energy and sound business qualities of the several chairmen whom it has been the good fortune of the concern to have had at the head of its affairs.

The name of Alderman W. Moulson will always be closely associated with its early history, in the days when its prospects were not so promising as now. It fell to the lot of Councillor W. C. Dixon also, who took office at a time when a strong hand was needed at the helm, to contribute considerably to its profitable development, and his disinterested labours in its behalf are beyond all praise. So also are the services of the present chairman (Councillor Thos. Speight), now filling the mayoral chair with marked distinction. The tact and ability which he has displayed in the performance of the duties devolving upon him as chairman of the Gas and Electricity Supply Committee have met with the commendation of all who are interested in the affairs of the Municipality, and he has beyond doubt proved himself fully capable of carrying out successfully the work so ably controlled by his predecessors.

NOTES ON ACCUMULATOR CONSTRUCTION.

BY DESMOND G. FITZ-GERALD.

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IV.

In connection with the question of the permissible thickness of the layer of active material on a conducting support, it is important to note (1) that the effective surface of a smooth plate (and *a fortiori* of a grooved plate) of given size (say one square foot) is greater than the interior surface of any (practical) grid or perforated plate of the same size and weight; and (2) that the weight of active material that can be effectively distributed over a given extent of surface depends upon the form of the support, and is greater in the case of a smooth (or grooved) plate than in the case of a grid of the same size (say one square foot) and weight.

The non-recognition of these facts has occasionally led to grave misapprehensions, under which electrical engineers have regarded as contradictory and paradoxical results which are quite susceptible of explanation. Notably, in the experimental trials of the Tommasi accumulator on the Liège tramways, it was found that 70 per cent. of the total lead in the cells constructed by the Compagnie Industrielle d'Accumulateurs was active material. Now in the experimental investigation of Prof. Eric Gérard, which has already been referred to, the conclusion was arrived at that the 35 per cent. of active material in the Julien grid was greatly in excess of what could be utilised in practice. The double percentage in the Tommasi accumulator appeared therefore an absurd proportion. And yet this form of cell could not well be condemned, since it was found in actual practice that 672 kilos of the Tommasi plates could do nearly the same amount of work as a double weight of the plates previously in use. The weight and bulk of the new battery were, in fact, 40 per cent. less than those of a battery supposed to be more rationally constructed. Well might the engineer-in-chief of the Belgian Railways, also Chef de Cabinet of the Minister of Railways, Posts, and Telegraphs, report that "it may be enquired to what extent, and wherefore, the results obtained by an increase of the thickness of active material are in contradiction to those which were obtained in the trials at Antwerp, Brussels, and Hamburg." The explanation is that in these trials the conducting support was a grid; and in this case, as is sufficiently obvious, the whole of the active material is by no means necessarily traversed by the current, whilst a considerable proportion of the latter, starting from those portions of the grid which are coated only by a film of peroxide (or spongy lead) does not traverse any of the active material in bulk, but passes in the path of least resistance, evolving free gases in waste long before the whole of the active material is converted. Whereas in the other case we have to consider an *embedded* conductor, from or to which the current cannot pass without traversing the whole bulk of active material; with the exception of those portions which, when the battery is over-discharged, may have become converted into non-conducting sulphate of lead not in contact with the metallic support. This non-conducting sulphate is essentially $PbSO_4$, *not* Pb_2SO_5.

V.

Most important also—in view to the production of a light and durable accumulator—is it to note the conditions which are favourable and unfavourable to destructive local action between the peroxide of lead and its metallic support. The conditions essential to a "single-fluid" voltaic circuit are that two conductors, relatively electro-positive and electro-negative, shall be, directly or indirectly, in metallic

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(as distinguished from electrolytic) contact with each other, and that these conductors should *both* be in contact with the electrolyte. Let us pass from the general to a particular case—that of the lead accumulator, in which there are two distinct circuits to be considered—viz.: (*a*) The main or efficient circuit—from the spongy lead, across the electrolyte to the peroxide layer; thence to the peroxide support, by those portions of it which may be directly in contact with the peroxide layer; thence through an external (wire) circuit to the spongy-lead support; and lastly, to the spongy lead through those portions of its support which may be directly in contact with the spongy lead. (*b*) The local, inefficient—but destructively effective—circuit between the peroxide layer and its metallic support; the path of this circuit is from the latter *electrolytically* (not possibly by simple conduction without reversing the normal direction of the current by means of an external E.M.F.) to the peroxide; thence completing the circuit to the peroxide support through those portions of the latter which may be directly in contact with the peroxide.

At the risk of appearing diffuse, where the brevity of Captain Cuttle should be aimed at, I must emphasise these laws of the circuit by a few cogent examples in the examination-paper form.

1. I take a plate of lead which has been coated, *secundum artem*, with a coherent film of lead sulphate, and over this I spread a layer of peroxide of lead, which I consolidate and maintain in position by suitable means. The prepared plate being immersed in dilute sulphuric acid, will there (*a*) be any local action between the peroxide and the metallic lead? Supposing the weight of peroxide to be ·61oz., and that I immerse in the acid a second lead plate having ·53oz. of spongy lead in contact with it, (*b*) what quantity of electricity, in ampere-hours, could be obtained, approximately, by bringing the two plates into metallic connection?

Answer (*a*).—There will be no local action; because, owing to the layer of peroxide not being in contact with the lead plate No. 1, the essential conditions for a voltaic circuit are not complied with. *Answer* (*b*).—The quantity will be nil, the elements being reguline lead and spongy lead, which do not constitute an effective couple. The peroxide layer does not here constitute an element; but is merely a diaphragm.*

2. I take a plate of lead which has been coated electrolytically with a dense crystalline layer of peroxide of lead, without any crack or flaw. I immerse the plate in dilute sulphuric acid. (*a*) Will there be violent local action between the peroxide and its support, these being in perfect conductive contact? Supposing the weight of peroxide to be ·13 gramme, if I connect the above plate with another lead plate coated with a comparatively large quantity of spongy lead, (*b*) what quantity of electricity, in terms of the ampere-hour, will approximately be produced?

Answer (*a*).—There will be scarcely any appreciable local action, because one of the elements of the local couple—viz., the metallic lead—is not effectively in contact with the electrolyte. *Answer* (*b*).—If the external resistance be small, there will be a strong current in the main circuit; and in any case, since the weight of Pb is ·13 × ·867 = ·11 gramme, the quantity of electricity will be $\frac{\cdot 11}{15} = \cdot 0073$ ampere-hour approximately.

3. With a sharp point I score some lines on the peroxide-coated plate, exposing the metal. (*a*) What will now happen when the plate is immersed in dilute sulphuric acid? (*b*) What will be the effect on the peroxide support of short-circuiting at frequent intervals, for a few seconds at a time, the couple of which the scored peroxide plate forms one of the elements?

Answer (*a*).—Violent local action will occur between the peroxide and the exposed metal until the latter becomes coated with a film of sulphate of lead, which to a great extent protects it from from further action. *Answer* (*b*).—The excess of hydrogen evolved at the cathode surface by the effect of short-circuiting will reduce to spongy lead the lead sulphate protecting the exposed metal. A fresh portion of lead will subsequently be converted into sulphate, and the destruction of the peroxide support will consequently be activated.

4. I take a plate of lead which is coated with a very pervious layer of peroxide, and I fill up the interstices of the latter with an inoxidisable substance not acted upon by sulphuric acid. How can I ascertain, without waiting during the period of time (which may extend over many months) necessary, in case of local action, to effect the disintegration and destruction of the peroxide support, whether local action has actually been arrested or to what extent it has taken place?

Answer.—By repeatedly charging and discharging the element, its capacity becomes constant if local action has been arrested; but continuously augments if local action occurs. If the capacity obtains an approximately fixed and known value, partly discharge the element, leaving a known residual charge. Now stand the element by for a comparatively short period—such as a week or a month—and then measure the residual charge. Any loss of charge will indicate to what extent local action has occurred.

The practical importance of experiments such as are here indicated, and also of methods for obviating the "shedding" of active material, can scarcely be overrated when it is considered that the destruction of the peroxide support, and the loss of active material in the form of "mud," are the only obstacles in the way of constructing accumulators, which, with careful treatment, would last for an indefinite period. In the case of the spongy-lead element, there is no destruction of the support by local action.

* Compare with the following: "In a Planté or Faure battery. the mass of peroxide which is in contact with the metallic lead plate expends its energy slowly. How comes it to pass that, if the same mass of peroxide be brought into connection through the first lead plate with another lead plate at a distance, it expends its energy through the greater length of sulphuric acid in a tenth or a hundredth part of the time? The answer . . . . is doubtless to be found in the formation of the insoluble sulphate of lead, which clogs up the interstices of the peroxide, and after a while forms an almost impermeable coating of high resistance between it and the first metallic plate."—"The Chemistry of the Secondary Batteries," by Gladstone and Tribe, p. 8. It will be seen that the "almost impermeable coating" would be common to both circuits, and, whilst obviating local action, would also prevent the passage of a current in the main circuit. Substitute "the electrolyte" for "it" (the peroxide) at the end of the passage quoted, admit that the peroxide is in good contact with its supports, and the explanation will then cover all the facts.

WATER POWER, WITH REFERENCE TO ITS APPLICATIONS TO ELECTRICAL MACHINERY.

BY J. HERMANN FIELD.

From the earliest times from which written documents, dealing with general subjects, have been handed down to us, devices and designs for the utilisation, by simple machinery, of the power afforded by moving water have been described and drawn. These show clearly that the ancients were not lacking in those faculties of perception and appreciation of the capabilities of the forces of nature, and their ready adaptation to the use of man, the acquisition of which, in our days, forms a not unimportant part of the engineer's training. So far back as the date 410 B.C., Archytas of Tarentum constructed machinery of various simple forms for use with falling water, and an even earlier disposition to curb this wildest steed of nature is indicated in the reference made by Hero of Alexandria to the devices of "ancient philosophers," which were traditional even at that remote period.

One of the earliest forms of water-engines, of which details have survived the test of time, is in the shape of a wheel with radial troughs and hollow axle. As described by Vitruvius about the year 4 B.C., this was used to scoop up water in the rising troughs, lifting it from the level of the river by which the wheel was driven to that of the tubular axle, along which the water flowed for distribution. China, that land where civilisation has never been unknown, and where time leaves no mark on habits and customs, was foremost in the field with the practical employment of water-driven and water-raising tools. A present-day survival of these is found in her utilisation of a bamboo-made wheel, of construction not dissimilar from that mentioned above, but of 70ft. diameter, and ready to deal with

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300 tons of water in the course of 24 hours. In the annals of days gone by, it is reported that Persia led the way to swivelled buckets, attached to the circumference of the revolving wheel, these buckets being overturned by a fixed pin on reaching the elevation to which it was required to raise the water. Developments of the earlier form of wheel, before mentioned, as applied to the raising of water, were designed and worked by De la Faye and by Wirtz a century ago, by which a more direct action on the water to be raised was secured, and in all of which the driving was effected by radial blades immersed in the stream. Radial blades may still be seen in many of the "undershot" wheels now in use.

It is stated by writers on hydraulics that the development of the principles of waterwheels and turbines, and the setting forth of the conditions necessary for the construction of efficient machines, is primarily due to Continental mathematicians, and that the initiation of practical manufacture, experiment, and use stands to the credit of Continental engineers. This is hardly to be wondered at when the circumstances obtaining on the Continent, largely absent in Great Britain, are taken into account. The abundance of water power, valuable in proportion as it is intelligently used, which may be found fairly evenly distributed in nearly all parts of Europe, contrasts strongly with the paucity and poorness of such natural advantages to be seen in Britain. London itself was glad to take advantage of foreign experience when, in 1582, a German engineer was welcomed for the purpose of erecting undershot wheels driven by the Thames, which raised a part of the river for the water supply of the Metropolis. This primitive service continued in use until as late as 1822, when the whole pumping station was removed, the supply being taken over by machinery better adapted to deal with the increased demand.

Until near the close of the last century the pumping of water seems to have been the only use for which waterwheels were employed, but as machinery, especially that of grinding mills, began to come into general use, the undershot waterwheel was constructed with gearing adapted to the various purposes for which it was required. In the course of time, and under the influence of the rapidly extending knowledge of mechanical engineering matters which at all times has accompanied the advancement of trade, the undershot wheel, with its radial blades, began to give place to an improved form, the Poncelet. For, although the former was sufficiently serviceable in the days when it was used chiefly for flour mills, and when efficiency was barely considered, the more correct construction and more careful setting of the latter recommended it for use, as it rendered possible the utilisation, to a fuller extent than had before been known, of the energy contained in the flowing stream. As a result of the transition from radial blades to the curved buckets of the Poncelet machine, nearly double the energy of the simple blade wheel could be obtained in the same circumstances, the improved wheel giving an efficiency of about 60 per cent. in practice. In addition to this, the energy was taken up without shock as the wheel revolved, and this tended to reduce the charges of depreciation and cost of repairs.

The overshot wheel, with buckets capable of receiving and holding water during nearly half a revolution, was not used to any very large extent till a considerably later date, probably because its use involved hydraulic works, in the way of lades and artificial head-races. Its efficiency in practice is frequently 65 per cent., and sometimes more, when the buckets are of ample size to retain their charge of water almost to the level of the tail-race.

A step between the under and over shot wheels, each of which is suited to special circumstances and character of river, is shown in the much-used breast wheel, where advantage is taken, not only of the momentum of water, as in the "undershot," but also of its energy of position, as is done in the "overshot" type.

These three forms of water-motors have continued in use without having changed their shape and design to any very marked extent during the whole period of their employment as practical power engines, while, at the same time, their action in varying circumstances has been suggestive of the principles underlying the proper construction of some of the earlier forms of turbine wheels. It has been by the gradual adoption of guides for the water before it enters the buckets of the wheel (which guides have finally formed a complete stationary enveloping case), and, further, by the producing of the buckets towards the centre of the wheel, that the type of our modern forms of turbine has been evolved.

With almost all mill machinery in use to-day, except those remnants of old practice the grinding millstones, the ultimate speed of working is such as to require a very considerable gearing up from the mill wheel to the tool. It is in the saving of the cost of expensive foundations and heavy gearing that the turbine, with its small size and high speed, recommends itself to the engineer. Its comparative immunity from the effects of back-water, which is fatal to the working of waterwheels, renders it indispensable in all such positions as are liable to varying levels of tail-water.

The measurement of water flow, with a view to ascertain what amount of power may be counted on with varying conditions, is one of the first considerations of the engineer who intends to develop the power for electrical purposes. It is a task which presents considerable difficulty in many ordinary situations; the best method for adoption must be decided according to the nature of the stream, and the circumstances in which the tests are made. Water power, as mostly found in Great Britain, is peculiarly subject to fluctuations, both with regard to amount and also in the levels of head and tail water. It will evidently be necessary, then, to provide that the measurements and observations taken give a fair indication of the minimum supply and head during such times as the power is required.

As connected with electric lighting, the variations of water flow in England fit in very reasonably with the wishes of the engineer, the river being flushed in winter and not affected injuriously by any but the hardest frost. Moreover, the increase in the quantity of water flow in the darker seasons of the year is seldom attended with a serious rising of back-water, as so often occurs on the Continent, where the melting of the winter snows will frequently lessen the fall available by nearly one half, so that the power obtained in times of plenty is smaller than in times of drought. It does, however, occur that in some cases the nature of the watershed renders a stream more than usually subject to conditions of weather, very little water being available on any approach of drought, and sudden rain causing such back-water as would seriously impair the effectual working of turbine machinery. It becomes therefore a matter for careful consideration whether the cost of providing against such contingencies as lack of supply, overflooding, and rising of tail-water will justify the use of turbines in place of steam-engines and the consumption of coal.

The researches of Prof. James Thomson have been of very great service in connection with water measurements, as having established empirical expressions on the basis of experiment, which give information with regard to the free flow of water over weirs and notches of set shape. Where liberty of damming up the stream is permissible, and the flow is of small size, a triangular gauge notch (Fig. 1), or for larger quantities of water, a rectangular gauge notch (Fig. 2) with sharp edges presented to the up-stream side, may be used with accurate results. It will be necessary to so dam up the stream that a reservoir is formed of sufficient capacity for the water behind the notch to be practically still, or approaching it with a very small velocity, care also being taken that a clear fall is obtained for the water below the lowest part of the notch, so that the flow of head-water may not be affected by any influence due to back-water. The quantity of water, in cubic feet, which, in any one second, flows over the sill, will be, in the case of the triangular notch,

$$Q = 2{\cdot}635\ h^{\frac{5}{2}},$$

where the angle at the apex is 90deg., or the ratio of the half-breadth of the notch to the height above the apex at that breadth = 1, and where h = the height in feet of still water (well behind notch) above apex, or

$$Q = 5{\cdot}3\ h^{\frac{5}{2}}$$

where the apex angle is 128deg., and the above ratio = 2.

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In the case of the rectangular notch, the quantity passed per second will be

$$Q = 3{\cdot}33\,(L - {\cdot}2\,h)\,h^{\frac{3}{2}}$$

where L = length of sill in feet, and
h = the height of still water above sill.

This method of water measurements is equally applicable to swiftly or to slowly flowing streams, provided that it be possible to throw across them such a dam as will comply with the conditions named above as regards velocity of approach. Similar measurements made of the water flowing over an already existing weir will, of course, obviate the necessity of the special construction of timber notch, and if the determination be made by this means, the quantity of water that flows per second may be found by the use of formulæ given in treatises on hydraulics for the different conditions likely to be encountered.

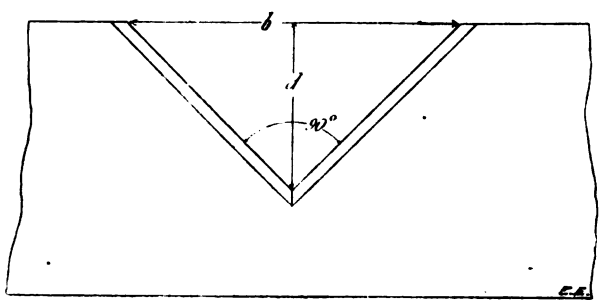

FIG. 1.

A more rough-and-ready way of determining the quantity of water flow in unit time is by the employment of a float, sunk just below the surface, preferably of cylindrical shape. The accuracy of this method varies between comparatively wide limits. The float is to be thrown into mid-stream some distance above one of two fixed points on the bank, a known distance apart, and between which the section of the channel is nearly of the same area and shape, and the stream free from bends. The velocity of the mid-surface water being recorded by the time taken by the float, after getting under weigh, to pass between the points of

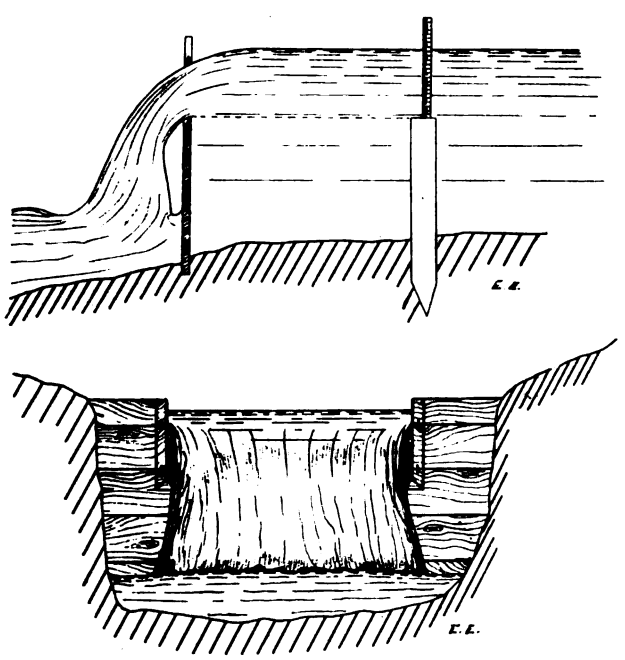

FIG 2.

observation, an approximate estimate may be made of the average velocity of the stream at that section; for, by reference to the results obtained from careful measurements in channels of various shapes, and with boundaries of given materials, figures are available which show by what percentage the observed velocity exceeds the average rate of flow. In accordance with such results, obtained in practice, the deduction that must be made from the observed value of the mid-stream flow increases from 16 per cent. for built smooth-timber channels of small size to as much as 30 per cent. for earth-built lades, while special conditions and sizes of races larger than are commonly met with do not lend themselves to comparison with such figures as are here given. Taking the case of a natural stream with a slow flow over pebble or earth bottom and sides, the ratio of the measured greatest velocity in mid-stream to the mean velocity of the whole will be approximately $\frac{5}{4}$, and with still slower streams this ratio increases in value to as much as $\frac{4}{3}$.

For rivers and large slow-moving streams a revolving fan current meter, with recording wheelwork, the whole attached to the end of a pole, may be used. The instrument being immersed in the water at several points of the same section of the river, a mean value of the velocity is calculated, and the sectional area being known for that place, the total quantity per second is readily obtained.

When designing the head and tail works for a low-fall turbine station, the total head of water—*i.e.*, the difference of level between *open* supply and *open* discharge — will determine the quantity of water that must be passed in unit time to obtain the requisite power; taking as an approximation a turbine with a full gate working efficiency of 70 to 75 per cent. As it is evident that an increase in the size and cost of the lade will decrease the head required to pass the given quantity of water, and *vice versâ*, the cost of the construction of races for various losses of head must be balanced against the capitalised value of those losses considered as a fraction of the total available fall of water. Since the value of a horse-power varies, of course, in different parts of the country, it becomes a matter for individual adjustment of the

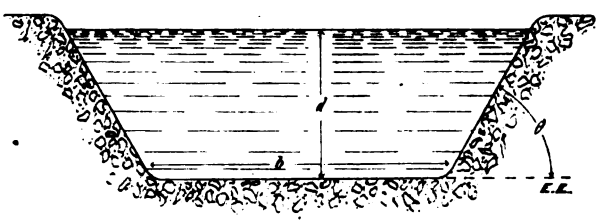

FIG. 3.

relation the cost of works shall bear to the power developed. With low falls, the cost of the head and tail works necessarily forms a very large item in the total expenditure involved, since with a maximum head of the order of 8ft., the loss that can be allowed in bringing and carrying away the water is a very small amount. The head of water lost in lades or races is influenced by their shape in proportion as friction is altered thereby, and this latter depends directly on the hydraulic mean depth or ratio of area to wetted perimeter of conduit. In an open rectangular trough it is evident that if the ratio of the breadth to the depth be very large or very small, this wetted perimeter will be greater than need correspond to the cross-section of the stream, and therefore a certain ratio lies between those extremes which will give a greater discharge, or will lessen the cost to construct. It can be shown that the best shape of a trapezoidal conduit is such that

$$b = d\left(\frac{2}{\sin\theta} - 2\cot\theta\right)$$

b, d, and θ being as indicated in the figure. For the special case of a rectangular section, where $\theta = 90$deg., this expression reduces to $b = 2\,d$. Taking then, this special case, the mean velocity of flow along the rectangular channel whose hydraulic radius is r, and whose slope is s $\left(= \frac{\text{fall}}{\text{length}}\right)$, will be $v = c\sqrt{r\,s}$, where c is a coefficient depending for value slightly on s and r, and varying to a very large extent with the nature and roughness of the bounding surfaces. The determination of the size and slope of a rectangular channel to pass Q ($= a\,v$) cubic feet of water, will be seen to require a value to be assigned to the coefficient c, agreeing with the circumstances of the case, due regard being had to the best relation, $b = 2\,d$. The value of this number c has been ascertained by many experimenters for the different conditions on which it depends, and although it is never possible

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accurately to predict from calculation the performance of such operations as involve it, the results obtained from prior practice afford a guide for its estimation in cases presenting similar conditions.

Mr. Smith, in his book on hydraulics, has given particulars of experiments from which the writer has drawn the curves in Fig. 4, connecting in four cases the ratio $\frac{d}{b}$ with corresponding values of c, for unplaned plank, pure cement, and brick; all considered, of course, solely with reference to the surface of their wetted perimeters. From these it will be seen that c rises rapidly as the water gets of a depth sufficient for the greater part of its bulk to be free from the frictional resistance of the bottom, and approaches its highest value as the ratio $\frac{d}{b}$ approaches $\frac{1}{2}$. The pure cement facing, for same size of channel, shows a gain in delivery of about 30 per cent. above brick and 20 per cent. above unplaned planking. By reference to the Curves 2 and 3, it will further be seen that with any material c is influenced by the actual scale of the lade, for these two curves, both relating to unplaned planking, show that with equal ratios of $\frac{d}{b}$, c is greater in the case of the channel of larger dimensions. This percentage variation, however, is not more than should be allowed as a safety factor in all calculations for water flow in practice. The following table of values of c will give all the accuracy that is usually

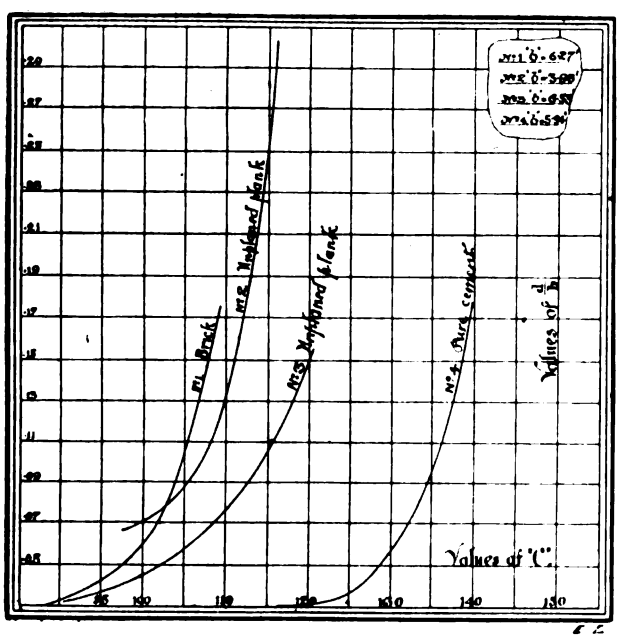

FIG. 4.

required for estimations of the size and slope of trapezoidal channels of given discharge, the higher figures being applicable to the larger sizes or better conditions of lades, the smaller figure to less favourable circumstances:

	c.
Unplaned plank	100 to 120
Smooth masonry	90 ,, 110
Clean earth	60 ,, 80
Stony earth	40 ,, 60
Rough stone	35 ,, 60
Earth and weeds	30 ,, 50

Since $c\sqrt{rs}$ = mean velocity $= \frac{Q}{a}$, any one desired unknown for a particular case can be found by the use of this table. For a commonly used shape, where $\theta = 45$deg. and $b = d$, the above reduces to $d = \cdot 863 \left(\frac{Q^2}{c^2 s}\right)^{\frac{1}{5}}$.

The nature of the soil will evidently place one limit on the value of the angle θ except in the case of built or faced channels. The following figures given by Mr. Merriman are interesting in connection with the construction of lades with natural bottoms, as showing the velocity of the water in feet per second that will displace some common materials.

Velocity.	Material.
·25	Fine clay.
·5	Loam and earth.
1·0	Sand.
2	Gravel.
3	Pebbles.
4	Stones.
6	Large stones.

Indeed, any velocity exceeding 2ft. per second will often prove injurious in wearing the sides and beds of natural earth watercourses.

ON THE DETERMINATION OF THE STATE OF IONISATION IN DILUTE AQUEOUS SOLUTIONS CONTAINING TWO ELECTROLYTES.*

BY PROF. J. G. MACGREGOR, D.SC., DALHOUSIE COLLEGE, HALIFAX, N.S.

The object of this communication is to draw attention to the possibility of determining in some cases what, according to the dissociation conception of electrolytic conduction, the coefficients of ionisation must be in the case of two electrolytes present in the same solution, the electrolytes either having or not having one ion in common, but being such as undergo no chemical change other than double decomposition.

When the two electrolytes (1 and 2) have one ion in common, they are the only electrolytes present in the solution. For determining the ionisation coefficients (α_1, α_2) we have then the following equations†: (*a*) $\alpha_1 / V_1 = \alpha_2 / V_2$, where V_1, V_2 are the regional dilutions of 1 and 2—*i.e.*, the quotients of the volumes of the regions of the solution which may be imagined to be occupied by 1 and 2 respectively—by the numbers N_1 and N_2 of gramme-equivalents of these electrolytes present, the equation being obtained from the conditions of kinetic equilibrium; (*b*) $N_1 V_1 + N_2 V_2 = v$, obtained from the equality of the volume (v) of the solution to the sum of the volumes of the regions referred to; (*c*) $\alpha_1 / V_1 = f_1(V_1)$ and $\alpha_2 / V_2 = f_2(V_2)$, the functions, f_1 and f_2, being determined by means of measurements of the conductivity of simple solutions, the concentrations of ions in the regions occupied by the respective electrolytes being assumed to be the same as they would be in simple solutions of the same dilution. A mode of solving these equations by a graphical process is described in the papers cited.

That the values of the ionisation coefficients obtained by solving these equations are those which the dissociation theory demands is borne out by the fact that in the case of solutions containing NaCl and KCl (see papers cited) or NaCl and HCl‡, when these values are substituted in the expression of the dissociation theory for the conductivity of a complex solution, the calculated values agree with those observed within a fraction of 1 per cent.

The following results of the observations made on the above solutions, with respect to the relation of the ionisation in such solutions to the concentration, may be stated: (1) In the case of dilute solutions—containing no more than about 0·5 grm.-equiv. per litre of either electrolyte—the rate at which the common concentration of ions increases with the concentration of either electrolyte is practically constant; (2) for solutions of greater concentration, this rate diminishes as the concentration of the solution with respect to either electrolyte increases.

When the electrolytes, 1 and 2, added to water in forming the solution, have no common ion, other two 3 and 4, are formed by double decomposition, and there are thus four present in the solution. For determining the ionisation coefficients, we have then the following equations§: (*a*) $\alpha_1 / V_1 = \alpha_2 / V_2 = \alpha_3 / V_3 = \alpha_4 / V_4$, and $N_1 V_1 \cdot N_3 V_3 = N_2 V_2 \cdot N_4 V_4$, obtained from the conditions of equilibrium; (*b*) $N_1 V_1 + N_2 V_2 + N_3 V_3 + N_4 V_4 = v$, from the volume relation; (*c*) $\alpha_1 / V_1 = f_1(V_1)$, $\alpha_2 / V_2 = f_2(V_2)$, etc., from the relation of concentration of irons to dilution, the

* Paper read at the British Association meeting at Toronto.

† *Trans.* N.S. Inst. Sci., 9, 101; *Phil. Mag.* [5], 41, 276 (1896).

‡ McIntosh, *Trans.* N.S. Inst. Sci., 9, 120; *Phil. Mag.* [5], 41, 510 (1896).

§ *Trans.* Roy. Soc. Can. [2], 2, Sec. III., 65 (1896).

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V's having the same signification as above; and (*d*) from the conservation of mass, n_1 and n_2 being the numbers of grm.-equivalents of 1 and 2 added to water in forming the solution, $n_1 = N_1 + N_3$, $n_2 = N_2 + N_4$, $N_3 = N_4$. The solution of these equations, even by the aid of a graphical process, seems to require more accurate values of the conductivity of simple solutions than we possess. But with the measurements available we may readily prepare a solution having any desired concentration of ions, and therefore having one of the electrolytes present with any desired degree of ionisation. For this purpose draw curves for simple solutions of 1, 2, 3, 4, giving the relation of concentration of ions to dilution. Read off from these curves the dilutions, V_1, V_2, etc., of simple solutions of 1, 2, 3, 4 respectively, having the desired common value of the concentration of ions. If simple solutions of these dilutions are mixed in proper proportions as to volume, there will be no change of ionisation on mixing. To find the proper proportions, select any arbitrary value, v_4, of the volume of 4 which is to be mixed with the others. It will contain $N_4 = v_4 / V_4$ grm.-equivalents of 4. From equations (*d*) above we must have $N_3 = N_4$. Hence the volume of 3 to be mixed with the others will be $v_3 = V_3 v_4 / V_4$. Next select arbitrarily any value of v_2. Then from the second of equations (*a*) we have $v_1 = v_3 v_4 / v_2 = V_3 v_4^2 / V_4 v_2$. The volumes of the simple solutions of dilutions V_1, V_2, V_3, V_4, which must be mixed, in order to form a complex solution having the desired concentration of ions, are thus known. The solution may therefore be prepared. Moreover, as the concentrations of the simple solutions and the volumes of them which are mixed are known, the numbers of grm.-equivalents of the four electrolytes present may be determined; and as the common concentration of ions and the dilutions are known, the ionisation coefficients may be determined. The conductivity of the solution may therefore be calculated.

That the values of the ionisation coefficients obtained in this way are those demanded by the dissociation theory is borne out in this case also by the agreement between the observed values of the conductivity of solutions of the kind under consideration and the values calculated by the aid of these coefficients. Mr. E. H. Archibald, working in my laboratory, has recently both observed (by Kohlrausch's method) and calculated the conductivities of solutions containing NaCl and K_2SO_4, and therefore also KCl and Na_2SO_4. I am indebted to him for the following statement of his results so far as he has gone:

Solution, 1 litre of which contains.				Concentration of ions.	Conductivity.		
NaCl grm.-equiv.	$\frac{1}{2}K_2SO_4$ grm.-equiv.	KCl grm.-equiv.	$\frac{1}{2}Na_2SO_4$ grm.-equiv.		Observed	Calculated.	Difference per cent.
·2041	·1537	·1851	·1851	·4541	5217	5183	−0·65
·1158	·0971	·1091	·1091	·2878	3311	3288	−0·7
·1087	·0927	·1035	·1035	·2744	3160	3139	−0·7
·03683	·03241	·03549	·03550	·1039	1192	1188	−0·3
·03077	·02710	·02987	·02988	·0887	1047	1044	−0·3

These results go to show that the ionisation coefficients of the electrolytes in the above solutions have been fairly accurately determined. They are interesting in themselves also as showing that the dissociation theory enables us to calculate the conductivity of a solution containing two electrolytes with no common ion.

CHELTENHAM ELECTRICITY WORKS.

The accounts of the Cheltenham electricity works made up to March 31, 1897, have just been issued. We give herewith the revenue account, balance-sheet, and statement of electricity generated, sold, etc.:

Revenue Account.

Dr.				£	s.	d.
Generation of Electricity.						
Coal and other fuel	£422	11	2			
Oil, waste, stores, etc.	64	3	6			
Salaries and wages	778	9	3			
Repairs and maintenance, buildings	4	8	6			
Ditto machinery	31	17	7			
Carbons and miscellaneous	6	12	6			
				1,308	2	6
Distribution of Electricity.						
Salaries and wages	28	12	0			
Repairs and maintenance, mains	80	0	8			
Ditto transformers	20	12	1			
Ditto sub-stations	5	18	2			
				135	2	11
Public Lamps.						
Salaries and wages	57	0	4			
Carbons, renewals, etc.	29	1	6			
				86	1	10
Rents, rates, and taxes				72	10	0
Management Expenses.						
Salaries and wages, engineers	176	4	11			
Stationery and printing	49	5	6			
General charges (including compensation and solicitor's costs *re* John Pugh, £25. 15s.)	53	3	10			
				278	14	3
Special charges, insurances				10	7	1
				1,890	18	7
Amount carried to net revenue account				54	9	3
				£1,945	7	10
Cr.				£	s.	d.
Electric energy at 6d. per unit, £1,911. 15s. 6d.; less cash discounts, £91. 10s. 5d.				1,820	5	1
Electric energy at 5d. per unit, £4. 13s. 3d.; less cash discounts, 4s. 8d.				4	8	7
Electric energy at 4d. per unit, £57. 8s. 4d.; less cash discounts, £2. 17s. 5d.				54	10	11
Electric energy at 3d. per unit, £25. 19s.; less cash discounts, 9s. 3d.				25	9	9
				1,904	14	4
Less rebates				148	10	8
				1,756	3	8
Electric energy sold by contract				40	0	0
Public lighting				147	14	2
Meter rents				1	10	0
				£1,945	7	10

General Balance-Sheet.

Liabilities.				£	s.	d.
Capital account—amount received				36,000	0	0
Sundry creditors—capital account	£2,031	11	9			
Ditto revenue account	290	9	8			
				2,322	1	5
Interest on debentures				208	7	8
Sinking fund provision account				347	5	0
Cash due to treasurer—revenue account				2,910	16	7
Sinking Fund.						
Amount of fund per account to March 31, 1896	438	16	11			
Amount set aside since	452	0	3			
				890	17	2
				£42,679	7	10
Assets.				£	s.	d.
Capital account—amount expended for works				36,416	3	2
Stores in hand on March 31, 1897—coal, £15. 12s. 5d.; oil, waste, etc., £24. 19s. 4d.; carbons and general, £60. 2s. 1d.				100	13	10
Sundry debtors for electric energy to March 31, 1897				665	9	6
Other debtors—for goods sold, £79. 11s. 3d.; meter rents, etc., £10. 5s. 8d.				89	16	11
Net revenue account—balance at debit thereof				2,949	19	8
Cash in treasurer's hands—capital account				1,535	17	4
Electrical engineer's advance account				30	10	3
Sinking Fund.						
Treasurer—balance at bank				890	17	2
				£42,679	7	10

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T.U.	179,031
Quantity used in public lamps	18,300
Quantity sold to private customers (metered)	82,215
Quantity used at works (metered)	16,070
Quantity used at works, sold to private customers, and unaccounted for (unmetered)	62,446
Number of public lamps	37
Maximum rate of supply during year (watts)	157,000

Note.—The electric energy used for drying transformers prior to their use and for all high-pressure testing, etc., was not metered at the works.

Sydney (New South Wales).—Tenders are required by October 18, at noon, at the General Post Office, for supplies to the Telegraph, Telephone, and Post Office Departments, including iron, copper, and insulated wire, insulators, nails, screws, nuts, bolts, electric batteries with all accessories and chemicals, diaphragms, arc lamps, incandescent lights, 11,000ft. carbon for arc lamps, and various other appliances.

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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BOUND VOLUMES.

Vol. XIX. of new series of "THE ELECTRICAL ENGINEER" can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.

ABRIDGMENTS OF PATENT SPECIFICATIONS.

There was a time when the Patent Office was supposed to take all the fees it could possibly obtain, and give as little as possible in return. According to the critics, enlightenment came very slowly, but even the most bigoted opponent of the system must admit that events have moved with some rapidity during the last few years. Of course, there still exists the bitter cry from some quarters that the Patent Office accepts specifications very much at the risk of the patentee, and the only supervision over a specification is a rough and cursory one that the invention is more or less truly the subject for a patent. Whether the patent has been forestalled, whether the subject is common knowledge, or whether the claims are too broad to be supported at law, is not the duty of the Patent Office to say, but of the patentee to risk. It is well known that at the present moment there are scores of patents running that could not be supported at law. So long as no one objects to a patent, so long it is valid. Others are held to be valid because interested parties agree to work and not to fight. The lawyers, if they felt inclined to, could tell many a tale of opposing parties coming to an amicable settlement as soon as it was seen a patent would be held to be invalid, and that the manufacture of certain apparatus is really freely open to the world. It is not in the interest of two rival firms to publish this broadcast to the world, and they agree to let the patent alone, pretend to the world that its validity has not been questioned, and manufacture under an agreement. There may be a dash of sharp practice in such a course, but it brings grist to the mills of the factories in the know, and prevents competition from factories ignorant of the question. It must be premised, too, that there is a class of patentees—and the number in this class is very large—which might be dubbed the professional patentee, that delights in the fact there is no official search. The income of the professional patentee would be largely restricted if there were such a search. To the real patentee there is much in the recent development of activity at the Patent Office which must commend itself. Not the least interesting and useful work is to be found in the issue of "Abridgments of Specifications." These abridgments are classified and issued at the uniform rate of one shilling each. We have before us the abridgments relating to Class 35—viz., "dynamo-electric generators and motors, frictional and influence machines, magnets and the like" during the period 1884-8. A list of the abridgments published shows one hundred and three volumes, at two shillings each, dealing with the period 1617-1876, one hundred and forty-six volumes illustrated, at a shilling, period 1877-1888, and a similar lot from 1884-88, besides a number of volumes without illustrations. We are referring to this subject at some length because the expenditure of a shilling or two will enable the would-be patentee to make a tolerably satisfactory examination or search for himself, though probably the patent agents would still prefer to do and charge for this kind of work. Of course, we have no idea of desperately contending that the examina-

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tion of these volumes will obviate all necessity of careful search—it will not; it will, however, enable the reader to obtain a very good idea of what has been done. Many important inventions, however, are really slight modifications in details of construction, and even when the general scope of previous inventions is known, the exact prior claims must be also known in order to come to a correct conclusion whether to patent or not. We imagine, however, that these abridgments will be found generally useful, and they are, so far as we have examined them, extremely well done, the accompanying illustrations showing the pith of the invention as described in the specification and claimed in the claims.

RESEARCH COURSES.

A new departure has been taken by the South-West Polytechnic Institute in arranging a "research course for teachers." The subject selected for the first research is "The Effect of Repeated Heating on the Magnetic Permeability and Electrical Conductivity of Iron and Steel." It is an important subject, and the value of the results obtained will in a great measure depend upon the limitation, if we may so term it, of the area traversed by the research. Assume for a moment that the research is intended to afford practical assistance in determining the best brand of iron or steel to be used in the construction of dynamos. The ordinary rise in temperature of the material so used is fairly well known, and the research should, we imagine, be confined within the limits of such rise of temperature. The dynamo constructor or user does not care one iota that the effect of a much higher temperature may be disastrous to his material; he constructs and designs for the ordinary and not the extra-ordinary variation in temperature, and his interest is to know what will happen to the material after repeated heating up to his limiting temperature. Then, again, in all probability the various members of the research class will each have a different brand of iron or steel to experiment upon, and it will be important that a careful analysis of the iron and steel under examination be made. These, however, are points too obvious to require further mention. It will be seen from the syllabus that "should the results of the investigations prove of sufficient importance, they will be offered for publication to one of the societies interested in the subject." Thus the course may be expected not only to benefit those who take part in it, but also the engineering world at large, and in this respect the institute deserves the sympathy of all engineers for the success of its latest departure.

REVIEWS.

The Principles of Alternate-Current Working. By ALFRED HAY, B.Sc. 5s. Biggs and Co., Salisbury-court, Fleet-street, E.C.

The book before us is the outcome of a series of lectures delivered by the author to evening students at the University College, Liverpool. As such students have usually a limited knowledge of higher mathematics, Mr. Hay has properly treated the subject in an elementary manner, and has added two chapters of mathematical introduction which make the book complete in itself. The great ease with which the differential and integral calculus can be applied to the solution of the many problems in alternate-current working has led to these problems being considered unduly abstruse by those who have not these branches of mathematics at their command. The beautiful graphic solutions developed by Blakesley, Kapp, Ferraris, and others, have done much to remove this exaggerated expression of abstruseness. We may add that the student of ordinary capacity will find in the book before us a collection of the best methods and a clearer elementary exposition than has been previously published. The author only presupposes that the reader has an elementary knowledge of algebra and of the fundamental principles of continuous-current phenomena. To such students the author's method of dealing with the rudiments of co-ordinate geometry, curve-plotting, and trigonometry in the first chapter, will be easy reading. The second chapter, on scalar and vector quantities, will break new ground, but the concise and clear treatment of the subject will prevent the new names from frightening the reader. Those who have had experience in stress diagrams, and other mechanical problems usually solved graphically, will readily grasp the usefulness of this chapter, which should be thoroughly grasped before proceeding to study the real subject of the book. Here we also get the explanation of that little letter p found in almost all alternate-current formulæ.

The electrical subject is commenced with Chapter III., and we at once notice the great care the author has bestowed on the arrangement of the matter. In alternate-current working there are a number of well-established facts which must be kept in mind. The proof of these facts is in the volume before us always given, but the propositions themselves, which are, so to speak, the basis of the volume, are always distinguished by the author by italics. These fundamental facts can in this way be easily picked out by students, and are most useful for reference after the book has been thoroughly read. Also at the end of each chapter the author adds a short note on the chapter, giving particulars of where the matter can be studied in a more advanced form, and also a general *résumé* of the same. These notes are followed by a few exercises, mostly of a numerical nature, which form a useful test as to whether the reader has understood the chapter. Before proceeding to review certain parts of the book individually we must disabuse our reader's mind of the idea that Mr. Hay's book only treats of the elementary principles of alternate-current working. The treatment is elementary, but the volume treats of practically all the phenomena met with in practical alternate-current working.

That Mr. Hay has succeeded in condensing without sacrificing lucidity so much information into 276 8vo. pages is greatly to his credit. The author commences in Chapter III. to consider the effect of a change in the number of magnetic lines passing through any electric circuit on the current in that circuit, and shows the modification of Ohm's law required to satisfy the conditions obtaining at any instant when such a change is taking place. This leads up to the definition of the coefficient of self-induction or inductance of a circuit, which the author defines as the magnetic flux through it due to unit current. The treatment here is such as can be easily understood. When describing the different construction of conductors to have little self-induction, there is one portion we think should be altered. The author gives two diagrams of different sections of conductors with lines of force round them, and then tells the student that by counting the lines of force he will see that one method gives rise to about three times as many lines of force as the other. This gives a student the idea that a line of force is a definite entity. The explanation that the closeness of the lines in the diagram shows diagrammatically the strengths of the magnetic fields would be a preferable statement. The next chapter commences with the subject of the growth and the current in a circuit when a steady E.M.F. is applied, and from this the transition to similar effects with the E.M.F. is itself a fluctuating quantity is natural, and easily followed. Chapter V. looks rather complicated at first sight, and as it deals with the analysis of E.M.F. and current curves it

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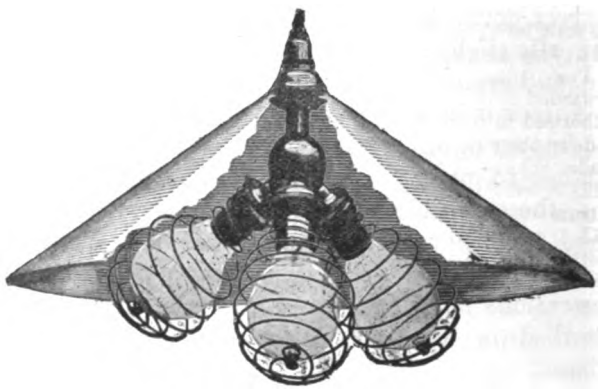
is not to be wondered at. The use of Fourier's series is explained, and some numerical examples running to three harmonic terms are worked out. Even if the student is tempted to skip the mathematics when first reading the chapter, he will find that the conclusions in italics are so important as to warrant him returning to the subject later on. The next chapter deals with one or two methods of obtaining the actual shapes of E.M.F. curves and current curves met with in practice, and gives a few useful hints as to precautions to be taken and errors to be avoided. The author then proceeds to investigate the properties of these waves, and their mean maximum and square root of mean square values. This chapter concludes with a few words on the so-called "form factor" of curves, and particulars of the measuring instruments which may be used in alternate-current circuits. The information in the chapter is clearly put, and until the student thoroughly grasps the relations of the above quantities he will be liable to endless errors. The simplification of calculation by the assumption that the curves of current and E.M.F. follow the simple sine law is treated in the eighth chapter, in which the difference between the power in a circuit and the product of the volts and amperes is taken up. This naturally leads to the question of the lag caused by inductance in a circuit; while the best methods of measuring power are deputed to the next chapter. We then come to the effects of a capacity. Here the author points out the fact, with alternate currents a flow can be maintained in a circuit part of which consists of an insulator. He adds, "The ability of an alternating current to traverse insulators gives rise to some interesting and somewhat complicated effects." The analogies given and all the phenomena to be explained can, we think, as far as the student is concerned, be better treated from the standpoint of charging and discharging a condenser. The statement that the dielectric of the condenser admits of the passage of a current is misleading. The practical results obtained by placing a condenser in various positions in an alternate-current circuit are then described with a liberal use of polar diagrams and curves. The succeeding chapters deal respectively with mutual inductance; problems of coreless transformers and "skin" effects in conductors; synchronous motors and the parallel running of alternators; the introduction to the study of induction motors; rotating fields produced by polyphase currents; the connections of polyphase circuits; induction motors, and, finally, the measurement of power in polyphase circuits. The information on synchronous motors and parallel running of alternators is most carefully thought out and explained. The author concludes that, "although the controlling current which passes between any two machines is to some extent determined by the types of the machines, yet the main factor determining it is not the type of alternator, but the type of engine. Successful parallel running is determined almost entirely by the capability of the prime mover to maintain a constant torque."

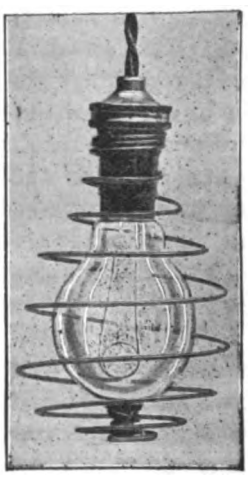
The treatment of the polyphase system is naturally condensed, but in the space at his disposal the author gives sound information, such that the student will be able to grasp the principles of working induction motors and the methods of generating the polyphase current. In conclusion, we can heartily recommend the book to all students, and are sure that a large number of practical engineers will read it with advantage. It is essentially a labour-saving book, the illustrations and arrangement being well adapted to save the reader's time.

THE IDEAL LAMP GUARD.

This is a device, patented by Mr. J. Dickson, for protecting incandescent electric lamps from breakage. The guard is in the form of a loose spiral spring, which receives the blow and completely absorbs it before it reaches the lamp. This guard should commend itself to the trade and electricians generally, as it dispenses with the necessity for a shade carrier, and is also very easily fixed. The guard throws practically no shadow, and is not nearly so heavy and clumsy as the old style of protector. Another advantage is that it can be used in clusters of lamps without appearing unsightly, or in any way spoiling the appearance of the cluster. A rubber cup is provided to keep the jar from the sealing point of the lamp. It is fixed by passing the cap of the lamp between the two largest rings in the spiral, up to the screw collar, and then taking two or three turns of the guard (until the screw



portion passes the lamp pin), and it will be found to be firmly fixed. The guards may be had in several qualities, such as of coppered steel, brass, or nickel-plated wire, and can be made of any size and thickness. They can be compressed into a very



small compass for packing. The illustrations show two applications of these guards, which can be obtained at 48, Gray's-inn-road.

BOARD OF TRADE ELECTRICAL STANDARDISING CHARGES.

We have received the following notice from Mr. T. H. W. Pelham, the assistant secretary of the Board of Trade, under the date of October 7, 1897:

1. The Board of Trade are now prepared to receive electrical instruments for examination or testing at their electrical standardising laboratory at 8, Richmond-terrace, Whitehall.
2. The only classes of electrical instruments which can be received at present for examination or testing are such as are intended for the measurement of electrical pressure, current, power, quantity, energy, or resistance.
3. Meters for the measurement of quantity or energy cannot be received with a view to certification for use in connection with the supply given by undertakers under electric lighting orders.
4. Instruments may be personally delivered at the laboratory for testing between the hours of 10 a.m. and 2 p.m., or may be forwarded by post or other delivery. In every case instruments must be accompanied by a form of application, which may be obtained from the laboratory.
5. The Board of Trade, or the officers of the Board, will not be responsible for any damage to any instrument, either in transport or while at the laboratory, nor for any loss sustained in consequence of the time that may elapse before the instrument is returned.
6. Instruments will not be received which are not plainly marked with the name of the manufacturer and an identification number.
7. Instruments will not be returned until all money due for fees or other charges incurred has been paid.
8. Every instrument submitted must be provided with suitable terminals or leads, so that it can be readily connected to the testing circuit without soldering.

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9. All indicating instruments must have their dials plainly marked with a suitable scale, which may be of equal or of unequal divisions.

10. The points of testing required must be specified in electrical units (volts, amperes, etc.), stating whether alternating or continuous or both, and not in numbers referring to the scale on the instrument.

11. The laboratory charges on any instrument may be paid by Post Office order or postal order if the instrument is to be forwarded by post or other delivery, or in cash by the person authorised to remove the instrument. All payments should be made to the assistant secretary, Finance Department, Board of Trade, Whitehall-gardens, S.W.

12. A certificate of test will be forwarded by post after the instrument has been removed.

13. The attached scale of fees for examination or testing of electrical instruments for the measurement of resistance, current, or electrical pressure, has been approved by the Treasury under Section 8 of the Weights and Measures Act, 1889.

Table of Fees for Examination or Testing of Electrical Instruments for the Measurement of Resistance, Current, or Electrical Pressure.

1. For an instrument intended to be used as a sub-standard and submitted for special examination and testing	£3	0	0
If required to be kept under observation for a period longer than one month; for each additional month or part of a month	1	0	0
2. For ordinary direct-reading instruments; for testing at three points:			
Voltmeter for continuous pressure only: not exceeding 200 volts	0	5	0
Exceeding 200 and not exceeding 500 volts	0	6	0
Exceeding 500 and not exceeding 2,000 volts	0	7	6
Voltmeter for alternating pressure only: exceeding 20 and not exceeding 2,000 volts	0	7	6
Exceeding 2,000 and not exceeding 10,000 volts	0	10	0
Extra fee if tests are to be made at one stated frequency of alternation	0	2	0
Voltmeter for both continuous and alternating pressures, or for alternating at two frequencies: exceeding 20 and not exceeding 2,000 volts	0	10	0
Ammeter for continuous current only: not exceeding 200 amperes	0	5	0
Exceeding 200 and not exceeding 500 amperes	0	7	6
Exceeding 500 and not exceeding 1,000 amperes	0	10	0
Exceeding 1,000 and not exceeding 2,500 amperes	0	15	0
Ammeter for alternating current only: not exceeding 500 amperes	0	7	6
Extra fee if tests are to be made at one stated frequency of alternation	0	2	0
Ammeter for both continuous and alternating currents: not exceeding 500 amperes	0	10	0
Wattmeter—continuous current—for testing at three points: not exceeding 200 volts or 200 amperes	0	12	0
Exceeding these limits up to 2,000 volts or 2,500 amperes	0	15	0
Wattmeter (alternating current) for testing at three points: not exceeding 10,000 volts or 1,000 amperes.	1	0	0
For each point tested beyond three points in any direct-reading instrument an addition of 20 per cent. will be made to the amount of fee.			
In the case of any direct-reading instrument if arranged to record, and if the accuracy of such record is arranged to be verified; extra fee for every record verified	0	2	6
3. For instruments reading by an adjustment to zero, an increase of 50 per cent. on the fees for similar direct-reading instruments will be charged.			
4. For determining the constants of integrating meters* at three rates within their range of measurement:			
Quantity meter, continuous current only: up to a maximum rate of 25 amperes	0	10	0
Up to a maximum rate exceeding 25 and not exceeding 100 amperes	0	15	0
Up to a maximum rate exceeding 100 and not exceeding 500 amperes	1	0	0
Up to a maximum rate exceeding 500 and not exceeding 2,000 amperes	1	10	0
Quantity meter, alternating current: up to a maximum rate of 25 amperes—if to be tested at one frequency of alternation	0	10	0
If to be tested at two frequencies, or at one frequency of alternation, and with continuous current	0	15	0
Up to a maximum rate exceeding 25 and not exceeding 100 amperes: if to be tested at one frequency	0	15	0
If to be tested at two frequencies, or at one frequency of alternation, and with continuous current	1	2	6
Up to a maximum rate exceeding 100 and not exceeding 500 amperes: if to be tested at one frequency	1	0	0
If to be tested at two frequencies, or at one frequency of alternation, and with continuous current	£1	10	0
Energy meter, continuous current only: up to a maximum rate of 10,000 watts	0	15	0
Up to a maximum rate exceeding 10,000 and not exceeding 50,000 watts	1	0	0
Up to a maximum rate exceeding 50,000 and not exceeding 200,000 watts	1	10	0
Energy meter (alternating current)†: up to a maximum rate of 20,000 watts—if to be tested at one frequency	1	0	0
If to be tested at two frequencies, or at one frequency of alternation, and with continuous current	1	10	0
Up to a maximum rate exceeding 20,000 watts and not exceeding 100,000 watts: if to be tested at one frequency	1	10	0
If to be tested at two frequencies, or at one frequency of alternation, and with continuous current	2	5	0
For each rate tested beyond three rates in any meter an addition of 20 per cent. will be made to the amount of fee.			
5. For testing resistance and standard cells.			
For a resistance coil of not less than 1 ohm resistance to an accuracy of 0·01 per cent.	0	5	0
For a resistance coil of resistance between 1 ohm and $\frac{1}{1000}$ ohm to an accuracy of 0·1 per cent.	0	5	0
For a box of resistance coils with Wheatstone bridge, Post Office, or dial pattern to an accuracy of 0·1 per cent. per coil tested	0	0	6
With a minimum fee of	0	2	6
For a coil of standard form to highest accuracy obtainable at one temperature	0	10	0
For determining the E.M.F. of a Clark's standard cell at one temperature	0	5	0
For testing resistances and standard cells at two different and determined temperatures the fee to be charged will be twice that specified above, with an additional charge of 5s. for each instrument.			

In the case of all the above-mentioned tests, except tests of standard instruments, integrating meters, and resistances, the fees charged will be reduced by one-third if from six to twelve similar instruments are submitted at the same time, and by one-half if the number exceeds 12.

* These instruments will only be accepted for testing if intended to be used as sub-standards or for scientific purposes.

† No greater alternating current than 500 amperes can be measured.

BRADFORD.

Bradford, like some other progressive towns, has been considering the question of tramway haulage. The accompanying report has just been issued:

Existing Tramways.—The Bradford Corporation tramways are 21¼ miles in length, calculated as single line. The first section (Manningham-lane) was opened January 31, 1882, and the last section in Wakefield-road on July 31, 1893. All the existing lines, with the exception of the Manchester-road tramway, are leased to the Bradford Tramway and Omnibus Company at a rental of £300 per mile of single track per annum. The Manchester-road section, comprising 3½ miles of single line, was constructed in 1884, and was leased to the Bradford and Shelf Tramway Company, the lease being made to expire at the same date as the other lines in February, 1903. The rental paid in this case is £400 per mile of single line. The Corporation maintain the tramways in both cases. At present all the lines are worked by steam haulage, but horse traction is also used on the Manningham section.

New Powers.—During the past session of Parliament the Corporation obtained powers to construct new tramways on two additional routes: (1) Great Horton, length calculated as single line, 6 miles 684 yards; (2) Bolton, 2 miles 1,164 yards. The Bradford Tramways and Improvement Act, 1897, gives the Corporation power to make the new lines and equip them for electric traction, and also to work them if they should deem it desirable to do so.

Tramway Traction.—The system of traction at present in use on the Bradford Corporation tramways has long been considered unsatisfactory both by the Corporation and the public, and the serious expense of maintaining the permanent way necessitated by the use of very heavy engines and cars, has caused the Corporation to look around for some other means of traction more up-to-date, and more suitable for the especial requirements of the city. The deputation have carefully considered the elaborate reports on the subject issued by the municipalities of Glasgow, Sheffield, Bristol, and other cities, and they have also visited Prescot, Brixton, Leeds, Birmingham, and Bristol, to inspect the latest developments in the several methods of tramway traction. It is unnecessary to refer to some of the older systems of haulage, such as horses, steam, and compressed air, all of which are now considered behind the times—nor is it necessary to dwell on the merits and demerits of gas, oil, and the several closed-conduit or magnetic systems, which have not proceeded much beyond the experimental stage. The attention of the deputation has been almost exclusively centred on—

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1. Cable traction.
2. Electric traction—(*a*) overhead trolley system, (*b*) open conduit or underground system, (*c*) accumulator system.

Cable Tramways.—Briefly described, the cable system consists of the employment of a constantly moving endless wire rope, carried within a continuous tube or conduit of either concrete, brick, or iron constructed below the surface of the street between the tramrails. The cable maintains its proper position by passing over small pulleys fixed within this conduit at intervals of about 40ft., and it receives its requisite motion from a stationary engine which may be situated at either terminus of the line or at some suitable intermediate position; the power being transmitted from the engine to the cable by means of a large driving drum. Midway between the tramrails at the road level is a narrow longitudinal slot communicating with the continuous underground tube to allow the passage of the cable-gripping appliances which are attached to each car. The grippers are worked by the driver by means of levers from either end of the car. The speed at which the cable travels is limited in Birmingham to seven miles an hour, but in the district beyond the Birmingham city boundary, a second cable moves at the rate of nine miles per hour. By gradually closing the gripper on the cable, the car is drawn forward without jerk, until it travels at the same speed as the cable; and in order to stop, the gripper is opened and the brakes applied to the car wheels.

Brixton and Streatham Cable Tramway, London, S.W.—This tramway, constructed in 1892, runs through a thickly populated residential district, which is able to maintain a two minutes' service. The route, which is 3½ miles in length, is a fairly wide and straight one, the quickest gradient being 1 in 20, but the route generally is on a slight inclination. The power station is at Telford-avenue, Streatham, from which two cables are worked, one 30,000ft. in length for the lower or Brixton part of the route, and the other 10,000ft. in length for the upper or Streatham portion. Steel girder rails, weighing 95lb. per yard, have been adopted, and they are laid on a bed of concrete 6in. thick. The tracks are laid with wood pavement. The conduit under the centre of the track in which the cable runs is 19in. deep by 9in. wide. It is formed of cement concrete, and cast-iron frames or yokes are placed at intervals of 3ft. 7in., to which the slot rails in the centre of the track are bolted. The slot is ⅝in. wide. Tie rods connect the yokes with the girder rails. Drains are laid at intervals to connect the conduit with the street sewer. To admit of access for oiling and repairs, hatches covered with wood blocks let into an iron cover are placed at each pulley. The pulleys which support the cable in the underground conduit are 14in. in diameter, and are placed 50ft. apart. The cable weighs one ton per 1,000ft. The last cable was worn out in 19 months, but the previous one lasted for two years and four months. The line has been in operation about 4½ years, and has proved very successful. The cost of a cable tramway is said to be about £11,000 per mile of single track.

City of Birmingham Tramways.—The Birmingham cable tramway was described in detail in the city surveyor's report to the Council dated October, 1890, and, as it is very similar to the Brixton line, it is unnecessary to describe it in detail here. The line is working very successfully. Four methods of tramway traction are in use at Birmingham—cable, steam, horse, electricity accumulators. The cable tramway in Birmingham belong until recently to the Central Tramway Company, but a short time ago the leases of all their lines were, with the consent of the Corporation, transferred to a Canadian syndicate, now known as the City of Birmingham Tramway Company. This company was prepared to convert all their steam lines into electric tramways if the Corporation would allow the use of overhead conductors; the Corporation, however, objected to that system, but expressed their willingness to allow electric traction, providing the conductors were placed underground on the open-conduit system. This the company declined to do, mainly on account of the expense, and consequently the steam-engines are still in use. One section of the city of Birmingham tramways is worked by horses. The Bristol-road tramway from Birmingham to Bournbrook is still being worked by electric accumulators. This tramway has been in operation nearly eight years, but it has not proved satisfactory. Although the line is nearly a level one, and the receipts per car mile amount to 15¾d., the expenses per car mile are 18½d. The line is nearly three miles long, laid to a gauge of 3ft., the steepest gradients being 1 in 27 and 1 in 30. The track is paved with wood for the greater portion of the distance. Each car is lighted by electricity, has accommodation for 50 passengers (24 in and 26 out), and weighs nearly nine tons, the excessive weight being mainly due to the accumulators, which are placed under the seats from the outside. The acids stored in the accumulators under the seats have a very injurious effect on the iron and woodwork of the cars, and complaints are occasionally made by passengers of the damage done to wearing apparel, and also as to annoyance from the fumes. The accumulators are charged at the Bournbrook depôt several times daily, and one charge will give an average run of about 12 miles. The electricity is conducted from the accumulators under the seats to the motor which is placed under the car between the wheels, causing it to rotate on an axle, from which the motion is transmitted to the wheels of the car. The motors are constructed to work at 12 h.p., and the car can be driven from either end. The current is shut off when descending gradients. The depôt, machinery, cars, and all complete exclusive of permanent way, cost nearly £30,000. The service is every 15 minutes, but as there is a loss on every car mile run, it is not likely that the company will increase it. For the information respecting the Birmingham tramways and tramway traction generally, the deputation are much indebted to Mr. Granville C. Cuningham, the engineer and managing director, and also to Mr. Warren, the secretary.

Electric Traction—Overhead or Trolley System.—This method of traction, which has come into such wide use in the United States and Canada and is now spreading rapidly on the Continent, is known as the trolley system. In this case the electricity from the power station is conveyed along the wire conductors, which are suspended above the tramway tracks. These trolley wires run overhead about 20ft. from the ground along the whole length of the tramway. They may be suspended either from cross wires attached to houses or to poles erected at intervals on each side of the street or directly from poles with brackets projecting from 12ft. to 15ft. over the tracks. In the latter case the conductors need not be placed directly over each track, as the radial trolley poles, which extend a considerable distance, are made to move in a circle. The trolley pole is attached to the roof of the car, and extends backwards and upwards to the conductor, where it terminates in a trolley or deeply-grooved wheel, which runs along the underside of the wire. Strong springs at the base of the pole cause the trolley to press firmly up against the wire. The current passes down the pole to the two electric motors, which are geared one to each axle under the car. By means of a controlling device the current can be switched on or off, and while the car is running a continuous supply of electricity passes from the wire down the trolley pole, along the car wiring, through the motors, causing them to rotate rapidly, and then from the wheels to the rails, which, along with auxiliary conductors, form the return part of the circuit to the power station. Heavy feeder cables laid underground along the route feed at intervals into the overhead conductor, and the joints of the rails are bonded with copper wire to secure continuous return.

Bristol.—The city of Bristol, before the recent extension of its boundaries, had an estimated population of 230,000. The extended area of the city will add about 100,000 to the population. The Bristol tramways belong to and are worked by the Imperial Tramway Company, who also work the Dublin, Kingstown, and Dalkey line by electric traction. The total mileage is 16½, of which 5½ miles are now worked by electric traction with overhead conductor. The Kingswood section was opened in September, 1895, and the Eastville section in February of this year; an extension of the latter is now in progress. Both routes have their terminus in Old Market-street, which is very wide. Here, and at two or three other places where the thoroughfare is over 20 yards in width, poles with double-bracket arms for supporting the trolley wires have been placed at intervals of 40 yards in the centre between the tracks, and every alternate pole is utilised for lighting the thoroughfare by an electric arc lamp. Certain portions of the route are too narrow for double line, and therefore single line with passing places are used, but wherever double line is practicable it is preferred. In some of the narrower places the double lines are interlaced so as to avoid the use of points and yet give the statutory width required by the Board of Trade between the kerb and the outer tramrail. For the greater portion of the route the overhead conductor is supported on neatly designed steel poles with ornamental single-bracket arms projecting over the track. These are generally placed on one side of the street within the line of kerb; but in certain cases where there are no buildings and little or no causeway, they are placed against the fence wall along the road side. The tramway extension on the Eastville section is nearly completed, and will shortly be opened for traffic. On this portion of the system steel poles have been placed on each side of the road, and span wires have been fixed across to support the overhead conductor. This method of fixing the overhead wires is not so sightly as that with single poles and bracket arms, but it is claimed that the trolley wire, when supported by span wires, is much more flexible and preferable for working than when rigidly held by the bracket arms. So far as appearance goes, the single poles with brackets are decidedly preferable to the double line of poles and cross wires. Although certain portions of the route are laid with single track and passing places, the trolley wires are double throughout. The rails are of steel, girder pattern, weighing 92lb. per yard, and the joints are all double-bonded for the return current. The track, as a rule, is paved with granite setts, but certain portions near the centre of the city are laid with wood paving. The gradients on the Kingswood route are somewhat severe

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1 in 15 being the heaviest. The total rise on the whole route is 325ft. in a distance of three miles, yet the motorcar with trailer attached can mount the gradients or stop and start again at any point with the greatest ease. The cars are 16 in number at present, but six additional cars are to be provided for the new extension. They weigh 5½ tons each when empty, and provide accommodation for 16 inside and 25 outside passengers (garden seats). Each car is provided with two 25-h.p. motors with single-reduction gear, one on each axle. The weight per motor is 19cwt. The driver has the car thoroughly under control, and can regulate the speed to the greatest nicety. In case of emergency, such as the hand-brake failing to act, the driver, by using the reversing switch, can bring the car to rest in a few yards. The electric current is shut off when descending gradients. The trolley pole is of the radial pattern, and works from the top of a pillar 6ft. 6in. high, which is fixed on the top of the car, and it is made to swing round in any direction, and even work at a right angle with the car without interfering in any way with the convenience of the passengers. This arrangement of trolley does away with the necessity of the overhead conductors being immediately over the centre of the track, and shortens the bracket arms considerably. Each car is lit by electricity, four lamps being supplied from storage batteries. and five lamps in series from the trolley wire. The service on the electric line is at intervals of 6 and 12 minutes, except on Saturday, when it is every 4½ and 9 minutes. The speed is limited to eight miles per hour by the Board of Trade regulations. The electrical line is divided into three penny stages, and the charge from end to end is 3d. Workmen's cars are, however, run at certain hours, when the fare is 1d. for any distance. Stopping places are provided at certain points, and are indicated by a number of rings painted round the poles. This custom is adopted throughout Germany, where it has become very popular, as it tends to save time and electrical energy. The power station at St. George, on the Kingswood line, has engines of 505 h.p., but new plant of an improved kind is now being erected which will give 920 h.p. It is stated that the cost per car mile run, with a 7½ minutes' service, is 5½d., as against 9½d. with horses. The total cost of the installation, including conversion of lines, overhead work, power station, and cars, was about £50,000. The work has been carried out by the British Thomson-Houston Company. The introduction of electric traction into Bristol appears to have been very successful. Plans for over 2,000 houses have been passed since the opening of the line two years ago. The company intended to promote a Bill empowering them to make large extensions, but could not come to terms with the Corporation, who stipulated that they should supply the electrical energy themselves, whilst the company wished to have their own generating station as at present. As the Corporation refused their sanction to the proposed extension unless this point were conceded, the company decided to abandon the Bill. The question of acquiring the tramway undertaking is now under consideration by the Corporation. The lease to the tramways company was for 21 years, of which 17 years have still to run.

Leeds City Tramways.—On August 24 last the Tramways Committee visited Leeds for the purpose of inspecting the new tramway from Kirkstall to Roundhay, now being worked by electric traction. The committee were received by Mr. Councillor Hannam, the chairman of the Leeds Tramways Committee; Dr. Hopkinson, the consulting electrician; and Mr. Wharam, the manager, each of whom afforded much information to the deputation as to the construction, equipment, and working of the new lines. The portion of the Leeds tramways now being worked on the overhead electric system is about seven miles in length, double track, extending from Kirkstall Abbey to Roundhay Park by way of Kirkstall-road, Wellington-street, Boar-lane, Briggate, North-street, and Roundhay-road. The tramway is laid with girder rails weighing 100lb. per yard. As the return current is conducted by means of the rails, the joints are bonded together by means of a copper rod having thimble-shaped terminals; holes are punched at the end of each rail, the terminal of the copper rod is inserted and made tight by means of a steel pin, which is placed in the centre of the thimble and driven home so as to expand the end of the copper rod and bring it into close contact with the steel rail. From Kirkstall to the Midland Station, also in North-street and Roundhay-road, poles are erected along the sides of the causeway for the purpose of carrying the overhead electric conductor, but in Boar-lane and Briggate poles with double brackets are fixed on the carriageway in the interspace between the double lines of tramway. The poles are 31ft. long, and are made in two section and fixed 40 yards apart. For the purpose of conveying the electric current from the generating station, five copper feeders are used, which are laid under the carriageway parallel to the tramways in Doulton's earthenware conduits. From one or the other of these feeders the current is supplied to the overhead wire or conductor at intervals of half a mile, so that each half-mile section is electrically complete in itself. The cars are 26ft. long, 7ft. wide, and 6ft. 6in. high, and will carry 22 passengers inside and 29 outside. Two motors of 30 h.p. each are attached, one to each wheel axle. The cars weigh about seven tons, and are lighted throughout by electricity. At present seven cars are running a 20 minutes' service, but it is intended to increase the frequency as soon as additional cars can be obtained. The power station is situate near Crown Point-road. There are two mild-steel Lancashire boilers, 30ft. long and 8ft. diameter, with mechanical stokers, and these boilers generate steam for driving two pairs of horizontal compound condensing engines of 400 h.p. each, which by means of ropes actuate the dynamos, one of which produces a current of 250 amperes at 530 volts when running at 450 revolutions per minute. The contractors were: engines, Messrs. John Fowler and Co., of Leeds; boilers, Messrs. Clayton, Son, and Co., of Leeds; cars, motors, and dynamos, Messrs. Greenwood and Batley, of Leeds, and Messrs. Milnes, of Birkenhead; poles and brackets, Messrs. James Russell and Sons, of Wednesbury and Leeds; conductors and bonding, Messrs. Laing, Wharton, and Downs, of London; underground earthenware conduits, Messrs. Glover and Co., of Manchester; consulting engineer, Dr. Hopkinson, F.R.S., has acted as consulting electrical engineer to the City Council.

Simplex System.—On March 16 last, upwards of 30 members of the Corporation proceeded to Prescot, near Liverpool, to inspect the Simplex conduit electric tramway, a quarter of a mile of which had been laid on land adjoining the works of the British Insulated Wire Company's premises. The conduit in the Simplex system is not laid under the centre of the track as at Blackpool, but under one rail. It is formed of concrete, with cast-iron yokes or frames placed at intervals of 4ft. apart, except at the ends of rails, where a pair are placed 18in. apart. The slot, ⅜in. wide, is formed by two rails being placed very near together, the traction rail weighing 50lb. per yard and the inner rail 43lb. per yard. These rails are supported by, and secured to the yokes every 4ft. apart. Below the rails, the internal dimensions of the conduit are 12in. deep by 7in. wide. On the straight portions of the line, insulators with a small curved bar attached are placed in the conduit at intervals of 30ft. at the junction of every pair of rail ends. At these points small hatchways are let into the conduit between the yokes, which are here 18in. apart, for gaining access to the conduit, insulators, etc. The conductor, a flexible wire cable, rests on the curved bars attached to the insulators, and at intervals of about a quarter of a mile, a box or small chamber is provided under the line in which tension gear and a lead weight of about 100lb. are placed for keeping the cable stretched. Two rigid collectors are fixed on each car, the bars of which pass through the slot into the conduit. These collectors are provided at the lower end with a U-shaped contact shoe of brass, through which the conductor is allowed to glide. As the collector passes each insulator, the conductor is lifted off the supporting arm and falls back thereon when the car has passed. The car and motors are practically the same as for the trolley system, except that the collector takes the place of the trolley pole. The principal advantages claimed are: (1) freedom from street obstructions, such as poles and overhead wires; (2) high permanent insulation; (3) accessibility of electric fittings for repairs or renewals; (4) economy in construction and simplicity.

General Conclusions. — When the Bradford Corporation tramways were constructed in 1882, the only systems of haulage in vogue were horse and steam. Both systems are now being rapidly superseded. For Bradford, horse traction from the first was considered almost out of the question owing to the hilly character of the city, and steam, although it has done some service, has obtained a very bad name for various reasons, such as serious wear of the track, emission of steam and smoke, nuisance from noise, dust, smell, and droppings of water, grease, and cinders on the track. The deputation are of opinion that electric traction by means of accumulators is out of the question, especially for a hilly district like Bradford, seeing that it has proved such a costly failure at Birmingham and Brussels on routes which are comparatively level. The chief advantages of the cable system are: (1) the steepest gradients can easily be climbed; (2) fluctuating traffic can be dealt with promptly, efficiently, and economically; (3) freedom from smoke, dirt, steam, and smells; (4) the power exerted by cars on descending gradients is to some extent utilised in assisting the ascending cars; (5) less destructive to the permanent way; (6) the slippery condition of the rails does not affect tractive efficiency; (7) absence of posts and wires from the streets. The disadvantages of the cable system are: (1) the heavy initial cost of construction and equipment; (2) great interference with the streets and disturbance of street traffic during construction; (3) occasional interference with railway bridges, gas and water mains, drains, telegraph and telephone wires, and cables for electric lighting; (4) more ironwork exposed on the street surface caused by the slot rails and the lids of pulley boxes and manholes; (5) cable car can only travel in one direction, at one speed, unlike the electric car, which can be reversed or driven at an increased speed so as to make up for lost time; (6) the cable car is whirled round a street corner at the maximum speed—a most dangerous practice—whereas the

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electric car can move round slowly; (7) the great weight of the cable has to be hauled whatever the amount of the traffic may be, and this forms a large proportion—three-fourths—of the power required; (8) any breakdown of the principal machinery or cables causes a temporary stoppage of the entire system. Before adopting the cable system in a city like Bradford it is desirable, if not absolutely necessary, in order to obtain satisfactory working conditions, that the routes proposed for cable lines should be approximately straight and wide enough to admit of double lines throughout, and that the districts which they are intended to serve should be capable of developing sufficient traffic to support a three minutes' service at the least. Bradford thoroughfares as a rule are somewhat tortuous, and the Great Horton and Bolton routes are no exception to the rule. The length of single line on the Great Horton section to the city boundary is 33,732ft., so that a cable weighing one ton per 1,000ft. would give a total weight of cable of 33¾ tons. The deputation was informed by the managing director of the Birmingham City Tramways that his company were prepared to abandon the cable tramway in that city and substitute for it the overhead electric system providing the Corporation would give their consent.

Some of the objections already mentioned against cable tramways equally apply to the electric conduit system, such as the heavy initial cost, the slot rails and hatchways, the prolonged disturbance of the street and interference with business, and interference with railway bridges, gas, sewerage, water, and other underground works, and the difficulty of locating any defects in the underground part of the system. It is also asserted that stoppages are likely to occur during snowstorms, and that difficulty has been experienced in keeping the conduit clear of water and mud and maintaining satisfactory insulation. The Blackpool Corporation have experienced some of the difficulties above mentioned, and have recently decided to abandon the electric conduit and substitute the overhead system.

Recommendations.—The deputation, after giving careful consideration to the whole subject, have decided unanimously to recommend the City Council to adopt the overhead system of electric traction for the proposed lines to Great Horton and Bolton. This system is by far the simplest, the most economical, and the most successful of the methods yet adopted for applying electrical energy to tramway haulage. Within the last six years it has made phenomenal progress in the United States, where over 11,000 miles of tramways have been constructed on this system, whilst electric conduits have made very little headway, being confined to experimental lines in Washington and New York, where it is said the cost is almost prohibitive. Even cable tramways, which held the field some 10 years ago in the States, have only been increased by 100 miles during the last six years. In a lesser degree the same observations may be applied to the Continent, where over 90 per cent. of the new lines and conversions made in recent years are all on the overhead system. Even in this country, which has held out longest against its introduction, the trolley system is making rapid progress. Glasgow, Leeds, Bristol, Sheffield, Coventry, Walsall, Wednesbury, Dover, Hartlepool, Stockton, Halifax, Manchester, Liverpool, Dublin, and Belfast have either already introduced the system or are now engaged in doing so. Since the subject was before the City Council in 1892, when the experiment in electric traction was tried in Cheapside, great improvements have been made. The chief objection to the system at that time was the unsightliness of the overhead wires, the ugly wood posts, and the rough-and-ready manner in which the experiment was carried out, all tended to give a bad impression; but the form of construction now in vogue is very much improved, inasmuch as well-designed steel poles with ornamental brackets are substituted for the objectionable wood posts, and as the conductors for both tracks can be supported by the same bracket arm, as at Leeds, it is not absolutely necessary to place span wires across the street to carry the trolley wire, although the deputation were informed from two authorities that the latter arrangement gives more flexibility to the conductor than the rigid supports on the bracket arms. In cases where buildings exist on each side of a street through which a tramway passes the wires are sometimes suspended entirely across the street and secured to the buildings by small ornamental iron rosettes, thus dispensing with the use of poles. The wires are now more neatly arranged than formerly, especially at street corners; the feeder cables are now placed underground, and the steel poles can be used for lighting the route by electricity, so that the ordinary gas lamps may possibly be dispensed with in many cases. Many other improvements have been introduced, such as electrically bonding the rails to facilitate the passage of the return current, and also for preventing electrolysis or damage to rails, iron pipes, and other underground work, by leakage of the current. Improvements have also taken place in the electric lighting of the cars, and in reducing the weight of the cars and motors, and also by the invention of the series-parallel controller, a most useful device which has for its object the reduction of the large momentary current when a car is started. This devices reduces the momentary maximum current required by about 30 per cent. Another improvement is that of dividing the tramway into several sections with separate feeders to supply the trolley wire in each, so that every section is electrically complete in itself, and is independent of a breakdown in any other section. The risk of other wires falling across the trolley wire has been largely exaggerated, and although accidents of this nature have occurred, there is no record of a fatal accident from such a cause, but provision is now made to guard against danger of this kind. In Hamburg the car-drivers and firemen are provided with shears and indiarubber gloves with which to handle and cut fallen wires if necessary. No difficulty need occur from fire-escapes passing under the wires, as they are now constructed in a collapsible form and travel along the street horizontally. It is invariably found that the introduction of electric traction means a growth of traffic varying from 20 to 30 per cent. The car service is more rapid and regular, each car making a greater daily mileage in consequence; the cars themselves are more comfortable, more attractive and better lighted, and the permanent way is kept much cleaner. The tramway in Hartlepool, when it was worked by horses, was a financial failure, but now they were working it by electrical energy on the overhead system it has become a financial success. The deputation feel convinced that the public will soon become reconciled to the poles and wires, and will cease to notice them as soon as they become acquainted with the advantages afforded by this mode of traction: This has been the experience in every town where the system has been introduced in recent years, even in places where the inhabitants had at first strong objections to its introduction. In the case of the Great Horton section the terminus might for the present be placed at the foot of Morley-street, whilst the Bolton-road terminus could be opposite the post office, so that no poles need actually be brought into the centre of the town until the Corporation have had ample experience of the working of the system. Perhaps the strongest argument that can be adduced in favour of the adoption of electric traction for the new tramways is that the Corporation are already owners of the electricity, and are in possession of one of the finest power stations in the kingdom. It is well known that their best customers are those who take the current during the day or at any hours when it is not required for lighting purposes. For lighting alone, the maximum load can only be reckoned at about three hours, whereas if electric traction were adopted for all the tramways in the city it would increase the duration of the maximum load to nearly 14 hours. Of course the full benefit of such a change cannot be felt until after the expiration of the existing leases, when all the tramways in the city, together with new extensions, can be worked by electricity. In the meantime, the electrical energy which would be required for operating the Great Horton and Bolton sections would make a substantial addition to the output at the electricity works. No doubt the two committees interested will both give careful consideration to the question of the charge to be made for the supply of electrical energy. It is certain that if the current be supplied for tramway purposes at anything like the cost of generating it, apart from lighting purposes, the cost of electric traction on the city tramways would be less than the cost of steam traction, without taking into account the great saving which would be effected in the cost of repairing and maintaining the lines. The deputation were assured, both at Birmingham and Bristol, that it was possible, under the most favourable circumstances, to produce energy at a cost as low as ¼d. per unit, assuming that the current could be generated and supplied at an equal rate throughout the 24 hours. It will at once be apparent that the combined working of the tramways and electric lighting from the Corporation electricity works will be mutually advantageous to both the committees concerned, providing equitable terms can be arranged.—JOSEPH COWGILL, chairman; WILLIAM HENRY BARKER, deputy chairman; THOMAS PRIESTLEY; WILLIAM LAND; CHARLES EDWARD DOWSON; J. H. COX, city surveyor.

DUBLIN ELECTRIC LIGHTING.

The following is a somewhat condensed version of the report recently presented by the Electric Lighting Committee to the Dublin Town Council with reference to the defective condition of certain cables, and as to the advisability of establishing a new central station at the Pigeon House Fort. As will be noticed, it consists of digested reports from the borough surveyor and from the electrical engineer. The first of these reports from the borough surveyor is dated July last, and reads as follows:

Gentlemen,—One of the causes for increased demand for electrical current is that the wiring of houses for electric light is being extensively taken up by several firms in the city, who are pushing the trade in their own interests; consequently the increased demand for current, and which is likely to extend still

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further in the near future. The plant originally erected in the station was equal to 7,500 16-c.p. lamps, the station being taken over from the contractor in September, 1892. Since then your committee has erected a day-load plant which can supply at least 700 16-c.p. lamps, and Fowler's plant, equal to 3,000 lamps; and you have now on order, and which must be erected and at work before the coming winter, the Willans and Robinson engine and the Thomson-Houston Company's alternator, which, it is hoped, will be equal to 3,000, in addition to the others, making a gross total of plant and machinery capable of giving light for, say, 14,200 16-c.p. lamps. Of course, the committee clearly understand that this is practically the total and maximum of the station, when all orders now in hand are complete; and in order to run the station with any safety at all, there must be one lying by, and, taking this to be one of the large engines and alternators, the capacity of the station will be for all practical purposes equal to 11,200 16-c.p. lamps. At present the demand on the works equals 9,500 lamps, and the places wired and light applied for equals 1,700 lamps, making a total of 11,200 lamps. So that the plant will be, it is expected, up to its full load this coming winter, when all these new lights already promised are connected up, and if by any unforeseen circumstances any should break down, it will be straining the balance of the plant to keep things going. Now, whilst the present station is just equal to meet the present demand, it will be a matter of impossibility to meet increased demands, and the committee should carefully consider their position in this respect, and whether it would not be wiser to at once face the fact of a new station being required, whether at the Pigeon House or elsewhere. No doubt, isolated demands for light in parts of the city, probably widely apart, may be perplexing to your committee; but still, if they are to be met at all, there must be the power and the plant necessary. I could foresee the possibility of a run being made on the powers of the station. Electrical engineers and people who wire houses are indifferent to any trouble they may cause so long as they get the work, and it is for you to say whether you will cope with this, with a very much larger and increased power and station, and face the difficulty at once. The Council gave you powers to spend £61,400, out of which you have spent £57,213, leaving a balance of £4,187, which you can still utilise (see report No. 73, 1889, and report No. 98, 1893). The present borrowing powers of the Corporation for all purposes whatever are £70,000 (Mr. Cotton, of the Local Government Board, says it is only £40,000), and possibly the cost of a new station at the Pigeon House, and the necessary mains to connect up the present system only would amount to £50,000 (this, of course, at present must be considered a rough estimate only), so that even to meet the cost of a new station you have neither the money nor, seemingly, the power to borrow it. The Corporation has arrived at a very serious point in their history in this respect, and it is not only for your committee, but for all the other committees in the house, to consider what joint action should be taken with regard to their borrowing powers. Indeed, the proper course would be for a committee of the whole house to meet and discuss what must prove to be a very serious state of affairs for the Corporation. With regard to the storage for coal, last winter the works were very much hampered for space, which, as is well known, is exceedingly small and limited. This winter, with the increased demand, there will of necessity be an increased demand for coal space and accommodation. Last winter about 35 tons of coal per day were used; this winter it will be about 45 tons. My verbal recommendation last week to your committee was to take down Mr. Barry's house, and utilise the space for coal. The adjoining house to this in Fleet-street is, I believe, only occupied by weekly tenants under the Corporation, and if your committee were to get this up from the Finance and Leases Committee, possibly you could then use it for a temporary Board-room if you so desire, or increase the station to that extent. (Signed) SPENSER HARTLEY.

The report of the committee then proceeds as follows: It was in July, 1896, that your committee began to encounter difficulties in the supply of electricity to the public lamps and the private consumers, which difficulties arose through the failure of the cables to convey electrical current. As the days passed, these interruptions in the supply became more and more frequent, until they culminated, within the past fortnight, in a general breakdown over almost the entire system. Your committee, in their breviate for the quarter ended March 31 last, set out a report from Mr. Ruddle, electrical superintendent, in which he directed the attention of the committee to the serious situation with which we were face to face. Having examined so far as they could into the matter, your committee deputed Mr. Ruddle to visit London and other English cities and towns with a view to ascertaining the nature and mode of working of various electrical systems. They ordered Mr. Ruddle to report also on the changes, if any, which other corporate bodies, finding themselves in a similar difficulty, had adopted. In the report furnished by him on his return, the electrical superintendent pointed out that at Blackpool and Leeds the cables had been either wholly or to a very large extent replaced by ones manufactured by the British Insulated Wire Company, Prescott. It appears that this particular cable is insulated by layers of manilla paper wound round the copper conductor in narrow strips, the number of layers varying from 4 to 16, according to the class of cable required. The cable is then covered with seamless lead piping under hydraulic pressure, and is finally saturated with resin oil under pressure, which gives a high degree of insulation to the paper. He saw some specimens tested to 30,000 volts, the normal test pressure being five times the working pressure—*i.e.*, 10,000 volts test pressure for a working pressure of 2,000 volts, such as we use. When the cable is laid directly in the ground it is further protected by braiding of jute and by an armouring of steel tape, but where drawn into pipes, no further protection than the lead covering is used. Special junction and joint boxes of various patterns are required for this class of cable, as it cannot well be insulated in the ordinary way by vulcanised rubber joints. Mr. Ruddle concludes his report with the following remarks: "I am of opinion that in any case it will be necessary to keep the arc lighting cables in a separate pipe from the incandescent cables, and as we have a spare 4in. pipe at present laid along one side of the principal streets, the amount of new 3in. pipe to be laid will be thereby reduced. New cable of some make will be necessary. As regards the incandescent cables, I consider the heavier cables, $^{19}/_{14}$ and $^{19}/_{16}$, are in good condition, but I am not of opinion that the $^{7}/_{16}$ cable is in very reliable condition, and I am certain that the whole of the $^{7}/_{18}$ cable, of which we have over 7,000 yards in use, should be replaced without delay with a better class. Most of the faults have occurred to the latter cable, and remainder to the $^{7}/_{16}$ cable, while the heavier cables have been free from faults, except when caused by the breakdown of the smaller cables in the same pipe. These alterations will mean a heavy expense, but I consider them to be absolutely necessary if we are to have a reliable system of supply. We have been exceptionally fortunate with our cables, considering we have been running since September, 1892, and comparing our mishaps with stations that only started in 1894."

Since the adoption by the Municipal Council of the breviate above referred to, the cables have broken down to such an extent as to render their entire renewal an absolute necessity. So impressed were your committee with the gravity of the situation that, at their meeting on September 16, 1897, they directed Mr. Ruddle to report fully on the condition of the electrical mains and cables.

The following is Mr. Ruddle's report: Gentlemen,—In accordance with your instructions of the 16th inst., I beg to submit the following report upon the street mains. As you are aware from my previous reports, the mains have been constantly breaking down for the last 18 months, without giving any indication until the mishap occurred, and in consequence I had, in March last, your instructions to visit certain stations in England which had passed through similar experience, and ascertain what remedies they had adopted. My report of March 24 last summarised the information I obtained, and also records my interviews with the makers of our cables (the Silvertown Company), and of their offer to send over an expert to examine the state of our cables. This was done, and the company had to acknowledge that the cables were faulty in many instances, but declined to accept the responsibility for the faults, except in the case of one consignment, which was too palpable to be disputed. From a careful examination of the numerous faults and of the remainder of the cables, I have reluctantly come to the conclusion that cables insulated with vulcanised rubber cannot at present be depended upon for permanent work under all conditions of use, owing to the apparent inability of the makers to guarantee them free from manufacturing faults, such as insufficiently neutralising the acid used in tinning the wires, and the rubber not being uniformly "cured" throughout; and even when these faults do not exist, the rubber seems to gradually perish when the protective braiding rots off. At the date of my report in March, I was of the opinion that by replacing the smaller sized cables with a heavier insulated make we could manage to keep them going for some years to come, but from the last series of breakdowns I find that the heavier insulated main cables are also giving way, and though they will probably last some time with occasional repairs, they cannot be depended upon to give that permanence of supply which is the essential requirement of a supply station. Having come to this conclusion, the only remedy I see left is to replace the whole system of cables with some other class of a more reliable reconstruction, and also, as suggested in my reports of September 29, 1896, and since, to entirely separate the cables for arc lighting in the streets, from contact with the cables for private lighting supply. In connection with this private lighting, I would point out that our present system of having isolated transformers in each consumer's premises, is now quite out of date, and tells heavily against the economical working of the station, owing to the enormous loss in magnetising current now necessary, as well as being a source of weakness in having so many connections direct on to the high-tension mains, and the consequent difficulty and risk when connecting up new con-

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sumers, and I would strongly advise that the new mains should be laid on the plan adopted by the most successful stations in England—namely, having high-tension feeders carried to transformer sub-stations at suitable points, and distributing thence to the consumers with low-tension cables, with the exception of large consumers of, say, 200 lamps and upwards. I would also advise that these high-tension feeders should be subdivided by suitable switches, so arranged that short sections could be disconnected from the remainder for testing or other purposes without having to cut off the supply from the whole circuit. The above plan is in use in the following towns: Blackpool, Bolton, Bristol, Huddersfield, Leeds, Portsmouth, Southport, Worcester, Islington, etc., and, with the exception of the latter place, the cables made by the British Insulated Wire Company, of Prescot, are, I understand, used either entirely, or for all recent extensions. I have already described the construction of this cable in my March report, so need not repeat it now. In the town of Reading, a cable of somewhat similar construction has been adopted, and was made by the Fowler-Waring Company, of London; but I have no further particulars of its suitability. It is, of course, impossible for me to state that this is the only suitable cable; but from its very extensive adoption, and the rigid tests to which it is subjected, I am of opinion it should stand well. I understand that the makers are willing to guarantee it free from faults due to defective manufacture for 10 years at least, and that they would be prepared to tender for the conversion of our system to that of the sub-transformer system, without causing stoppage of supply to the consumers, and they have carried out such conversion in the case of Blackpool and West Brompton stations. It is not possible at present writing to estimate accurately the cost of carrying out these recommendations, as so much depends upon the details of the plan; for instance, in some towns the mains are laid in cast-iron or earthenware conduits, and in others they are armoured with steel tape and laid either direct in the ground or in wood troughing filled in with bituminous compounds. Also the arrangement of the transformer sub-stations much varies; in some cases they are placed above ground, and in others underground, in large chambers, or in small cast-iron tanks, and the same variation occurs in the switching arrangements. Judging, however, from the outlay in other places, and providing for a supply capacity of 30,000 8-c.p. lamps, the cost would be about £16,000, in addition to the cost for the alterations to the arc circuits, which would cost about £3,300—say, a total expenditure of £19,500—and all of which would work in when a new station was built. I have no doubt that either of the manufacturers would send over to examine the extent of the work, and give an approximate guiding estimate based upon their experience in other places. An exact tender could then be invited when the plans were finally decided upon in detail, which, with the necessary specification would take some time to draw up.

(Signed) M. RUDDLE, Electrical Engineer.

Your committee, in view of the circumstances detailed above, and with the object of securing in the future an electrical supply which can be safely depended on for public and private purposes, beg leave to make the following recommendations: (1) That a new station, equipped on such a scale as will enable the Corporation by degrees to light the city, be provided at the Pigeon House Fort. (2) That a system of sub-transformer stations be adopted, as such will ultimately prove a saving to the Corporation. (These transformer stations have been contemplated since the initiation of the present electrical station.) (3) That the entire system of cables or mains, so far as it may be found necessary by the borough surveyor, be altered or renewed. (4) That for the purpose of such renewal the sum of £20,000 be provided. (5) That a sum of £100,000 for the purpose of erecting and fitting up a new station at the Pigeon House Fort be also provided. (6) That as the total of these amounts would exceed the present borrowing powers of the Corporation, a provisional order be promoted to enable the Corporation to borrow the sums in question outside their borrowing powers, having regard to the fact that the undertaking will be self-supporting and that the provisional order would furthermore be required to enable the Corporation to open streets and roads outside the city boundary. (7) That in order to make the suggested undertakings a success, the services of a first-class consulting electrical engineer be obtained, with a view to having his advice on all matters connected with the proposed changes and alterations. (8) That your committee be authorised to have the statutable notices published, in order that the necessary powers may be secured to enable the Corporation to proceed with the proposed works. (9) That your committee be empowered to apply to the Local Government Board for a provisional order and for the sanction of the Board to a loan of £120,000, the law agent and the town clerk to take whatever legal steps are essential to attain these ends. (10) And that your committee be given leave to incur any expenditure which the carrying out of the foregoing recommendations may entail.

All which we beg to submit as our report, this 23rd day of September, 1897. (Signed) WILLIAM BUCKLEY, Chairman.

QUESTIONS.

In our issue of October 8 we announced our intention of offering *one shilling* for each suitable question for insertion in this section of the paper, and *ten shillings* for the best answer sent in to any question. We herewith give two questions out of a number sent in, and propose to insert the answers in our issue of October 29. Answers should be sent in by Tuesday morning, October 26. We shall be glad to receive other questions.—ED. *E. E.*

QUESTIONS.

1. How could the output of an alternator be increased without altering the speed?—F. B. (Bolton).
2. Two alternators running in parallel, the load being 100 amperes, it is required that they should do 80 and 20 amperes respectively. How could this be done?—F. B. (Bolton).

REFUSE DESTRUCTORS AND ELECTRIC LIGHT AT PLYMOUTH.

A special meeting of the Plymouth Borough Council was held on the 11th inst. to consider a report of the Refuse Destructor Sub-Committee. This sub-committee was appointed to consider and report upon the arrangements to be made for the work of refuse collection and disposal. They visited Oldham, Rochdale, Dewsbury, Cambridge, Hornsey, and Lewisham, and describe at length the types of refuse destructor in use in these towns. Having considered the question in the light of this information, and having regard to local conditions in Plymouth, they arrived at the following conclusions: (1) That it is undesirable to dispose of the town refuse by conveying it to sea for the following reasons—(*a*) the cost is greater than by burning (at Liverpool the cost varies from 1s. 6d. to 1s. 7d. per ton); (*b*) during stormy weather vessels are unable to proceed to sea, and in consequence large accumulations of refuse will take place at the depôt; (*c*) the deposit of refuse at sea would probably foul the fishing grounds, and consequently prejudicially affect the fishing industry of the port. (2) That the town refuse can be disposed of rapidly and effectually by means of a destructor without causing any nuisance, and that this method is the best way of dealing with it in a manner to satisfy sanitary requirements. (3) That town refuse has considerable calorific value, consequently the heat resulting from the burning of the refuse is valuable for steam-raising purposes. (4) That the first essential requirement of a destructor is to destroy the refuse rapidly and effectually. (5) That in designing the destructor the cells and furnace should be so arranged that steam boilers may be placed as near as practicable to the furnaces in order to utilise the heat to the fullest extent. (6) That the destructor should comply with the following requirements: (*a*) the temperature of the furnaces should be from 1,700deg. to 2,000deg. F. in order to thoroughly consume all vapours and gases arising from combustion; (*b*) the cells and furnaces should be supplied with forced draught; (*c*) the installation should be capable of burning a minimum quantity of refuse equal to 150 tons in 24 hours. The committee are of opinion that the proposed destructor should adjoin the electricity station at Prince Rock in order that the heat for it may be used as far as possible for raising steam to generate electric energy. The average quantity of refuse is calculated at 120 tons a day. The committee estimate that 1lb. of refuse will evaporate 1lb. of water, so that the 120 tons per day is capable of evaporating 268,800lb. of water in 24 hours. If the burning of the refuse could be spread evenly over the day, and assuming an average consumption of 26lb. per indicated horse-power, the horse power available would be 430 i.h.p. per hour. The equivalent amount of ordinary slack coal required to obtain this result would probably be 20 tons per day. Assuming that slack can be obtained at 8s. 6d. per ton delivered, the saving in the cost of coal to the Electric Lighting Committee would be £2,652 per annum, provided they required this power evenly throughout the day. Until the whole of the Corporation tramways are worked by electricity not more than 200 i.h.p. will be required for about 18 out of the 24 hours, and for the rest of the day about 500 i.h.p. They recommended that designs and tenders should be invited from the Horsfall Furnace Syndicate, Limited; Beaman and Deas Syndicate, Limited; and Manlove, Alliott, and Co., for a destructor, embodying the characteristics and requirements set forth in the report, and such other requirements as might be imposed. The Mayor, who accompanied the deputation, concurs with the committee's recommendations.

At the meeting of the Town Council last Monday, **Mr. T. H. Harvey** moved the adoption of the recommendation. He said the time had arrived when the whole Council were of opinion that something must be done to get rid of the house refuse, and the only reasonable and proper way was to burn it. The only alternative was to take it out to sea. But it would be wrong to adopt that course, because besides filling up the sea with refuse at a time when large sums were being spent in dredging operations in the port, the deposit of a mass of light stuff, such as house refuse, at sea would damage the fishing industry. The heat which would be utilised for the destructor would be very considerable indeed. After carefully considering the various systems in use, the committee selected

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the Horsfall, Beaman and Deas, and the Manlove and Alliott as the best. Either of them would answer their purpose, and would enable them to use the steam for the electric light works. The committee were divided as to whether they should recommend one system only. But they saw in each points which were excellent of their kind, and they thought they could seize upon all those points and get a destructor combining the best points of all the systems. Nothing was said in their report about the Shoreditch destructor. The thermal storage in connection with it was an experimental system, but the system was one of those they recommended, and the firm who supplied it was among those invited to tender. **Mr. Debnam** proposed an amendment as follows: "That the report be referred back to the committee, in order that further information be obtained as to other and more recent destructors than those recommended, and also that the cost of removing the refuse to sea be ascertained." Mr. Debnam pointed out that this was a very large question, as anyone acquainted with the enormous expenditure incurred by other towns and the many failures which had occurred very well knew. It was stated in the report that the cost per ton varied from 10d. to 13½d. But that was the cost of stoking only, and it was hardly fair for the committee to tell the Council that the cost of destroying the refuse was the small cost of stoking only. Actually the cost of the destruction of refuse by this method in other places came to 1s. 10d. per ton. In Hamburg, where labour was cheaper, it was 1s. 9d. per ton. Then there was nothing in the report as to the probable cost of the cells. To destroy 150 tons per day would require 18 cells, with four in reserve. Those 22 cells would cost £11,000. At Oldham the cells originally fixed there were entirely rebuilt after four years. They must consequently take one-fourth of £11,000 as the annual cost of the destructor, and add it to the working expenses. At Dewsbury in 18 months extensive repairs had to be carried out, and at the end of that time the whole thing had to be rebuilt. Did not that show the destructor was still an experiment? He estimated that the Council would have to pay 3s. 2d. per ton for the destruction of the refuse. At Fulham the committee appointed to make investigations advised the Vestry not to adopt a combined scheme of dust destruction and electric lighting until they saw the result of the experiment now being tried at Shoreditch. In face of this information, would Plymouth be wise in rushing in where Fulham feared to tread? Quite recently another destructor had been invented on a principle intended to obviate the inrush of cold air. Under these circumstances he strongly urged the wisdom of putting off the scheme for six months, in order to consider the experiments now being made at Shoreditch and other places. One fact to be remembered was that in the case of the towns which had adopted the destructor it cost from 3s. to 3s. 6d. per ton to barge the refuse away. For economical reasons, consequently, it was almost a necessity for them to destroy it. But for Plymouth, which could remove it to sea for 1s. per ton, it was not a necessity to destroy the refuse. Even from a sanitary point of view it was not necessary, since with a destructor the refuse would remain for 24 hours after collection before being destroyed, and if the plan of disposal at sea was adopted, it would not be kept much longer in the hoppers, even in stormy weather. After further discussion the amendment was put and carried by 25 votes to 23.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Guadix (Spain).—The Corporation invite tenders for an electric light installation to supply the town. Address the Syndico, Guadix, province of Grenada, Spain. Tenders by October 25.

Santona (Spain).—The Corporation invite tenders for an electric light installation to supply the town. Address the Syndico, Guadix, province of Grenada, Spain. Tenders by October 29.

Real Sitio de Ildefonso (Spain).—The Corporation invite tenders for lighting the town by electricity. Address the Syndico of the above town, province of Segovia, Spain. Tenders by October 21.

Harrogate.—The Corporation are prepared to receive tenders for the supply and erection of various plant at their electricity works, the particulars of which appear in our advertising columns. Tenders by 12 noon on October 25.

Axnaga (Spain).—Tenders are required by November 3 for the lighting of the town; the system to consist of 250 lamps of 10 c.p. The estimate amounts to £264 per annum. Address the Syndico, Guadix, province of Grenada, Spain.

Russia.—The Municipal Authorities of Novorossisk, South Russia, are inviting tenders for the concession for the construction and working of an electric tramway, and for the electric lighting of the town. Tenders by November 1.

Ploesti (Roumania).—Tenders are invited for lease of lighting the town by electricity for a period of 40 years, also for power transmission purposes. Particulars may be obtained on application to the Municipal Authorities at Ploesti. Tenders by Nov. 27.

Paris.—A public adjudication of tenders will take place at the Tribunal of Commerce, Paris, for the installation of electric light into the barracks of the fire brigade now being constructed in the rue Jean Saques Rousseau. The estimate is £549. 14s. 2d. Tenders are to be sent in by October 23.

St. Pancras.—The Vestry of St. Pancras are inviting tenders for supplying and fixing additional plant at the Regent's Park electricity works, comprising dynamos, engines, and switchboards, for full information of which we refer readers to our advertising columns. Tenders are to be sent in by 12 noon on November 2.

Southampton.—The Corporation invite tenders for the supply and erection of various engines, alternators, motor-alternator, rectifiers, high-tension switchboards, continuous current generators, balancing and volt raising transformers, low-tension switchboards, and a battery of accumulators and accessories, particulars of which appear in our advertising columns. Tenders by October 18.

Sheffield Prize Competition.—The Tramways Committee of the City Council of Sheffield invite designs for centre standards and side posts for use in connection with their proposed electric tramways and offer a prize of £10. 10s. for the design which, in their opinion, is the best submitted. Particulars as to dimensions can be obtained at the City Surveyor's Office, Town Hall, and designs must be deposited with the City Surveyor, endorsed "Designs for Tramway Standards," not later than the 30th inst.

Singapore.—The Municipal Commissioners of the town of Singapore, Straits Settlement, invite proposals for the lighting of the public street lamps for five years from January 1, 1899. Tenderers may submit proposals for lighting by gas or oil, or partly with one illuminant and partly with the other. Further particulars may be obtained on application to Mr. C C. Lindsay, M.I.C.E., 167, St. Vincent-street, Glasgow, or to Mr. J. Polglase, secretary to the Municipal Commissioners of Singapore, Singapore. Tenders may be sent either to Mr. Lindsay, up to November 30 next, or to the Secretary up to December 31.

Queensland (Australia).—The Municipal Council of Ipswich, Queensland, is inviting tenders for the supply and erection of the following electric lighting plant, etc.: tubular boilers, pipes, pumps and heaters, alternators and exciters, switchboard, high and low tension mains, junction boxes, transformers, etc. Specifications and all particulars as to conditions, etc., may be obtained from Messrs. Gordon and Gotch, St. Bride-street, Ludgate-circus, London, E C., and tenders have to be forwarded to the town clerk (Mr. Albion Hayne), Council Chambers, Ipswich, Queensland. Tenders by November 15.

Glasgow.—The City Council invite tenders for the electrical equipment of the Springburn and Mitchell-street route of the Corporation tramways. Specification, with form of tender and plan of route, can be obtained on application to Mr. John Young, general manager, 88, Renfield-street, Glasgow. Intending contractors must remit to the General Manager the sum of £10, by bank draft, payable to Glasgow Corporation Tramways, and this sum will be returned to them on receipt of a bona fide tender, together with the plan of route. Sealed tenders, marked "Springburn and Mitchell-street Route, Tender for Electrical Equipment," to be lodged with Mr. J. D. Marwick, town clerk, City Chambers, Glasgow, by 10 a.m. on October 20.

Belize (British Honduras).—Tenders are invited by the District Board of Belize for the lighting by electricity of the town of Belize. The system decided upon is that known as the three-wire or neutral-wire system, and comprises boilers, engines, dynamos, accumulators, copper mains, flexible leads, iron lamp standards, switches, fuses, lamps (glow), and lamps (arc), meters, etc. Full particulars of the requirements of the Board can be obtained on application to Mr. A. R. M. Simkins, M.I.E.E., care of F. Otto, Esq., Tower-chambers, Moorgate-street, London, E.C. (Telegraphic address, Helios, London). Tenders should be addressed and should reach Mr. Simkins by October 20, and should be enclosed in a sealed package, marked "Tender for Electric Lighting."

London, E.C.—The Shoreditch Vestry invite tenders for the supply and erection of additional engines and high tension continuous-current generators, with an extension of the existing switchboard. Specifications and forms of tender can be obtained at the offices of the engineers, Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, on payment of a fee of £5. 5s., which sum will be returned on the receipt of a bona fide tender. The contractor whose tender is accepted will be required to enter into a formal agreement, under seal, with sufficient sureties, for the fulfilment of contract. Trade union rates of wages and hours to be observed. Sealed tenders, endorsed "Electricity Supply, Tender for Contract No. 10," to be sent at or before noon on November 2 to Mr. H. Mansfield Robinson, vestry clerk, Town Hall, Old street, E.C.

Hull.—The Corporation are advertising for tenders for the electrical equipment of their tramways, to the extent of about nine miles double track and half mile single track. It will be open to contractors to submit tenders for various systems, and the contract, which will not be divided, will include engines and generators, switchboards, feeders, poles, brackets, trolley wire, rail bonding, and all accessories, also the first instalment of cars (15 motorcars and five trailers). It is expected that the specification, lithographed plans of the routes, and other particulars will be ready for issue early in September, and copies, when ready, may be obtained from Mr. A. E. White, city engineer, Town Hall, Hull, by persons proposing to tender, upon payment of a deposit of £10, which will be refunded upon receipt of a bona fide tender and return of the papers and plans supplied. Cheques to be made payable to Mr. Thos. G. Milner, city treasurer. Tenders, endorsed "Tender for Tramway Equipment," are to be addressed to the Chairman of the Works Committee, and delivered at the Town Clerk's Office, Hull, before noon on November 5.

Madras.—Tenders are invited for the utilisation of water flowing from the Periyár Lake for purposes other than irrigation and not incompatible with the use of the water for drinking. The irrigating season extends over nine to ten months, during

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which time the discharge is likely to be from 1,100 to about 500 cubic feet a second, according to the demands for irrigation and the available quantity in the lake. Subject to the risk of interruption by accident or drought, supply can be given throughout the irrigation season. No supply can be guaranteed at other times, but, so long as water is available, the Government will be prepared to issue it in such daily quantities as may seem to it advisable with reference to the time which is likely to elapse before the supply is replenished by the setting in of the rains. The fall from the tunnel to the foot of the hills is approximately 900ft., and the distance measured along the course of the stream about 6,800ft. One cubic foot per second falling 900ft. is estimated to produce over 60 effective horse-power. Intending lessees should state the quantity of water required in cubic feet per second and the annual rent offered for each cubic foot per second. No rent will be charged for the first year from the date of the concession; for the second year the charge will be one-fifth, and an additional charge of one-fifth will be made every year until the full rent is reached. The whole or part of the concession may be surrendered on a year's notice being given. Lessees will construct at their own expense, on plans to be approved by Government, all the weirs and other works required to divert the water from the river below the tunnel. For further information, application may be made to the Chief Engineer for Irrigation, Madras, by whom tenders will be received up to July 1, 1898.

RESULTS OF TENDERS.

Llandudno.—The following tenders have been received by the Llandudno Urban District Council for erection of proposed electric lighting and refuse destructor buildings at Llandudno:

R. L. Roberts, Craigydon Llandudno (accepted)	£5,004 13 6
S. Warburton, Manchester	5,503 2 0
E Roberts and Son, Manchester	6,391 0 0
Gledhill and Thomas, Halifax	7,859 10 8

Paisley.—The Corporation have agreed to accept the following tenders for the erection of the new electric lighting buildings: Excavator, brick, and mason's work, George Primrose, £7,888. 18s. 5d.; iron and steel work, Hanna, Donald, and Wilson, £541. 9s. 10d.; carpenter and joiner's work, G. and T. Houston, £1,156. 13s. 4d.; slater's work, James Jeffrey and Co., £320. 17s. 3d.; plumber's work, William Allison, £360. 10s. 6½d; plasterer's work, Alexander Maxwell, £332. 5s. 5d.; glazier's work, G. G. Kirk, £247. 7s.

London.—The following tenders have been received by the Metropolitan Asylums Board for extending the electric lighting system to the new staff blocks now in course of erection at the North-Western Hospital:

T. S. Anderson, Royal Insurance-buildings, Sheffield*	£380 0 0
P. Speedy, 55, Victoria-street, Westminster	395 0 0
Laing, Wharton, and Down, Limited, 82A, New Bond-street, W.	497 16 0
Hill, Upton, and Co., 13, Magdalen-street, Oxford	520 0 0
J. Sax and Co., Limited, 119, Coldharbour-lane, Camberwell, S.E.	536 8 0
Fricker, Miller, and Co., 149, Fleet-street, E.C.	754 0 0
G. F. Ratcliffe and Co, 87, Edgware-road, W.	859 15 6

Consulting engineer's revised estimate, £400.
* Recommended for acceptance.

Plymouth.—The Corporation have received the following tenders for engineering works in connection with the electric traction scheme:

Contract No. 10.—Overhead trolley line, posts, brackets, &c.

J. Spencer (not complete to specification)	£2,130 10 0
Telegraph Manufacturing Company (not complete to specification)	2,164 15 0
Electric Construction Company (accepted)	2,171 0 0
Siemens Bros.	2,268 0 0
Brush Company	2,314 18 0
Laing, Wharton, and Down	2,448 0 0
Crompton and Co.	2,547 7 2
Westinghouse Company	2 548 0 0
R. W. Blackwell	2,548 2 5
Bergtheil and Young	2,636 5 0

Alternative.

Siemens Bros. and Co.	2,058 0 0
Laing, Wharton, and Down	2,426 0 0
Crompton and Co.	2,277 11 10
Westinghouse Company	2,278 0 0

Contract No. 11.—Tramcars, trucks, motors, trolleys, arms, &c.

Westinghouse Company (accepted)	3,083 0 0
British Thomson-Houston Company	3,093 15 9
Brush Company	3.199 10 0
R. W. Blackwell	3,230 7 8
Laing, Wharton, and Down	3 240 14 0
Greenwood and Batley	3,354 13 6
Electric Construction Company	3,388 5 0
Crompton and Co.	4,481 15 0
Siemens Bros. and Co.	4,782 0 0

Alternative.

Westinghouse Company	2,863 0 0
Laing, Wharton, and Down	3,138 14 0
Greenwood and Batley	3,224 13 6
Electric Construction Company	3,268 5 0
Crompton and Co.	4,336 15 0
Crompton and Co.	3,478 15 0
Siemens Bros. and Co.	4,696 10 0

BUSINESS NOTES.

Cheltenham.—The Winter Garden is to be fitted with the electric light at a cost of £200.

St. James, Westminster.—It is reported that the electric light will be introduced shortly into this parish.

Globe Telegraph and Trust Company.—An interim dividend of 1s. 9d. per share is announced for the past quarter.

Change of Address.—Messrs. White and Co. Manchester, have removed their offices to 1, Lancaster-avenue, Fennel-street.

Wimbledon.—The Board of Trade has formally sanctioned the electric lighting scheme proposed by Mr. A. H. Preece for Wimbledon.

Rochdale.—From remarks made during a debate at the Council meeting it appears that the electric lighting question has not been lost sight of.

Middlesbrough.—At the monthly meeting of this Council, on the 12th inst., an electric lighting scheme, estimated to cost £25 000, was passed.

Clontarf.—A trial which was made on the 12th inst. on the Clontarf electric tramway system on the Dollymount section of the line has proved highly successful.

Southport.—At the Town Council meeting held on October 12 it was decided to apply to the Local Government Board for a further loan of £21,000 for extensions to the electricity works.

St Annes.—A notice of motion has been tabled for a meeting to be called to sanction on the part of the Council an application for a provisional order for lighting the district by electricity.

Bermondsey.—The Vestry have appointed the vestry clerk as their parliamentary agent for the purpose of carrying out the necessary negotiations for obtaining a provisional order for electric lighting purposes.

Bury.—The trustees of the Brunswick Chapel have accepted the terms of the committee for lighting the chapel with electricity. Doulton's patent conduits are to be used for the length of cable down Manchester-road.

West India and Panama Telegraph Company.—The directors recommend dividends of 6s. per share on the first and second preference shares and 1s. per share on the ordinary shares for the six months ended June 30.

Colne.—The Corporation have instructed the town clerk to apply to the Board of Trade for a provisional order empowering the Town Council to supply electricity for lighting and other purposes within the district.

Lincoln.—Colonel W. L. Coke, M.I.C.E., held an unopposed enquiry on the 13th inst. into an application of the Town Council for the sanction of the Local Government Board to borrow £21,000 for purposes of electric lighting.

Radcliffe.—The introduction of electric lighting has been again brought forward. It was stated at the last Council meeting that if this was not done, it will be necessary to at least double the present supply of gas.

Tynemouth.—At a recent meeting of the Town Council it was resolved that the Corporation should retain the public supply of electricity and the supply of motive power by electricity to the tramway company in their own hands.

Polytechnic Institution.—A social reunion will be held at the Polytechnic Institution, Regent-street, on Tuesday, 19th inst., to celebrate the opening of the trade classes for photography and photo-engraving for the winter evenings of 1897-98.

Matlock.—The Postmaster-General, in response to a requisition, gave intimation that telegraphic extension would be taken to Tansley if consent were obtained to erect the poles, and this has been readily acceded to by the Urban District Council.

Godalming.—The *Aldershot Gazette* states that before the current municipal year closes, and possibly within the next few days, the Town Council will be called upon to decide upon its policy with respect to the introduction of the electric light.

Brussels Exhibition Award.—We note that Messrs. Thomas Parker, Limited, have been awarded a gold medal at the Brussels Exhibition for their electric railway motors. These motors are used to drive the carriage of Behr's high-speed monorail railway.

Metropolitan Telephone Service.—The London County Council on the 12th inst. agreed to a resolution to the effect "that it be referred to the Highways Committee to report to the Council what steps can be taken to investigate the present position of the telephone service of the Metropolis."

Bournemouth.—We are informed that a company intends to apply for powers to construct an electric tramway on the best and most approved type and on the overhead system, from Pokesdown to Bournemouth and Poole, provided the consent of the Corporation could be obtained for the scheme.

Portsmouth.—The *Hampshire Telegraph* says "At last there is a probability of the Royal dockyards being properly lighted, for estimates have been forwarded to the Admiralty for lighting them by electricity. It is to be hoped that the Admiralty will make provision for the work in next year's estimates."

Coventry.—The Town Council have passed a resolution to the effect that the Electric Light Committee be instructed to add £2,000 to the amount sanctioned by the Council for the purpose of the electric light undertaking, such sum to be expended in installing electric arc lamps in lieu of gas in various streets.

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Bowness-on-Windermere.—The Urban District Council have decided upon a question of disposing of available extra 9-c.p. lamps, that this extra light be applied to the main streets in preference to the outlying portions of the district, the present 25-c.p. lamps to be increased to 32 c.p., and the other 16-c.p. lamps to remain as at present.

Morecambe.—At the monthly meeting of this Council on the 11th inst., it was decided to borrow £7,000 in addition to the £26,000 for the electric light scheme, in accordance with the recommendation of the resident engineer. The Chairman said it was absolutely necessary that the extra £7,000 should be spent if the town was to be lighted satisfactorily.

Maidstone.—The typhoid epidemic at Maidstone is keeping back the electric light. The minutes of the Electric Lighting Committee recommending that Mr. Hawtayne be asked to attend a meeting and fully discuss the position of affairs with regard to the electric lighting provisional order were not reached at the meeting of the 6th, owing to want of time.

Salisbury.—The town clerk having received statutory notice and plan of the system of street mains to be laid down by the Salisbury Electric Light and Supply Company, the engineer (Mr. Bothams) has been instructed to see the engineer to the company and report to the General Purposes Committee, who would, if necessary, report to the Council at a future meeting.

Brechin.—The Police Commission have decided to apply to the Board of Trade for a provisional order empowering them to introduce the electric light within the burgh. As already reported, the Commissioners do not intend undertaking the lighting themselves, this part of the work having been taken on by the Edmundson's Electric Corporation, Limited, London.

Blackpool.—The Wright system of charging at Blackpool is causing much talk in the town. A few consumers had the idea that the more electricity they used the less they had to pay, but are finding that their opinions are not in agreement with the bills they receive. The Tradesmen's Association are going to consider and discuss the question of electrical charges to-night.

Skipton.—The Urban Council have appointed a sub-committee to enquire into the desirability of the town being lighted by electricity under the control of the local authority. The generating power, it is suggested, can be obtained from the Council's water supply at Eastby. The idea is the outcome of the decision of the gas company to increase the price of gas from 2s. 8½d. to 2s. 11d. per 1,000ft.

Castleford.—The following resolution of the Gas and Water Committee of the Urban District Council has been agreed to: "That it is desirable for the Council to apply to the Board of Trade for powers to provide and sell electricity for lighting and other purposes, and with that view the Finance Committee be instructed to include the sum of £100 in their next estimate for general district rate."

Newcastle.—The Parliamentary and By laws Committee have reported to the Town Council that they had had for some time past under consideration the question of making an application to the Board of Trade for a provisional order to empower the Corporation to supply electric lighting within the borough. They would report further when they had come to a definite conclusion relative to the proposal.

York.—At a meeting of the Municipal Electric Lighting Committee held on the 11th inst. it was unanimously resolved to recommend to the Council that the Corporation carry out the electric lighting themselves, and that they therefore do not accept any of the proposals of the various companies which have been submitted to them. This report will be discussed at a special meeting to be held during this month.

Chichester.—A special meeting of the Chichester Town Council was held on the 11th inst. to receive a report from the Finance and General Purposes Committee. The committee recommended that the Council should take the necessary steps to procure a provisional order for lighting the city with electricity. After a long debate the voting was equal—eight on each side—and the Mayor gave a casting vote in favour of applying for the provisional order.

Belfast.—The Belfast Street Tramways Order, 1897, has been made by the Lords Justices-General and General Governors of Ireland, in exercise of the power in the Tramways (Ireland) Act, 1860, and the amending Act by and with the advice of her Majesty's Privy Council, sanctioning the making and maintaining of the tramways set out in the memorial to the Lord-Lieutenant in Council presented by the promoters, the Belfast Street Tramways Company, on May 13 last.

Brazilian Submarine Telegraph Company.—The accounts, subject to audit, show a profit sufficient to enable the directors to recommend a final dividend of 3s. per share, making, with previous distributions, a total dividend of 6 per cent. for the year ended June 30, and also the payment of a bonus of 2s. per share, both free of income tax, which together will amount to £32,500, leaving a balance of £17,221, of which amount £10 000 has been placed to the reserve fund, and £7,221 carried forward.

Poplar.—The Guardians have had under consideration the question of lighting their establishments with the electric light, and also putting on a new steam and water supply at the workhouse. For this purpose Mr. F. J. Warden Stevens has been asked to prepare a report, and after the consideration of that report the Board agreed that to carry the work out would involve so large an expenditure that it would be prudent to postpone any further action in the matter until after the next election of Guardians.

Glasgow.—The return of the revenue, expenditure, liabilities, and assets of the Corporation, as at May 31, 1897, and of the interest paid in the year to same date, prepared by the city chamberlain in terms of a motion of Bailie M'Cutcheon, which has just been issued, contains the statistics of electric lighting, as follows: revenue, £30.474; expenditure, £28,947; liabilities, £146,600; assets, £141,650; net interest paid, £4,300.

Eastbourne.—A deputation from the Eastbourne Town Council have visited the Shoreditch electricity works and refuse destructors. The inspection of the works proved very interesting. The deputation consider that there is no doubt that if the electric lighting works at Eastbourne were in the hands of the Town Council, the furnaces at the Eastbourne destructor could be made to yield a large amount of power. On the other hand, it would be somewhat expensive to provide plant for furnishing the electric light for municipal purposes only.

Edinburgh.—At the meeting of the Town Council on the 12th inst. a discussion took place regarding the working of electric light men on the "Sabbath," and in Edinburgh—of all places. In the course of the debate it was stated that the Town Council had sanctioned that the electric light should go down Newington next year for public lighting. But as many of the houses had been wired for private lighting and were anxious to have the light, they were laying the mains this year. They had to cross the street for the public lamps at various places.

Derby.—The Earl of Jersey and Colonel Boughey, commissioners under the Light Railway Acts, held an enquiry at Derby on the 12th inst. into a proposed electric railway between Derby and Ashbourne. The length of the line would be about 13 miles, and it would run alongside the highway. In addition to serving a rich agricultural district, it would have the effect of considerably facilitating tourist traffic to Dovedale. The commissioners, after hearing the evidence, expressed their approval of the proposals, which, it was stated, would involve an outlay of £70,000.

Fulham.—As a result of the investigations undertaken in many of the principal towns by the special committee appointed by the Fulham Vestry to consider the best means of disposing of the dust and refuse of the parish, it has been determined to follow the plan adopted in Shoreditch, and to establish a similar system of dust destructors and electric light producers as was recently inaugurated by Lord Kelvin. At first provision is only to be made in Fulham for the destruction of one-half of the parish refuse. It is probable that the same method will be adopted both at Brentford and in Newington.

Darlaston.—The matter of the application of various companies to obtain from the Board of Trade a provisional order to introduce electric lighting and works into a wide local area, including Wednesbury, Darlaston, Bilston, Willenhall, etc., was discussed at the last meeting of the Urban District Council. The Clerk said a meeting of local authorities had been held, but nothing unanimous was arrived at, though it was thought that the application should not be approved. It was suggested that Darlaston should generate its own electricity. The matter was deferred to the General Purposes Committee for consideration.

Soulcoates.—At a former meeting of the Council the Hessle representative objected to the National Telephone Company erecting telephone poles at Hessle, and so making the landscape unsightly. Now the company states that it is impossible to fix the wires underground, as suggested, owing to the expense and the small number of subscribers. The Hessle representative objected to the poles going through the village. Plans were produced of the proposed sites of the poles, and eventually the Council agreed to give their sanction to the erection, subject to the consent of the surveyor being given.

Submarine Cables Trust.—It is announced that on and after 15th inst. the coupon due on that date will be paid in full by Messrs. Glyn, Mills, and Co., 67, Lombard-street, between the hours of 10 a.m. and 2 p.m. The coupons should be left with the bankers for examination four clear days before payment. New sheets of coupons are ready for delivery, and those certificate holders who have not already applied for the same may obtain them on application at the office of the Trust, Winchester House, 50, Old Broad-street, E.C., between the hours of 11 a.m. and 2 p.m., on production of the certificates.

Chelsea.—The Works and Sanitary Committee have discussed the question whether it would be better to hand over Kensal Green to the County of London and Brush Provincial Electric Lighting Company, or to reserve the future illumination of Kensal Green for the Vestry itself. The committee not unwisely declined to commit itself, at least for the present, to handing over to a private body the lighting of Kensal Green, and, to gain further materials for its future guidance, decided to write to six London vestries and six provincial Boards asking them to furnish any information which they have relative to electric lighting.

Edison and Swan Company.—We have received a very attractive souvenir of the Imperial Victorian Exhibition at the Crystal Palace, now just closing. It is issued by the Edison and Swan United Electric Company, Limited, and contains in a brief form the history of the introduction of electric light into this country. An interesting fact in this connection is that the Edison and Swan Company were the founders of the first central station in this country, and during the period of their patents they were the only makers of incandescent lamps. This little souvenir is well got up, and contains some good illustrations of lamps, etc.

Catalogues.—Mercier's Patents, Limited, manufacturers of electrical specialities, Manchester, have issued a catalogue containing details of their patent watertight bells, watertight Morse

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and ringing keys, and domestic damp-proof bells and pushes, etc. The firm claims that the former is the only electric bell that is so well protected from the weather as to be absolutely watertight—that is to say, it will actually work, and that it has been tested submerged in water for over 18 months.—We have received No. 11 of the "General Electric Progress," issued by the General Electric Company, Limited, containing illustrations and quotations for lamps, bells, and fixtures.

Birkenhead.—At the monthly meeting of the Town Council information referring to the tramway question was elicited incidentally. It appears that the special committee have held several meetings, and, after considering the various modes of tramway haulage, have come to the conclusion that at present the overhead trolley system was the best. The question last under discussion was whether such a system should be carried out by entering into an agreement with some company, or whether the Municipality should take in hand both construction and working, and it seems that they have arrived at the opinion that the Council itself should take up the work entirely.

Stokefleming.—In accordance with a resolution carried at the last Parish Council, a meeting was held "to consider the advisability of lighting the village, and whether it should be done by private subscription or otherwise." It was stated that if the lighting of the village was undertaken by the Parish Council, the Lighting and Watching Act must undoubtedly be adopted, which would involve formalities, delay, and extra expense. If the residents in the village really wished to have it lighted, this could be done with less trouble and at no great expense by voluntary subscription. A resolution was carried to the effect that the village should not be lighted out of the rates.

Islington.—At the recent meeting of the Vestry, the Electric Lighting Committee submitted a report by the electrical engineer upon the proposed Essex-road and Highbury New-park extensions. Mr. Gay's estimate was as follows: Highbury New-park scheme: pipes, conduits, cables, etc., £8,152; transformer chambers, £600; transformers, switches, and accessories, £1,500; low-tension distributing mains, £2,000—total, £12,452. For Essex-road scheme: conduits, mains, feeders, labour, etc., £9,120; transformer chambers, etc., £200; transformers, etc., £500; low-tension mains, £1,100 – total, £10,920. The latter scheme includes street-lighting. No decision was arrived at in the matter.

Paddington.—At last week's meeting of the Vestry the Electric Lighting Committee recommended that inasmuch as the Metropolitan Electric Supply Company had given a written undertaking reducing their terms for the supply of current to private consumers in the parish from 7½d. to 6d. per Board of Trade unit, from January 1 next, and from 6d. to 5½d. per Board of Trade unit from January, 1899, and to remit from the first-mentioned date the charge for hire of converter and main switch, this committee be empowered to instruct the solicitor as and when necessary to oppose the application of the County of London and Brush Provincial Electric Supply Company for a provisional order.

Dudley.—With reference to the negotiations going on between the Council, as proprietors of the electric supply monopoly, and the British Electric Traction Corporation, reported in our last issue, it was stated at the Council meeting that the committee had taken great trouble in regard to the matter, and they had obtained the very best expert evidence; and not only that, but, knowing how scientific witnesses sometimes differed, they had obtained information from other towns. The thanks of that Corporation were due to the town clerks and surveyors who had given them the fullest possible information respecting the agreements between their councils and the tramway companies in their districts. No effort would be spared to bring the negotiations to a satisfactory conclusion.

Brighton.—The Lighting Committee presented a resolution to the Town Council at its last meeting instructing the borough surveyor to employ a contractor to repair the shaft at the electricity generating station, which had cracked down two of its sides. The shaft was erected in 1891-92, and the cracks had been watched for some time. They were undoubtedly extending, and it was proposed to place 10 wrought iron bands round the shaft. A statement was made that though the cracks were serious, there was no cause to consider the shaft unsafe. Referring to a sum of over £1,700 overspent on the year's estimate, it was explained that there had been 17 extra arc lamps erected beyond the number contemplated, also 60 extra incandescent lamps, and the Madeira-road had been lit by electricity, and several arc-lamp pillars had been stocked.

Brighton and Rottingdean Seashore Electric Tramroad Company.—The above Company invite applications for the subscription of 800 £10 preference shares. The Company state that the line is now practically completed and the car has been running for about 10 weeks, during which time the receipts have averaged over £100 per week, although, as a rule, only three trips to Rottingdean have been made daily, owing to the engine which supplies the electric current not giving out the power expected from it. This defect will shortly be remedied, and the car will then be able to do the journey regularly in 25 minutes each way, and thus make regular hourly trips throughout the day, when the receipts will probably be at least double. The directors estimate that the annual revenue in the future will be £4,720, while the probable expenditure is calculated to be £2,320.

Ayr.—The engineer (Mr. A. J. Fuller) has reported to the Lighting Committee of the Town Council that the cable for the mains extension has arrived, and a start will be made on the opening up and laying of the cable early next week. The transformers and other fittings are delayed by the strike. The steam-piping, etc., has been delivered and tested, and is now being erected. The main pipes are fixed ready, from the boiler stop-valves up to the engine branches. The remaining pipes, etc., will be fixed as they are delivered. The whole of the fittings and mountings of the boilers have been fixed, and the first batch of the new arc lamps have arrived, and are being tested and adjusted at the works ready for erection when the lamp-posts, etc., arrive. The committee have unanimously authorised Mr. Fuller to get an auxiliary engine for stoking machinery at an estimated cost of £30.

Stapleton.—The Surveyor reported at the fortnightly meeting of the Urban District Council that he attended, on behalf of the Council, at the inspection of the line to Fishponds. Some complaint was made to the inspector by residents at Eastville as to the loop line on the Stapleton main road near Eastville Chapel, which, it was contended, was not finished in accordance with the promise of the company. He had explained this to the inspector, who had informed him that, unless the company finished it either in accordance with the parliamentary plan or with an alternative plan which had been suggested by the Council, the license to use the line would be suspended. The inspector's attention was also called to the line near Mrs. Kingston's premises at Fishponds. The inspector acquiesced in a suggestion to widen the road at that point, and the tramways company agreed to pay for the same.

Lytham.—On Tuesday the tramlines from Lytham to St. Annes were inspected on behalf of the Board of Trade. The lines have been laid some time, but owing to the difficulty of procuring a site for the erection of a charging station at the Lytham end, trams have not been run yet, although the length from St. Annes to Blackpool has been used for several months, and with great sucess. The terminus at Lytham is in Clifton-square, and the lines go down Church road, along the railway at Ansdell, thence along Clifton-drive to St. Annes, and on to Blackpool. The construction of the tramway has opened up the route for building purposes, and there is every probability of its being so utilised. With the completion of the Blackpool to Fleetwood line, which is now being constructed, it will be possible for visitors to travel by tramway along the coast from Lytham to Fleetwood, a distance of about 20 miles.

Monte Video Telephone Company.—The report of the directors for the year ended July 31 last show a net profit for that period of £6,237, after providing for all working expenses in Monte Video and London, and after writing off amounts for bad debts and depreciation of stock of materials at Monte Video and of office furniture. This amount, added to the sum of £838 brought forward from last year, leaves an available balance of £7,076 While the value of subscriptions shows a small increase, the working expenses in Monte Video are substantially less, owing to the absence of the extra expenditure entailed during the previous year by the cyclone and change of microphone. The plant has been kept in efficient condition at the cost of revenue. After placing £500 to reserve fund, the directors recommend the payment of a dividend of 4 per cent. on the preference share capital of the Company, absorbing £5,600, and leaving the sum of £976 to be carried forward to next year.

Weston-super-Mare.—A meeting of the committee of the Urban District Council was held on the 11th inst. The purport of the meeting was to consider the report of Mr. Hawtayne, electrical engineer (which appeared in our last issue), with regard to the proposal to utilise the powers secured under a provisional order from the Board of Trade *re* electric lighting, and to adopt the same for public and other purposes. It was resolved: "That scheme No. 2 of Mr. Hawtayne, comprising the Great Western Railway site, minus destructor, be adopted, subject to such modifications, if any, as may be considered desirable, and that an early interview be arranged with Mr. Hawtayne to discuss with him what modifications should be made in the scheme before applying to the Local Government Board for such sum of money as may be required for carrying out such portions of the scheme as may be decided upon." A special meeting of the Council was subsequently held, when the adoption of the minutes of the committee was confirmed.

Newport.—On the report of the Electricity Committee being brought up at the meeting of the Town Council on the 12th inst., a letter from the Trades Council, in reference to the engineers and stokers in the employ of the Corporation, was read. The council asked that the Electricity Committee should furnish a table showing the rate of wages at Newport and other places, and "demanded" that the wages of the men at Newport should be advanced to the standard of other places. It was resolved that the letter be referred to the Electricity Committee for consideration. It was said the committee had seen no reason to advance the wages of the men, because the Corporation were paying quite as much as, and, in some cases, a little more than, other employers in the town. The committee did their best for the general body of ratepayers, who were the owners of the works, and they did not see why they should be dominated by any parties who had no authority in the matter. The Corporation seemed to be dropping into the ways of those outside people but they would surely rue the day.

Bristol.—The Bristol Town Council at its meeting on the 12th inst., after a lively debate, adopted the report of the Tramways Committee. Councillor Howell Davies, who presented the report, said the committee were appointed in January last. The time had not been wasted, for the committee had met on several occasions and had had before them a mass of material from all parts of the country. The opinion of the committee was set forth in the report, and the House would not expect him to go into detail that day, for it would not be wise so to do. The committee had made some approach towards closer relationship with the com-

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pany, and the committee asked for a continuance of the power to come to still closer relations. If the House did this, he thought that before long the committee would be able to bring up a detailed report. Of course, the committee would only have power to negotiate and not to pledge the city to a purchase, but all terms would be brought before the Council for ratification. He thought that the committee might be further trusted by a continuance of the power which had been entrusted to it.

Doncaster.—At a special meeting of the Town Council the ex-Mayor moved the following resolution, as recommended by the Council in committee: "That this Council make immediate application to the Board of Trade in pursuance of the Electric Lighting Acts, 1882 and 1888, for a provisional order authorising the Town Council to supply electricity for public and private purposes in the borough of Doncaster, and that all necessary notices be given and the corporate seal affixed to the memorial to the Board of Trade and to such other documents as may be necessary for giving effect to this resolution." This resolution was carried by 18 votes to 1. During the debate it was said that the engineer's estimate was based upon the assumption that 7,000 lamps would be taken by private tradesmen, which would cost about £25,000, and to light the whole of the borough would cost another £25,000. The resolution did not bind the Council to light the borough with electricity at once; it only bound them to commence the works within two years, and it was desirable that they should apply for powers in order to keep out a private company.

Shoreditch.—At last week's meeting of the Vestry the Lighting Committee reported, in view of the numerous applications that were being received for electric lighting and power, that they deemed it advisable to increase the plant for next year. The consulting engineers advised that it would be quite six months from now before the machines could possibly be delivered, and in view of the delay already experienced the committee recommended that tenders be invited by advertisement for the supply of three high-tension sets of combined engines and dynamos similar to those already installed at a cost of about £6,500. This was agreed to, and the committee further reported that having been advised that an additional sub-station was required in the neighbourhood of Worship-street, they had instructed the consulting engineers, Messrs. Kincaid, Waller, and Manville, to prepare plans and specifications. The committee also intimated that arrangements were being made with the Free Wiring Company for the adoption in the district of their system and forms of agreements. The committee further reported that a new weighbridge was required, but they had first to consider the question of the additional space which would be necessary. The report was adopted.

Rotherham.—A slight alteration to a minute relating to the installation of the electric light has been decided upon as follows: "That a plan submitted showing the small area of the electric light supply and streets to be lighted in the first instance be approved." At the last meeting of the Council a member said that since the committee appointed Prof. Kennedy, he had conferred with the town clerk, and he thought the town clerk should see him, as the time was drawing near when a provisional order should be secured. It was decided that the electric light should only be fixed within a small area. A proposal to sell certain lands was defeated by a large majority. During the debate it was stated as desirable that the Lighting Committee should use the site (which was intended for a fire-engine station) and put the first new holder upon it, then the next new one, a larger one still, on the wider portion of the ground. This would give ample land for the fire-engine station, electric lighting station, and yard for other street departments. It appeared, looking at the future requirements of the department and that of others above mentioned, that every portion of the land was required by the Municipality.

Northwich Electric Supply Company.—At the first meeting of the shareholders of this Company on the 12th inst., under the presidency of Mr. T. Ward, the directors submitted a report as to the position of the Company and of the progress of the undertaking. This showed that the prospectus was issued in September, 1896, and 1,113 shares, by over 60 shareholders, representing £5,565 of capital, were applied for. As this sum was expected to equal all requirements for some time, the directors decided to proceed to allotment. Since the provisional order had been obtained, the works had been proceeded with as speedily as possible, and it was anticipated that the company would be able to commence operations within a few weeks. Favourable arrangements had been entered into with Messrs. Brunner, Mond, and Co., which would enable them to produce the electricity required at a lower cost than any other company. Mr. Swinburne, of Altrincham, had been appointed, and, having had considerable experience in Manchester and elsewhere, the directors felt confident the work would be efficiently performed. They considered the electric lighting of Northwich would be a boon to the district. The report was adopted, and articles of association were adopted.

Gillingham.—The chairman has informed the District Council that he had attended a conference with the mayors of Chatham and Rochester to take into consideration the question of electric tramways being brought into the towns. Mr. Fraser, the engineer, attended and explained the whole of the plans, and urged the desirability of obtaining the consent of the authorities as early as possible, because of the notices that were required for parliamentary purposes. Practically the representatives were unanimously in favour of the scheme. There was a little difference of opinion at Rochester, but he did not know whether that would come to anything or not. The question of the general route was considered, and suggestions were invited as to any alterations that might be thought necessary. As to Gillingham, he thought the proposal was quite satisfactory. The plan would be before the members of the Council, and he suggested that the matter should be considered at a special general meeting this week. They might then arrive at a definite decision. It was decided to consider the matter after the committee meeting. In answer to a question, the Chairman said the scheme was a private enterprise, and nothing to do with the Council. The company were prepared to place £120,000 in the undertaking.

Morley.—The Town Council are in receipt of a communication from the Local Government Board to the effect that they had received the report of their inspector, Colonel Durnford, of an enquiry held by him with reference to the application of the Council for sanction to borrow £19,500 for the purposes of electric light. The Board learned from the report that the works had been put in hand, and that considerable progress had been made with them, and they enquired whether the direction to proceed with the works was given after the receipt of the Board's letter of February 4 with respect to the town hall loan. As regarded the site for the installation, they were informed that it was stated at the enquiry that the land was purchased for the erection of that installation and for the baths, stables, storehouses, etc., by means of a loan sanctioned on May 7, 1895. They pointed out, however, that the loan in question was sanctioned for the purchase of land for the purpose of a depôt only, and therefore they requested that the Board be furnished with an explanation on that subject, and with a plan of the whole site showing how it was proposed to be utilised. They also requested to be furnished with plans and detailed estimates of the costs of the works included in the application for a loan for £3,000 for purposes of electric lighting.

Liverpool.—At the monthly meeting of the City Council a letter was read from the Simplex Company in which they stated their willingness to lay down two miles of line, and if the Corporation, after three months' trial, were dissatisfied, the company would take it up at their own expense. If found successful the Corporation should have the option of purchasing the line at its cost, plus 10 per cent. The following resolution was carried: "That the Special Tramways Committee be requested to reconsider the offer of the Simplex Electric Tramway Conduit Syndicate, Limited, to lay and equip at their own cost an experimental line of tramway, and that they be authorised to accept such offer if they deem it desirable to do so." One of the objections raised to the acceptance of this offer was that the Council would again be delivering themselves into the power of a monopoly. The first line of tramway ever put down in Liverpool, that between the Pierhead and the Dingle, was removable at the pleasure of the Corporation, but when the Corporation went to law to enforce the removal they were beaten. Out of that had grown the tramways monopoly, which they had just paid close upon £600,000 to extinguish, though so great an authority as Sir Arthur Forwood had just previously declared that it was not worth more than £150,000.

Stourport.—Good progress is being made with the construction of the Kidderminster and Stourport electric tramway. Three of the four bridges on the Stourport road which had to be widened have been completed, and the fourth will be finished this week. The road to Stourport is widened at different points for a total length of about 2,500 yards, the soil removed being used for filling up in some places, and the rest tipped at Foley Park and on a low-lying part of Kidderminster Corporation farm. The generating station, which is situate near the new canal basin at Kidderminster, is also in a forward state. The roof has been commenced, and the stack built to nearly half its intended height. The rails for the line are being obtained from America; the first consignment is now on its way to this country, and the whole are ready for shipment. From the progress made with the undertaking there seems to be little doubt that the line will be ready for opening early in January. The tramway is one of the undertakings of the British Electric Traction Company, and Mr. Parlett is the resident engineer, acting on behalf of Messrs. C. Dickinson and Co., the engineers to the tramway. Mr. G. Law, of Kidderminster, is the contractor. It will, no doubt, prove a great public convenience, as, besides the line between Kidderminster and Stourport, a branch will run from the road near the Anchor to a point about a quarter of a mile beyond the railway station.

Isle of Man.—At a rather stormy meeting of the Douglas Town Council the question of overhead electric traction for the Douglas Bay tramways was further considered. The Isle of Man Tramways and Electric Power Company, who hold a 21 years' concession of the Bay tramway—20 years unexpired—had offered, provided they were allowed to substitute overhead electric traction for the present horse traction on such tramway, to light the promenades and principal thoroughfares of Douglas by electricity without charge. A committee had been appointed to consider the offer, and had visited the principal cities of the Continent and inspected the various systems of traction, and on returning reported in favour of the overhead electric system. Half the cost of the committee's visit was paid by the company and half by the town. The Council had reported, by a majority of six to one, in favour of the overhead traction. An amendment substituting mechanical for overhead electric traction was rejected by 13 votes to 12, and it was eventually resolved to further adjourn the matter until after the November elections. The secretary of the company has now written to the town clerk of Douglas intimating that the directors unanimously withdrew the offer in consequence of a number of the Council being unwilling to give a direct answer. The directors say they consider it a waste of time to pursue the matter further, but thank the members of the committee for the trouble and inconvenience they had put themselves to, and for the conscientious and intelligent manner in which they had given their valuable report.

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Shrewsbury.—At a special meeting of the Town Council a report was received from the Finance and General Purposes Committee in reference to the purchase by the Corporation of the works and rights of the Shropshire Electric Light and Power Company. The report stated that in accordance with instructions which the committee had received from the Council and given to the town clerk, negotiations had been carried on, and a letter had been received from Messrs. Peele and Peele stating that the company's directors had decided to accept a verbal offer which had been made by Councillor Deakin on behalf of the Corporation for the purchase of the undertaking for £21,500. The price which the directors agreed to was less than they had been led under professional advice to believe was the true value of the undertaking, but as local men they were anxious to see the undertaking in the hands of the Corporation, and they thought that they might hereafter derive some further benefit as ratepayers of the borough. Mr. T. P. Deakin, who moved the adoption of the report, replied to some observations recently made by the chairman of the gaslight company in reference to the proposed purchase, and gave a number of facts and figures to show the results of electric lighting in other towns, and the success which has generally attended it, not only as an illuminant but in the reduction of the rates. Mr. J. Woodhouse seconded the motion, which was carried all but unanimously. A loan of £35,000 will be needed for the purchase of the works.

Aston Manor.—The Highways Committee's report has been adopted by the Council. Referring to tramways, the committee reported that for some time they had been in communication with the City of Birmingham Tramways Company and the Birmingham and Aston Tramways Company in reference to the continual discharge of water on the roads by the drivers in charge of the engines and also the defective condition of the lines running through the district. They had also had their attention drawn to the constant emission of sulphurous fumes and smoke from the engines of both companies, and the defective condition of the engines and rolling-stock generally. The committee were of opinion that the time had arrived when measures should be taken to remedy this state of things, and had accordingly instructed the clerk to direct the attention of the Board of Trade to the complaint in question, and to ask that an enquiry be held in reference thereto. They had received an application from the Birmingham and Aston Tramways Company asking for the consent of the Council to the renewal of steam for a further period of 12 months. The committee recommended that the consent of the Council be withheld pending the holding of the enquiry above referred to. The committee had had under consideration the desirability of the Council applying for a provisional order enabling them to electrically light the district, and having regard to the fact that already there are notices by three separate companies seeking powers, the committee think it desirable that the Council should have sole control, and recommend that they be empowered to take such steps and employ such professional assistance as may be necessary to this purpose. The estimated cost of an unopposed order would be about £300.

Grand Central Electric Supply Company, Limited.—It is well known that the capital obtained for the Grand Central (late Manchester, Sheffield, and Lincolnshire) Railway Company's extension to the Metropolis is not sufficient for the equipment of the new line, and that already a rolling-stock supply company for the new section is in existence. Still another Grand Central "relief" company is being floated, of which the prospectus will, we are informed, be issued in the course of a week or two. The title is not yet fixed; but the object is to supply the electric current and the electrical installation at the new stations of the Grand Central Railway, including the good yards, sorting sidings, engine sheds, and warehouses at St. John's Wood, London; Neasden, London; Woodford, Leicester, Nottingham, and Annesley. The flotation is in the hands of Mr. Marshall Stevens, managing director of the Trafford Park Estates, Limited; the share capital is to be £75,000, of which £25,000 will be in deferred shares, reserved for the vendor; and the ordinary shares will be entitled to receive a 6 per cent. dividend before anything goes to deferred or for directors' fees. For at least 10 years, and until the railway company purchase the generating stations, the electrical company will supply the Grand Central with the electric current for the several installations. The company is also to supply the complete electric lighting installations, consisting of cables, standards, lamps, fittings, and other accessories, and the Grand Central is to pay interest at the rate of 4 per cent. per annum upon the total cost, which is to be repaid in full. As the contract proceeds, debentures will be issued for amounts not exceeding the expenditure, upon which the railway company guarantee interest at 4 per cent.—*Pall Mall Gazette.*

South London Electric Supply Corporation, Limited.—We have received from the secretary of this Company the following report: "Three acres of freehold land in the parish of Lambeth have been acquired, on about half of which property the generating station, dust destructor works, yards, and offices will stand, leaving ample space for future extensions. The site is very suitably situated, and, moreover, is likely to prove exceptionally favourable in consequence of being alongside a railway—the London, Chatham, and Dover. It lies on the north-west side of this line near Loughborough Junction, Brixon, and negotiations are in progress to obtain a siding. An agreement is about to be concluded with a neighbouring company whereby the South London Electric Supply Corporation is to draw, at a wholesale price, a supply of electricity during the period of construction of works, and everything is being prepared to make a start, secure consumers, earn income, and build up a connection in readiness for taking over when this corporation's own machines can supply the public. The laying of mains is being proceeded with, and it is hoped that by the winter several miles will be in the streets. One large daytime consumer is already receiving a great quantity of electrical current over the South London Electric Supply Corporation's mains. I refer to the London Electrical Cab Company, which is drawing supply by an arrangement under which another company uses the main at a rental, and when this corporation is in a position to generate the current the consumer will be taken over. Many other consumers are waiting for current, and their requirements will be met directly mains can be laid to reach them from the point where the temporary supply enters Lambeth. All the formalities of the Stock Exchange having been complied with, the committee have granted an official quotation to, and fixed a settling day for the shares."

Halifax.—Major Cardew, R.E., has held an enquiry on behalf of the Local Government Board respecting the application of the Town Council for powers to borrow £9,300 for purposes connected with the electric tramway scheme now being constructed. Mr. T. P. Wilmshurst, electrical engineer, explained the technical part of the scheme. The battery being put down was necessarily a large one, as a Bill for the extension of the tramways system was being applied for. In reply to the inspector, he said he did not think there was any fear of their burning out the alternators. The main work would be done by the direct-current dynamo. He did not think the variations of the alternating motor at all too severe; the battery would be kept going. The Inspector: Oh, it is all right so long as you have everything running, but you have got such a division of power behind you. Mr. Wilmshurst further stated that the second motor-alternator would not be put down until the result of the working of the first one was ascertained.—The new workhouse hospital will involve a total estimated expenditure of £130,000. Accommodation will then have been provided for 642 patients, about 100 nurses, and for general administration. For the present, however, only part of the scheme is to be carried out, the contracts let amounting to £95,000. It will contain an electric station, which is placed below the ground-level. Here the engine, dynamos, and cables will be accommodated for supplying the whole institution with power, and works all the electric bed lifts and others intended for general use, also hot hearths for cooking in nurses' kitchen to ward, also the telephones, bells, clocks, and electric fans for ventilating the wards, and the whole of the institution will be illuminated exclusively by electric light generated from the centre, no gas being used except for cooking purposes in the large general kitchen. Workshops are provided for over the electric centre on the ground level.

The Underground Railway.—The *Daily Telegraph* publishes an interview with Mr. John Bell, the managing director of the Metropolitan Railway. Upon it being pointed out that, according to the special committee of the Board of Trade, the best way of dealing with the ventilation of the Metropolitan tunnels would be to adopt electric traction, Mr. Bell replied that the question of electric traction had not been lost sight of, and that the company was continuing to do its utmost to satisfy the public in every possible way. "I have," he continued, "been to America on two occasions in order to see what improved system of traction we could adopt. At present there are difficulties in the way, which may, it is true, be overcome in the immediate future, but which are for the time being insurmountable. The company is in the hands of practical men, who are trying their best to solve the problem. We have made some experiments, as, for example, locomotives driven by compressed air, but they did not answer. There are plenty of good electric locomotives which would take our trains, and in most respects do the work well. Our difficulty, however, is that we have 22 stations and 14 Circle trains running—seven on each line. Supposing three or four trains want to start at the same time, the difficulty is to get sufficient power to put them into motion. It is the initial power we want, but, as I say, the difficulty may yet be overcome. Meantime we are doing our best to improve the ventilation, though, of course, we do not admit that it is as bad as represented. We have tried fans, and were not satisfied." Mr. Bell added that the directors were prepared to do their best in carrying out the recommendations of the committee as to ventilation "openings," which would be found useful even when the line is worked electrically. "The committee," he said, "really sanctions certain openings which were proposed by us last year."

Dundee.—The tramways proposals which are before the Town Council, as reported in our last issue, have been delayed, a motion having been carried to print and circulate the draft of the agreement proposed by the company before further steps are taken by the Council. The mover said that the Council required considerably more information than they possessed. He questioned if they were aware—of course, some were aware, but many were not—of the amount of money that was involved in this question. He thought it would be far better if they had a little more information before going any further. This scheme, along with what they had already spent, meant an outlay of £200,000 on the tramways. He did not know himself, and he did not know if many of the members of the Town Council knew, the amount of the sinking fund, for instance, and what was involved in the annual outlay in connection with this matter. He thought, therefore, it would be wise to get a little more information. Again, as to the agreement between the tramway company and the Town Council, he questioned very much if they had given it the careful consideration they ought to have given it. He thought at the same time that most of the Council and the ratepayers were in favour of the tramways being taken over by the Town Council. The motion he had to propose was that

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the clerk be instructed to print and circulate amongst the Council the draft of the proposed agreement with the tramway company. He did not know if any alteration was to be made; but if that were done, it ought to be printed along with the original draft. He also wished to propose that the treasurer of police be instructed to prepare a report showing what sum would be required annually to meet payments in respect of interest and sinking fund or otherwise on all the proposed new tramways and electric station and electric motive power as embraced in Messrs. Urquhart and Small's report. In addition to that there should be included the amount of money required in the improving and altering of the tramway gauge and any payment proposed to be made to the tramway company. His opinion was that they could not have too much information in regard to this matter—in fact, the more information they had the better. It was a very large scheme, and the Council and the ratepayers ought to know exactly how they stood before they went into it.

Folkestone.—The monthly meeting of the Corporation discussed at length a motion which read: "That in consequence of Mr. W. B. Hopkins having failed to carry out the terms of the agreement entered into by him within the time specified in such agreement—namely (*a*) to satisfy the Corporation that his company is in a position to carry out the provisions of the electric lighting order; (*b*) that the consent of the Board of Trade has not been obtained to such transfer—the Council hereby resolves to make the agreement entered with Mr. W. B. Hopkins void and of no effect, and to themselves undertake the carrying out of the electric lighting order at a cost not exceeding £15,000, and that a committee of the whole Council be appointed to arrange the preliminary details and generally to assist in the preparation of the necessary scheme for carrying out the said order." The debate which ensued brought out the value of the Board of Trade in showing the efforts of that body to effectively guard the interests of the public. Mr. Hopkins, who was in attendance, argued that the duty of obtaining the consent of the Board of Trade rested with the Corporation. He understood that practically it had been obtained, but if it had not, it was not his fault, and he could not be held responsible for any delay that might occur. If the resolution was carried, he should have to bring an action for the specific performance of it. He had actually secured a site for the central station, and a contract was entered into for carrying out the necessary work, and as soon as the sanction of the Board of Trade was received, he should be prepared to commence the work Mr. Hopkins explained what had been done, and said that up to the last month the Corporation had been doing all they could to help get the order transferred. Nobody regretted the delay more than he did, but there was always delay in getting the consent of the Board of Trade. The Board of Trade was very particular in seeing that the company was not over-capitalised. They considered themselves the guardians of the people interested, and were naturally anxious to see that too much money was not paid for the works. In the middle of August they received a communication from the Board of Trade that they wished to be satisfied as to the financial position of the company. They sent them a letter from Messrs. Edmondson, a company with a capital of £200,000, stating that they were prepared to carry out the whole of the works up to £50,000. The Board of Trade wrote back saying they wished for the contract, as they did not consider that letter binding enough. A contract was then entered into with Messrs. Edmundson, in which the latter agreed to carry out the whole of the work, subject to the approval of the Board of Trade. He was surprised to hear that they were still not satisfied, and asked the reason why. They told him that as guardians of the public interest they wished to see the company was not over-capitalised, and they wished to see the contract give more details—a regularly definite contract. They wished to be fully assured that they could carry out the work, and, therefore, it was arranged to give them the scheme in detail. That had been done, and he thought the matter was going to be cleared up. They were waiting to receive the report of an expert, and as soon as that was obtained, it would be forwarded to the Board of Trade, and he had not the least doubt whatever that the deed of transfer would be sent down for the Corporation to seal. The Board of Trade informed him that the matter had been submitted to counsel, and it was absolutely ready, but they wanted to see the definite contract and see how much money was going to be spent. From the end of May, when the notice was advertised that a deed of transfer was going to be prepared, up to August, they had done nothing at all. The matter rested with the Board of Trade, and they were powerless. They had tried to satisfy them in every way, and at the present moment he believed they had done so. The contract would be signed probably next week. Upon a vote being taken it was found that there were five for the motion and five against, and the Mayor declined to give the casting vote. He considered the amendment was lost and the motion lost.

Dublin.—The special meeting of the Municipal Council, referred to in our last issue, took place on the 8th inst. The Council resolved itself into committee of the whole house to report immediately afterwards. The original recommendations of the committee were as follows: "With the object of securing in the future an electrical supply which can be safely depended on for public and private purposes, we beg leave to make the following recommendations: (1) that a new station, equipped on such a scale as will enable the Corporation by degrees to light the city, be provided at the Pigeon House Fort; (2) that a system of sub-transformer stations be adopted, as such will ultimately prove a saving to the Corporation (these transformer stations have been contemplated since the initiation of the present electrical station); (3) that the entire system of cables or mains, so far as it may be found necessary by the borough surveyor, be altered or renewed; (4) that for the purpose of such renewal the sum of £20,000 be provided; (5) that a sum of £100,000 for the purpose of erecting and fitting up a new station at the Pigeon House Fort be also provided; (6) that as the total of these amounts would exceed the present borrowing powers of the Corporation, a provisional order be promoted to enable the Corporation to borrow the sums in question outside their borrowing powers, having regard to the fact that the undertaking will be self-supporting, and that the provisional order would furthermore be required to enable the Corporation to open streets and roads outside the city boundary; (7) that in order to make the suggested undertakings a success the services of a first-class consulting electrical engineer be obtained with a view to having his advice on all matters connected with the proposed changes and alterations; (8) that your committee be authorised to have the statutable notices published, in order that the necessary powers may be secured to enable the Corporation to proceed with the proposed works; (9) that your committee be empowered to apply to the Local Government Board for a provisional order, and for the sanction of the Board to a loan of £120,000, the law agent and the town clerk to take whatever legal steps are essential to attain these ends; (10) and that your committee be given leave to incur any expenditure which the carrying out of the foregoing recommendations may entail. The house resumed after the Council had been two hours in committee. The following report was submitted: "The committee of the whole house, in reporting to the Council on the recommendations contained in the report No. 145 of the Electric Lighting Committee, beg to state that the recommendations Nos. 1 and 5 suggested by the Electric Lighting Committee on page 432 of their report, being the entire question of the proposed new station at the Pigeon House Fort, be referred to the best experts obtainable for their advice, and that such experts be asked to report, in conjunction with the borough surveyor and Mr. Ruddle, on the practical and financial features of the scheme, and what advantages would accrue to the Corporation by the adoption of it. That a system of sub-transformer stations be adopted, as such will ultimately prove a saving to the Corporation. That the entire system of cables and mains, so far as it may be found necessary, be altered or renewed. That for the purposes of such renewal the sum of £20,000 be provided, but that no portion of this amount be expended or orders given until the description of cable be reported on by the consulting engineer with the borough surveyor to a committee of the whole house, to be called for that purpose, and approved of by them. That the services of a first-class electrical consulting engineer, or engineers, be obtained, with a view to having his or their advice on all matters connected with the proposed changes and alterations. That the Electric Lighting Committee be empowered to apply to the Local Government Board for their sanction to a loan of £20,000, the law agent and town clerk to take whatever steps are essential for this purpose; and that the Electric Lighting Committee be given leave to incur any expenditure which the carrying out of the foregoing recommendations may entail." The Town Clerk explained that no expenditure was to be incurred without the conditions of the expenditure and the purposes for which it was to be gone to coming before a committee of the whole house, the committee having power only to carry out any application to the Local Government Board, or any preliminary expenditure that was necessary. The Lord Mayor said arrangements had been made with the Finance and Leases Committee to come to their rescue. A meeting would be summoned next week. His Lordship moved the adoption of the report of the committee of the whole house, and in doing so said he thought they had come to a very wise conclusion, and one that would be most satisfactory to the public outside. They did not rush into a large expenditure or suggest that it should be done without having a proper report from an expert as to the advisability of touching the Pigeon House Fort. But he firmly believed from what he had heard from various sources that ultimately they would have to erect a large and proper station for the lighting of the city either at the Pigeon House or somewhere else. The report was then unanimously adopted.

TRAFFIC RECEIPTS.

Bristol Tramways.—The traffic returns for the week ending October 8 were £2,749. 13s. 9d., compared with £2,278. 17s. 11d. for the corresponding period of last year, being an increase of £470. 15s. 10d.

Birmingham Tramways.—The traffic receipts for the week ending October 9 were £3,690. 3s. 7d., as compared with £3,344. 3s. 3d. in the corresponding week in 1896, being an increase of £346. 0s. 4d.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended October 10 amounted to £1,321, as compared with £1,076 in the corresponding week of the previous year, being an increase of £245.

City and South London Railway.—The returns for the week ended October 10 were £970, compared with £965 for the corresponding period of last year, being an increase of £5. The total receipts for the half-year 1897 amounted to £13,590, compared with £13,680 for the corresponding period last year, being a decrease of £90.

South Staffordshire Tramways.—The traffic returns for the week ending October 8 were £670. 14s. 3d., as compared with

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£643. 17s. 11d. in the corresponding week of the previous year. The aggregate receipts so far this year were £25,503. 17s. 0d., as compared with £24,855. 12s. 5d. in the corresponding period in 1896.

S.D. Tramways, Dublin.—The traffic receipts for the week ending October 8 were £522. 2s. 2d., as compared with £508. 0s. 0d. in the corresponding week in the previous year, being an increase of £14. 2s. 2d. The number of passengers carried was 81,765 in 1897 and 74,588 in 1896. The aggregate returns up to date are £10 823. 5s. 10d., as compared with £11,557. 3s. 4d. last year, being a decrease of £733. 17s. 6d. The mileage open is the same as last year—viz., eight miles. There were 299 cars running, against 266 in 1896; the number of miles travelled being 24,233 (27,696 in the same period of 1896).

PROVISIONAL PATENTS, 1897.

OCTOBER 4.

22657. An improved switch for large numbers of electric circuits. Henry Justus Eck and Harold King-Smith, 82A, New Bond-street, London.

22693. Improvements in oval incandescent filament lamps. William Gordon Potter, 899, Fulham-road, London.

22717. Improvements in interruptors for electrical circuits more particularly applicable to induction coils. Charles Edmund Stanley Phillips, 28, Southampton-buildings, Chancery-lane, London.

22738. Improvements in or connected with telephonic apparatus. George Thomas-Davies, 40, Chancery-lane, London.

OCTOBER 5.

22772. Improvements in dynamo-electric machines. Milton Ellsworth Thompson, 52, Chancery-lane, London. (Complete specification.)

22796. Improved wall connection for electric lighting. Julius Peschek, 8, Great Portland-street, London.

22800. Improvements in electrical apparatus for use in dental surgery and other electro-surgical treatments. Willard Elbridge Dow, 55, Chancery-lane, London. (Complete specification.)

22806. Improvements in and relating to alternating-current dynamo-electric generators. Charles Schenck Bradley, 70, Market-street, Manchester. (Complete specification.)

22807. Improvements in and relating to alternating-current electromotors. Charles Schenck Bradley, 70, Market-street, Manchester. (Complete specification.)

22844. Improvements in switches for electric railways. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Detroit Automatic Switch Company, Limited, United States.) (Complete specification.)

22845. Improvements in and relating to junction-boxes for use in electric distributing systems. Jacob Cloos, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, March 6, 1897, being date of application in United States.) (Complete specification.)

22849. Electric signalling apparatus. Stanislaus Szubert, 40, Chancery-lane, London. (Complete specification.)

22851. Improvements in electrical measuring instruments. William Phillips Thompson, 322, High Holborn, London. (Oliver Blackburn Shallenberger, United States.)

22852. Improvements in phase adjusting and regulating methods and means for alternating-current apparatus. Reginald Belfield, 322, High Holborn, London. (Egbert M. Tingley and Oliver Blackburn Shallenberger, United States.)

OCTOBER 6.

22895. Improvements in cord-grips for electric lampholders. Alfred Watson, 24, Temple-row, Birmingham.

22897. Improvements in cut-outs for electric lighting and other purposes. Thomas Taylor, 24, Temple-row, Birmingham.

22939. Improvements in connection with electric lamps and apparatus for signalling and advertising purposes. Cornelius Edward Kelway, 9, London-street, London.

OCTOBER 7.

22978. Improved fusible cut-out for electric lighting and the like. Julius Peschek, 8, Great Portland-street, London.

23033. An improvement in electric plug contacts. Henry Charles Gover, Matthew Selby Blair, and Charles Faraday Proctor, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

23057. Improvements in and relating to electric railways. Eben Clinch Crocker and Edwin Chapin Howe, 77, Chancery-lane, London. (Complete specification.)

OCTOBER 8.

23097. Electrical conductor or cable. George Hinde Nisbett, 15, Water-street, Liverpool.

23098. Conduits for underground electrical conductors. George Hinde Nisbett, 15, Water-street, Liverpool.

23099. Improvements in or connected with arc light electrical generators. James Swinburne, 66, Victoria-street, Westminster, London.

23123. An electrolyte for carbon and zinc elements suitable for lighting and other purposes. Jeppe Sören Johansen, 171, Queen Victoria-street, London. (Complete specification.)

OCTOBER 9.

23192. A dynamo-electric machine and motor. Archibald Henry Finlay, 6, Chichester-street, Belfast.

23239. Improvements in automatic telephone exchanges. William Phillips Thompson, 6, Lord-street, Liverpool. (The Strowger Automatic Telephone Exchange, United States.) (Complete specification.)

23260. Improvements in automatic magnetic circuit breakers. William M. Scott, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, March 17, 1897, being date of application in United States.) (Complete specification.)

SPECIFICATIONS PUBLISHED.

1896.

21655. Trolley heads for electric railways. Aström.

21826. Grids for plates in secondary electrical batteries. Froggatt.

24064. Switches for electromotors and the like purposes. Hall and Craven.

25577. Electrical transmitters and indicators for indicating and recording motion. Lowne.

25661. Cells or boxes of electric batteries. Moffatt.

25729. Electric meters. Batault.

25895. Electric arc lamps. Blackburn and Fairall.

26289. Electric annunciators. Wiederhold.

26947. Electrical switches. Byng and Bell.

29629. Method of and apparatus for the production of light by means of electricity for signalling, theatrical effects, and similar purposes. Tabulewitch.

1897.

1996. Electric rollers for therapeutical and massage purposes. Gibbs. (Date applied for under International Convention, September 22, 1896.)

13268. Electric mountain railways. Andree and Silbermann.

17824. Electric alarms for cars. Nathan.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	11-11¼
Brush Company, Ordinary	2	1-1¼
—— Non. Cum., 6 per cent. Pref.	2	1¾-2¼
—— 4½ per cent. Debenture Stock	100	103-107
—— 4½ per cent. 2nd Debenture Stock	100	96-100
Cal'ender's Cable Company, Debentures	100	108-113
—— Ordinary	5	7-8
Central London Railway, Ordinary	10	9¾-10⅛
——	6	5¾-6¼
Charing Cross and Strand	5	12-13
Chelsea Electricity Company	5	10¼-10⅝
—— 4½ per cent. Debentures	100	111-113
City of London, Ordinary	10	25-26
—— 6 per cent. Cumulative Pref.	10	17-18
—— 5 per cent. Debenture Stock	100	131-136
City and South London Railway, Consolidated Ordinary	100	69-71
—— 4 per cent. Debenture Stock	100	138-140
—— 5 per cent. Pref. Shares	10	15¼-15¾
County of London and Brush Provincial Co., Ordinary	10	12¾-13¼
—— 6 per cent. Cum. Pref.	10	15-15¾
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1¾-2
—— 5 per cent. Debentures	—	89-94
Edison and Swan United Ordinary	2	2¼-2⅝
—— 5 per cent. Debentures	5	4-5
Electric Construction, Limited	2	2-2¼
—— 7 per cent. Cumulative Pref.	2	3¼-3⅝
Elmore's Copper Depositing	1	⅛-¼
Elmore's Wire Company	2	¼-½
W. T. Henley's Telegraph Works, Ordinary	10	19-20
—— 7 per cent. Preference	10	18¼-19¾
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	9-9¼
—— 7 per cent. Preference	5	10¾-11¼
India Rubber and Gutta Percha Works	10	21¼-22¾
—— 4½ per cent. Debentures	100	103-107
Kensington and Knightsbridge Ordinary	5	13¾-14¼
—— 6 per cent. Pref.	5	8-8½ xd
London Electric Supply	5	1¾-2
Metropolitan Electric Supply	10	18-19
—— 4½ per cent. First Mortgage Debenture Stock	100	119-123
National Telephone, Ordinary	5	6¾-6⅞
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	15-17
—— 5 per cent. Non. Cum. Third Pref.	5	6-6½
—— 3½ per cent. Deb. Stock	100	105-110
Notting Hill Company	10	15¼-16
Oriental, Limited, £1 shares	1	1¼-2
—— £5 Shares	5	8-8½
—— £4½ shares	4½	7¼-7¾
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	103-105
St. James's and Pall Mall, Ordinary	5	16-17
—— 7 per cent. Pref.	5	9-9½
Telegraph Construction and Maintenance	12	36-39
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	8	12¾-13¼
Westminster Electric Supply, Ordinary	5	14¼-15¼
Yorkshire House-to-House	5	8-8¼

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NOTES.

The Durban Trams.—Mr. A. K. Murray, on behalf of capitalists, has offered to capitalise the whole of the present Durban Corporation and private company horse-tram system in the borough and to substitute electric cars. A special meeting is to be called to discuss the subject.

Newfoundland Copper.—According to the *Times* correspondent who cables from St. John's, a splendid deposit of copper has been discovered on the west coast. Analysis shows that the ore contains 83 per cent. of copper. It is located on the treaty shore, but can be worked through the new railway.

The Swiss Railways.—The directors of the Jura-Simplon Railway Company have accepted the offer of a syndicate of Swiss bankers to advance the sum of 36,000,000fr. for the construction of the Simplon Tunnel. The Bill for the repurchase of the railways by the State has been passed by both Federal Councils.

Aluminium.—The present production of aluminium in the world is said to be about 10 tons per day, of which the United States supplies 4,000lb., Switzerland 5,000lb., England 6,000lb., and France 8,000lb. The current price quoted in England is 16$\frac{3}{4}$d. per pound, and the cost of production is said to be 13$\frac{3}{4}$d., of which 6d. is for the raw material.

The Paris Trams.—The Paris General Omnibus Company has laid before the Municipal Council a project for transforming its animal traction into mechanical power on all the lines. The company proposes to make the necessary installations, establish new lines, and carry out the issue of the required loans for the payment of the preliminary expenses.

An Australian Telegraphic Feat.—A feat in telegraphic operating was performed by the Sydney staff of telegraph operators on the night of the Federal elections. No fewer than 1,065,570 words were received and transmitted in the offices between 6.20 p.m. and 2.30 a.m., or at the rate of 133,196 words per hour. The staff of operators employed consisted of 120 men engaged at 56 instruments. This forms the record for Australia.

The Physical Society.—A meeting of the Physical Society of London will be held on Friday, October 29, at 5 p.m., at the rooms of the Chemical Society, Burlington House. Prof. Stroud will exhibit and describe the Barr and Stroud naval range finder, and will also read a paper on "A Telemetrical Focometer and Spherometor." Mr. Ackermann will exhibit a surface-tension experiment. A council meeting will be held at 4 p.m.

The Institution of Civil Engineers of France.—The *Proceedings* of the Société des Ingénieurs Civils de France contains, among other things, an interesting report of the visit of the society to Belgium and to the exhibition at Brussels under the guidance of Mr. Léon Gérard, president of the Society of Engineers of Brussels, and of Mr. Travailler, the municipal electrical engineer of Brussels. The report was penned by Mr. R. Soreau and Mr. V. Langlois.

A Lady Electrician.—There is a new danger ahead. The new woman having tried every other profession, and failed in most, is turning her attention to electricity. We read that the electric installation of the Opera House at Syracuse, New York, consisting of 1,250 incandescent lamps in the auditorium, stage, and foyers, has been carried out by Mrs. Blackburn, the wife of a theatrical electrician. It is not the first job she has done, and she says she finds the work very fascinating. We had hoped that the fear of shocks would have kept this profession sacred to man.

The Gauge Question.—It is understood that the Railway Commissioners, who recently met in conference at Melbourne, recommend the general adoption of a 4ft. 8in. gauge for railways of the various eastern colonies. The cost of securing this uniformity is estimated at £2,400,000. Although it is, perhaps, too much to ask that the gauge of English railways should be identical with that of the light railways and street railways, still we hope that rigid uniformity in each section will be observed.

The Thames Floods.—Many people have held the theory that telephonic communication between the Thames locks would be of invaluable service in the prevention of floods. The Thames Conservancy, however, have different views, evidently not having been convinced that the scheme possesses the advantages claimed for it by the local authorities who have advocated it. We learn that Sir F. Dixon-Hartland, M.P., has informed Mr. J. Heaton, chairman of the Datchet Parish Council, that the Conservancy have decided not to establish telephonic communication between the river locks.

Dover Again in Darkness.—"The better the day the better the deed." Twice has an accident happened at the electric light works of Dover which has resulted in the extinction of the light, and on each occasion the accident happened on a Sunday. Last Sunday it was due to an accident in connection with the water supply at the works, rendering it impossible to fill the boilers. The greatest inconvenience resulted, especially in some of the churches. After some time a hose pipe was attached to a hydrant near the works, and the boilers being filled by this means the lights were got into working order.

Electricity in Africa.—Last Saturday the Rand Central Electrical Works at Brakpan were formally opened. The President, a large number of Volksraad members, and representative men of the mining industry were present. The President expressed his pleasure at seeing such large undertakings going on, and said it was his desire and that of the Volksraad to assist the mining industry in every way possible, and they realised that the country was bound up in the industry, and if the one suffered the other was bound to. He would do his best to reduce railway and dynamite tariffs and the cost of imports.

The Telephone Monopoly.—In his report to the City Commission of Sewers Mr. Morton (who gave evidence at the recent telephone enquiry) referred to the fact that the London County Council had, instead of insisting upon reductions of charges as a concession for easements, given every facility to the company. The St. James's (Westminster) Vestry have adopted the action of the Commissioners, and declined the applications of the National Telephone Company in respect of underground wires, as the company were not prepared to make any proposals for the benefit of the parishioners.

The Continuous Current in Telegraphy.—The application of the continuous current in the Swiss telegraph system does not appear to have proved much of a success. It was introduced in 1896 over nine wires, and eventually over 104 wires, but in one instance it has been replaced by the ordinary current. In their annual report, the Telegraph Department say that it does not seem desirable to make a large extension of the system, its advantages being counterbalanced by its no less important disadvantages, which consists principally in the fact that the intermediate offices are much less independent than under the ordinary system of working.

The Philippine Islands.—The Board of Trade have received through the Foreign Office a despatch from her Majesty's Consul at Manila enclosing copy of a decree in

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virtue of which an extraordinary Customs due of 6 per cent. *ad valorem* will, for the future, be levied in respect of all merchandise imported into the Philippine Islands, without regard to country of origin. This additional duty became leviable throughout the islands on August 21 last. Goods which may have left the last port of departure of the ship in which imported before the date mentioned, and with regard to which a certificate to that effect could be presented, were to be exempted from this surtax.

The Penmarch Lighthouse.—A lighthouse at Penmarch, in Brittany, which has been the scene of many shipwrecks, was opened last week. The Marquise de Blocqueville, daughter of Marshal Davoust, who died in 1892, bequeathed £12,000 for the erection of a lighthouse on some dangerous part of the coast, and Penmarch was selected. A bronze statue of her father, in accordance with the will, is placed inside, the names of his battles being inscribed on the pedestal. The electric lamp will be visible in fine weather at a distance of 62 miles and in foggy weather at a distance of 24 miles. It will far exceed in brilliancy any other lighthouse lamp.

Large Induction Motors.—The *Western Electrician* recently claimed that a Westinghouse induction motor of 400 h.p., which was described in that paper, was the largest ever made, but they omitted to give the speed. This omission supplies Messrs. Brown, Boveri, and Co. with the opportunity to point out that they have had two induction motors running for over a year and a half giving 300 h.p. each at the exceptionally low speed of 200 revolutions per minute. They are coupled directly to the main shafts of a cotton mill in Italy, and run day and night at full load. They are built for a voltage of 3,000 with 50 periods per second, and during the tests it was found that they would give out their full power even if the voltage were reduced by about a third.

Motorcars in War Time.—An interesting experiment as to the value of motorcars for the transmission of despatches in time of war over a rough country has been carried out in Paris under the auspices of the Technical Department of the War Office. Six cars were lent by French owners, and, each in charge of an officer, left at 20 minutes past six in the morning for a run of 125 miles. Each car took a separate route. The experiment is regarded as a success, for the cars accomplished their several journeys without a mishap, in spite of the bad state of the roads, and returned to the starting point between six and eight o'clock in the evening. They were inspected by an officer before being cleaned so that the amount of wear and tear could be ascertained.

Liverpool Engineering Society.—The opening meeting of the twenty-fourth session of this society will be held at the Royal Institution, Liverpool, on the evening of Wednesday, November 3 next, at 8 o'clock, when the president-elect, Mr. George Farren, M.I.C.E., etc., will deliver his inaugural address. The agendas of the succeeding meetings are not yet quite complete, but they will be held fortnightly up till April 27, 1898. The dates which are of special interest to our readers are—February 2, a paper (title not yet announced) by Mr. W. H. Preece, C.B.; February 16, a paper by Dr. J. H. T. Tudsbery, M.I.C.E., on "Engineering Survey Work"; and March 16, a paper by Prof. Oliver J. Lodge on "Telegraphy by Electric Waves Across Space."

Post Office Revenue. — The Chancellor of the Exchequer, in his reply to the resolutions of the Association of Chambers of Commerce, to the effect that the Post Office was looked upon too much as a revenue-earning department, says: "While he hopes that full attention will always be given by the Post Office, as he believes has been the case in the past, to the reasonable requirements of the important interests which your association represents, he is not at all prepared to admit that the postal telegraphic or telephonic services, some of which benefit comparatively small portions of the public, should be carried on without profit to the general taxpayers, and that he is surprised such a complaint should be made in a year in which a considerable part of the postal revenue has been devoted to cheapening and extending the facilities already given."

Electric Light for Cabs.—The Parisians are nothing if not luxurious, and it would be quite in keeping with their national character if what we hear is correct—that the cabs are to be fitted with electric light this winter. Another improvement is also proposed, and one which might with advantage be adopted in this country. Under present arrangements, if we want to make the cabby drive to the right or the left we flourish our stick or umbrella in that direction, and if we want him to stop we wave it to and fro, but our vocabulary ends here unless we can manage to twist our necks sufficiently to hold a conversation through the little trap-door in the roof. The proposed Parisian improvement obviates all this by having a disc in front of the driver, on which, by pressing various buttons inside the cab the following words appear in a red light: "left," "right," "walk," "quicker," "stop," "turn," "home," and "slower." The selection is a good one, but we doubt whether it would be much use pressing the fourth button.

The Siemens-Halske Jubilee.—In continuation of the festivities at Berlin to celebrate the fiftieth anniversary of the establishment of the firm of Messrs. Siemens and Halske, a banquet was given at the Kaiserhof Hotel on the Wednesday evening, and passed off with great success. About 500 guests were present, including Dr. Bosse, Minister of Public Instruction; Herr Thielen, Minister of Public Works; representatives of the Military and Civil Services and the city of Berlin, and distinguished men of science, art, and industry. Herr Arnold Siemens called for cheers for the Emperor. Herr Bödiker read a telegram of thanks from the Emperor for the courteous message sent to him. His Majesty expressed a wish that the firm might flourish and prosper for the renown of German intelligence and industry. Herr Thielen proposed the toast of the firm, and laid stress on the good relations prevailing between the firm and its employés. Herr Wilhelm Siemens drank to the health of the Imperial and Prussian authorities.

South Australian Cable Messages.—The secretary of the London Chamber of Commerce has received a letter from the Adelaide Treasury, enclosing a statement by the Postmaster-General of South Australia with reference to the alleged delays in the transmission of cable messages to and from that colony. The latter says that the delays arose partly from heavy business, difficult circuit on the Port Darwin line from weather conditions, and largely by introduction of the universal telegraph code at that time. So far as the lines in the colony are concerned, delays have very rarely occurred, and the recent experience was quite exceptional. It, of course, happens occasionally that messages from the westward are late in reaching Port Darwin owing to delays *en route* due to defective circuit on one or other section of the long line connecting Australia and England. As a rule messages are transmitted very quickly over the line between Adelaide and Port Darwin, and the difficulties as regards the new code have been completely overcome.

An Interesting Motor.—An interesting machine has been shown at the Saxo-Thueringian exhibition at Leipsic. It is a 30-h.p. electric motor of 220 volts, with 600 revolutions. It has four poles cased in cast steel, which is

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made in two parts so that the core can be taken out easily. The winding consists of solid pieces of copper let into notches cut in the armature. On both sides these copper pieces are bent and soldered together, and the ends which project will cause very effective cooling. This method of winding diminishes the loss of power in the core considerably, and in consequence of the use of cast steel for the casing of the poles the power used in the magnet coils is very small. This explains the high effectiveness of the motor, which is 92 per cent., and also the further effect that the machine runs only 2 per cent. slower at full load than it does when there is no load. In order to start the motor a liquid starting resistance is used, and carefully regulating the resister enables a change to be made in the number of revolutions from 500 up to 650. The collector running free of spark has very great length in proportion to very small diameter. In consideration of the wear and tear which is unavoidable, a proportionately large amount of material is used for the commutator segments.

Electric Light Blindness.—The severe symptoms which attack persons engaged in electric welding and similar operations are attracting the attention of the medical fraternity. The first cases were noted a few years ago by Dr. Hewetson, of Leeds, when several engineers who had witnessed electric welding operations with their eyes only partially guarded subsequently suffered intense pain in the eyes. Since then somewhat similar instances have occurred of electricians attending to the electric search-lights carried on the bows of great liners through the Suez Canal. The attack is sometimes so severe that delirium sets in for a while almost amounting to mania, necessitating temporary restraint, and the usual effects are great pain, photophobia, and spasm of the eyelids, though a considerable period intervenes between the exposure to the electric light and the acute period of the attack. Vision becomes normal within 12 hours or less. Dr. Hewetson has made some enquiries into the matter, and says that it is found by experience in Sheffield that ruby-glass shields or spectacles of such a density as to reduce the full light of the sun's disc to the intensity of a single candle-power are required to preserve the workmen's eyes from the effects of large welding operations. We hope that electrical engineers will bring all reports of these symptoms promptly to the notice of the medical profession with the view of their ultimate prevention and cure.

Technical Education and Competition.—The Speaker visited Carlisle on Monday to distribute the science and art certificates gained by the students attending the local school of art, and in doing so spoke upon the importance of technical education in relation to the industries of the country and foreign competition. Quoting from the letter of Sir Philip Magnus and his colleagues to the Duke of Devonshire, describing the results of their recent visit to Germany, he observed that there was one matter in which science undoubtedly was essential, and that was a knowledge of electricity for matters of electrical engineering, a knowledge in which we had apparently stood still for the last 10 or 12 years, while Germany had been advancing in science, and had, by the expenditure of enormous sums of money, brought themselves from a position behind England to one in front; and, if they continued to consider that what was good enough 10 years ago was good enough now, they should not be able to compete with those who were wiser. He hoped the lesson would be taken to heart all over England. They must be prepared, if they were to compete successfully with other countries, to spend a great deal of money and take great trouble in bringing up to a higher point the technical education of this country in a great many more branches of trade than were at present dealt with. Unless some such steps as he had indicated were taken, technical education stopped short of obtaining the practical end to which it should be directed.

Electrical Communication with Lighthouses.—The fifth and final report of the Royal Commission on Electrical Communication with Lighthouses and Light-Vessels has just been issued as a parliamentary paper. The Royal warrant by which the Commissioners were appointed directed them (1) to enquire and report what lighthouses and light-vessels it was desirable to connect by electrical communication; and (2) to suggest how such communication should be established. They experienced no difficulty in deciding upon the manner in which electrical communication should be established with the shore lighthouses or with the island or pile lighthouses which they selected, but the difficulties which they met with in their endeavours to find an efficient and reliable system of electrical communication with lightships were more serious. They are of opinion that the system known as the "sunk" system is the best system of continuous connection which has been brought to their notice. The Commissioners regret, however, that they cannot regard the "sunk" system, in its present form, as affording an entirely satisfactory solution of the difficulties of maintaining in an efficient manner, and at a reasonable cost, electrical communication with light-vessels anchored in deep water and in exposed positions. Having regard to the present expense of establishing and maintaining electrical communication with light-vessels, they do not feel justified in recommending the connection of any more of these stations until the ethereal system at present under trial has been fully tested. When this has been done, they recommend the establishment of electrical communication with 19 light-stations at an estimated total cost of £16,179.

Electric Traction in New York.—The municipal authorities having been firm in their determination not to allow overhead trolley lines, the tramway companies have had to convert to the conduit system. The Metropolitan Street Railway Company are building a new central power station for an output of 70,000 h.p. to supply the company's entire railway system with current. The boilers will be arranged in three tiers on either side of a central passage, with the chimney in the centre. There will be 87 boilers altogether, grouped in nests of two each, and each boiler will have a nominal capacity of 500 h.p., with a maximum of 800 h.p. They will be of the water-tube type, and provision will be made for forced draught, the blowers being located at the centre of the boiler-house opposite the base of the chimney stack. The chimney itself will be 350ft. high and 22ft. in inside diameter. There will be a stand-pipe in the boiler-house for each engine, connecting to each of the three tiers of boilers, so that the size of the piping is kept down to a maximum of 16in. There will also be four independent risers for the engines for free exhaust. As the entire system will ultimately depend for power on this station, special arrangements had to be made for the storage of an adequate quantity of coal to tide over any temporary stoppage of the source of supplies. For this purpose coal-storage bins have been provided for at the top of the boiler-house with a capacity of 9,000 tons. The coal will be handled by conveyors, which will run out to the dock at the side of the station, from which it will be transferred directly from barges to the coal-bin. The ashes will also be handled by conveyors. There will be 11 vertical cross-compound engines directly connected to the generators. Each of these engines will have a nominal capacity of 4,000 h.p., with a maximum of 6,600 h.p. Eleven three-

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phase alternating-current generators will be installed operating at 6,000 volts. The sub-stations will be fitted with rotary transformers to convert the current to a pressure of 550 volts direct, which will be supplied to the conductors in the conduit.

The New Canadian Tariff.—The following provisions of the new Canadian tariff will be interesting to the electrical trade as showing the duty chargeable on electrical goods: Wire, single or several, covered with cotton, linen, or silk, rubber, or other material, including cable so covered, N.E.S., 30 per cent. *ad valorem*, 30 per cent. Copper wire, plain, tinned, or plated, 15 per cent. *ad valorem*. Telephone and telegraph instruments, electric and galvanic batteries, electric motors, dynamos, generators, sockets, insulators of all kinds, and electric apparatus, N.E.S., 25 per cent. *ad valorem*. Electric light carbons and carbon points of all kinds, N.E.S., 35 per cent. *ad valorem* Carbons over 6in. in circumference, 15 per cent. *ad valorem*. Lamps, sidelights and headlights, lanterns, chandeliers, gaz, coal, or other oil fixtures, and electric light fixtures, or metal parts thereof, including lava or other tips, burners, collars, galleries, shades and shade holders, 30 per cent. *ad valorem*. Lamp springs and glass bulbs for electric light, 10 per cent. *ad valorem*. Indiarubber boots and shoes, and all manufactures of indiarubber and guttapercha, N.O P., 25 per cent. *ad valorem*. All goods not enumerated in the Act as subject to any other rate of duty, nor declared free of duty by the Act, and not being goods the importation whereof is by the Act or any other Act prohibited, shall be subject to a duty of 20 per cent. *ad valorem*. Free list—Platinum wire and platinum in bars, strips, sheets, or plates, platinum retorts, pans, condensers, tubing and pipe, when imported by the manufacturers of sulphuric acid for use in their works in the manufacture or concentration of sulphuric acid. The reciprocal tariff clause provides that when the tariff of any other country will admit Canadian products on terms which are as favourable to Canada as Canada's terms are to the countries to which they apply, imported articles from that country may be entered for duty or taken from warehouse for consumption in Canada at a reduced rate of duty set forth in the reciprocal tariff schedule of the law. The benefits of this reciprocal tariff may be extended to any country which may be entitled to it by virtue of a treaty with her Majesty.

Artificial Gold.—After centuries of toil and painful research, it has been left to an electrician to discover the philosopher's stone. We should have thought that the discovery of the way to manufacture a substance equal to gold would have convulsed the world, and made the whole universe pause to contemplate the genius who was capable of producing single-handed more of the yellow metal than was contained in all the Klondike mines put together. It therefore comes somewhat as a shock to find that with the exception of a solitary Buenos Ayres paper, the *Boletin de la Unión Industrial Argentina*, scarcely any notice has been taken of the discovery at all, and even that paper treats the matter more in a spirit of unbelief than is warranted by the apparent genuineness of the facts it relates. We read that the United States of America have just bought from the Argentaurum Syndicate the first ingot of artificial gold. In reality this gold is not gold, but it possesses all the physical attributes of that metal, and the inventor, Mr. Emmens, has given it the sufficiently explicit name of *argentaurum*. Mr. Emmens is a member of the American Society of Chemistry and the American Institute of Mining Engineers. He is also a member of the International Society of Electricians and the inventor of an explosive called "emmenite." His gold has been made from silver through several processes, which are at present kept secret, but he explains that it proceeds from a molecular modification of the silver, and says that it will occupy in the hypothetical theories of the simple bodies as expounded by Mendeleeff the place between gold and silver which is at present vacant. The official analysis of the Mint gives 65·8 per cent. of gold and 26 per cent. of silver, but does not account for the rest of the 100 parts. The weight of the material before the analysis was 7·6oz., and after analysis 7·4oz. The value of the gold was stated to be 95·76dol. and that of the silver 1·11dol. The cost of the manufacture was 1·22dol., so the profit on the operation was 95·65dol, from which has to be deducted the cost of the silver employed. It is also stated that this "argentaurum" will henceforth be considered as pure gold by the Office of Assays in the United States.

The Electrical Properties of Fumes.—A most interesting paper by Lord Kelvin and Dr. Magnus Maclean is printed in the recent issue of the *Proceedings* of the Royal Society of Edinburgh. The subject is that of the electrical properties of fumes proceeding from flames and burning charcoal. The authors adopted three different methods of investigation, and give the detailed results obtained by each method. The first method used was to test by the Kelvin electric filter the fumes arising from the various burning substances. The circulation of the fumes over the filter was maintained by an air-pump. The difference of potential was measured by a delicate electrometer. It was then found that negative electrification took place from the fumes arising from a candle, a paraffin lamp, a spirit lamp, a Bunsen burner, and four electrometer matches respectively. The actual potentials observed varied from ·27 volt with the Bunsen burner to ·99 volt with the spirit lamp, and 2·03 volts with the electrometer matches. A lighting flame at low pressure gave a small negative reading, while at high pressure a large positive electrification was observed. Both charcoal and coal gave negative electrification when burning with a flame, and positive electrification when glowing without flame. The other two methods of experiments were as follows: To observe the difference of potential maintained between two wires of the same metal connected with a copper plate and a zinc plate when the fumes from different flames and burning pass between and around the plates; and, lastly, to observe the leakage between two parallel metal plates with any difference of potential between them when the flames were allowed to pass between the plates. The first of the above methods gave irregular results when the flames were within 5cm or 6cm. of the plates. With a paraffin lamp 7cm. away a difference of potential of 2·05 volts was observed, and this decreased as the distance of the lamp from the plates was increased. The authors conclude that the effect is of the same kind as if the plates were connected by a drop of water. The last experiments as to leakage are also interesting, and the whole paper is worthy of a thorough perusal.

More Municipal Tramways.—The London County Council having acquired by purchase the London Street Tramway system under Section 43 of the Tramway Act, 1870, what is practically the first municipal tramway in the Metropolis is inaugurated this week. The sections of the newly acquired line ply between Highgate Archway and Euston, Holloway and Euston, Hampstead Heath and the Angel at Islington, Hampstead Heath and Euston, Swain's-lane, Highgate, and Holborn, and Holloway and Clerkenwell and Holborn. When this property was purchased by the Council notice of purchase was given in respect of other North London Tramway sections as they

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came under the purchase clause of the Act, but as the acquirement of the 48 miles of tramway north of the Thames would take many years to secure in such a piecemeal way, and would possibly involve costly legal proceedings, it was proposed by the North Metropolitan Tramway Company, that, instead of the Council purchasing the whole system in sections, it should be handed over to the Council forthwith at a stated price, on condition that the company should receive from the Council a lease of the lines for the ensuing 14 years. The County Council have purchased the whole system accordingly, the terms being settled on the 14th inst., and under the Council's lease the North Metropolitan Company have taken over the working of the London Street Tramway section with immediate pecuniary advantages to the travelling public, apart from the prospective benefit to the ratepayers which the acquirement of this—one of the best paying tramway companies in London—promises ultimately. The fares for intermediate journeys have not been reduced, but the stages have been considerably increased, hence it is now possible to travel for 1d. over a distance that until the present cost 2d. Furthermore, the system of return tickets has been introduced, which enables a passenger to make a return journey of about 10 miles for 3d., or for the same fare two separate journeys in any direction over the 48 miles of line on any day in any year during the existence of the lease, at any time on any of the company's cars. These tickets are also transferable. An improvement in the service of cars is said to be contemplated, and the popularity of the innovation has already caused some of the competing 'bus companies to revise their fares.

The Engineering Dispute.—The position between masters and men has not changed, and the outlook is daily becoming more and more disastrous. The men are alarmed at the shrinkage of the funds upon which they had to look for relief in sickness, want of employment, and superannuation, and the proposal to advance a loan to cover deficits caused by the strike after the termination of the struggle is being unfavourably received because of the natural unwillingness to raise a primary mortgage upon the society's assets. The feeling amongst engineers, both unionists and non-unionists, in the Midland districts is becoming more pronounced against a continuation of the strike, and although there has been no distinct secession, the relations between the men and the Amalgamated Society are somewhat strained. In the meantime everything is being done in the way of outside appeals to relieve the drain on the coffers of the society; but in Birmingham and the Black Country the voluntary levies by the trade societies are not realising expectations, and the trade unionists are apathetic. Up till Wednesday evening the total number of men idle throughout the United Kingdom was 80,000, including 30,000 engineers and 25,000 labourers. Sir Christopher Furness, of West Hartlepool, has written a letter on the subject of the dispute, in which he says that he has always advocated trade unionism, but he believes that if it is to be crippled or killed it will be by some of the men's leaders of what may be termed the "new school," and not by the masters. In his opinion the present deadlock is largely due to a militant policy on the one side and a dangerous Socialistic policy on the other. The eight hours was not the only question at issue. The employers felt keenly that of late years there had been encouraged by the society a desire to destroy their power in the control of their establishments. The London society had made a mistake in rushing the matter. He felt strongly that the time had now arrived when the leaders of the Amalgamated Society of Engineers should take immediate steps to procure a vote of all their members, so that the country might know the opinions of the men themselves, and he suggests that the basis of such vote should be on the following lines: (1) Are you in favour of 48 hours per week with 53 hours' pay? (2) Are you in favour of 48 hours per week with 48 hours' pay? (3) Are you in favour of the hours and pay remaining as they are?

Localisation and Measurement by Rontgen Rays.—An article has been contributed to the *Lancet* by Dr. J. Mackenzie Davidson and Dr. W. S. Hedley describing a method of precise localisation and measurement by means of Röntgen rays. The shadows obtained in the ordinary process indicate the presence of an object, but give no correct idea of its form or size or relative position, because the picture has no relief. Their process is to actually work out the position of the foreign body by means of fine silk threads so arranged as to represent the actual path of the X rays which produced the negatives. Two wires at right angles to each other are placed upon the photographic plate, film, or paper. The Crookes tube is then placed with its anode at a measured distance from the plate and exactly perpendicularly to where the wires cross. The tube is fixed in a holder which slides in one plane. Further, one of the cross-wires must be in exactly the same plane as that in which the tube is to be displaced. The wires being painted over with some pigment, the part to be photographed is placed on the plate and carries with it a mark of the cross-wires. The tube is then displaced to a measured distance to one side of the perpendicular and an exposure given, then to a corresponding point on the other side of the perpendicular and another similar exposure given. The resulting negative shows double images from the two different points of view. A further precaution is necessary—viz., to mark one quadrant of the plate and the corresponding quadrant on the patient's skin. The negative having been developed, fixed, and slightly washed, is at once placed on a horizontal stage illuminated from below by a suitable reflector (an arrangement similar to a re-toucher's desk). The negative may be placed with the gelatin surface upwards, or downwards if the glass is not too thick. In the case of celluloid films it is most convenient to place them downwards. The negative is adjusted so that a perpendicular dropped from a notch in a horizontal scale falls upon the point where the shadows of the wires cross. On each side of it another notch is made at the exact distance and height that the anode of the Crookes tube occupied in the two exposures. A fine silk thread is then passed through each lateral notch, and a small lead counterweight is attached to one end of each thread, while the other is passed through the eye of a fine needle. The needle is weighted with lead so that its eye lies flat on the surface of the negative. In short, these two silk threads represent the path of the X-rays, so that if each needle be carefully placed upon a corresponding point in each shadow it follows that the point where these threads cross marks the position occupied by the corresponding part of the actual object. Further, its distance can be measured perpendicularly from three planes—from the horizontal which gives its depth and from the two planes represented by the shadows of the cross-wires. By measuring any other desired corresponding points the precise size, position, and direction of the object can be determined, and remembering that the cross-wires have left their mark on the patient's skin, the surgeon can at once obtain all the information he can possibly desire. It has been suggested that, instead of displacing the tube, two tubes be used and a simultaneous exposure given. The method has been fully tested on the living subject as well as on artificial models, and has proved very accurate and reliable.

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SOME NOTES ON THE PARALLEL RUNNING OF ALTERNATORS.

BY SIDNEY E. T. EWING, A.I.E.E.

In the early days of alternating-current distribution the practice usually followed—especially in America—was to instal a number of units of plant, of such size that each was capable of dealing with the maximum load of one feeder or circuit. Economy of steam was to some extent obtained by driving several more or less under-loaded alternators from a single engine, through the medium of counter-shafting and clutches. The use of this method had the great advantage of diminishing the area over which disturbance of the supply would occur in the event of a heavy short-circuit, or the failure of an alternator. On the other hand, it was impossible to effect any fresh grouping of different feeders to different alternators without an unmistakeable "blink" in the lamps.

At the present time the practice of connecting alternators, so as to feed in parallel, on to a pair of common 'bus bars has become almost universal. The advantages of so doing are, indeed, sufficiently striking, for it becomes possible by the use of different sized units of plant to keep each engine and alternator working at or near its most economical load, and to effect all changes of plant without any interruption to the supply.

Yet, together with these and many other advantages that have led to its general adoption, the system possesses several inherent drawbacks. Perhaps the most obvious of these is that a heavy short-circuit on a heavily-fused feeder may affect the voltage over the whole area of supply. This is to some extent guarded against in one or two systems by arrangements whereby a feeder known to be in a faulty condition can be isolated from the 'bus bars, and supplied by a separate set of plant. As a rule, this operation necessitates the objectionable "blink," but it is quite possible, at the cost of some additional complication of switching gear, to arrange for the withdrawal of any single, or set of, feeders and machines from the 'bus bars without any interruption whatever. For example, it may be managed by dividing the 'bus bars into two portions separated by a switch, each portion having its own switches to each machine and feeder. In very large stations serving a lamp connection running into hundreds of thousands, the risks of even momentary disturbance which would affect the whole area become too serious to be incurred. Doubtless it is this reason which has led one of the largest alternating plants supplying London to be divided into two groups of machines and mains, which are normally operated as two distinct and separate plants.

Without entering into ancient history, it may be remarked that the mutual controlling action of two or more alternators coupled in parallel was for the first time fully discussed in two papers by Dr. Hopkinson—one read before the Institution of Civil Engineers in 1883, and more fully in the other published in the *Proceedings* of the Society of Telegraph Engineers in 1884. In the following five years transformer work underwent large developments, and in May, 1889, Mr. Mordey read a very important paper before the Institution of Electrical Engineers, in which he discussed the working of his own alternators. Readers who have not access to the original papers will find the substance of these and others fully treated in Dr. Fleming's work on the "Alternate-Current Transformer," Part II.

Much was about this time said and written with regard to the relative advantages of alternators possessing little or considerable self-induction with reference to their suitability for parallel working. It was thought by some that ironless machines would be preferable, apart from other grounds, on the score of their ability to give out and receive large momentary currents, which property would cause them to run steadily in parallel under unfavourable conditions of driving or external load. Since this question was first discussed, much experience with all types of machines has been gained, and one result has been to show that even when machines have very considerable self-induction, the stability which they exhibit under the heaviest short-circuits is very remarkable. The writer has frequently seen two 75-kw. belt-driven machines pull each other into synchronism in a second or two when coupled together almost exactly out of phase, and no doubt many similar instances will occur to those who have had charge of such machines. A short-circuit on mains, actual carelessness in paralleling, or accidental failure of a field circuit, are impossible to entirely guard against, and the resultant rushes of armature current, never sufficiently large to damage the latter class of machine, may attain enormous values and seriously strain a machine having practically no impedance in its armature circuit before the fuse has time to act. Hence some form of non-return cut-out design to open at very low values of return current becomes a very necessary adjunct of these machines. To meet this want, a form of cut-out embodying much actual experience has, indeed, been recently put upon the market, and is said to give excellent results.

As opposed to these safe working properties of iron-cored machines, it must be admitted that they require careful and frequent adjustment of the field strength with varying loads to get the best results, independently of the fact that their drooping characteristic naturally necessitates more regulation to counteract variations of terminal pressure. It will be found, too, in the case of two machines, both of which have considerable armature self-induction, but in which the values of this self-induction are sensibly different, that steady running cannot be obtained with the load evenly divided, but that there is a particular distribution of load which gives the best results. It appears that this distribution is in the inverse ratio of the values of the self-induction in the two machines. Naturally, it is not always convenient to work under these conditions, and one of the main advantages of parallel working is lost.

Some makers prefer to excite their machines from a common 'bus bar, with little or no means for controlling the field of each individual alternator; others excite each separately, and place a rheostat in the field circuit, or in the shunt circuit of the exciter. The first method seems preferable for ironless machines, or those that approximate to that class, and is as a rule used in conjunction with them. The second lends itself more readily to controlling the idiosyncrasies of iron-cored machines, and is usually to be found in stations possessing them.

In some plants the practice obtains of inserting a reactive coil and small fuse between the machines at the moment of synchronising, which safety device is cut out when the operation has been successfully performed and the machine begins to take up its load, but the more usual practice is to couple the machines directly. For this purpose, too, a non-return cut-out is sometimes used, and undoubtedly confers a greater degree of safety to the somewhat critical operation of synchronising than can be assured without its use.

In order to indicate the relative phases of the two machines about to be connected in parallel, a lamp or voltmeter is put across the secondaries of two transformers whose primaries are connected to the two machines, the secondaries being, of course, in series, and usually with their windings connected so as to help each other. Thus, when the voltage is at its maximum across the extremities of these windings, the alternators are exactly "in phase." A couple of lamps are often put across two 100-volt secondaries, one lamp being preferably placed within sight of the engine-driver. It will be found, however, that it is difficult to judge of the degree of brilliancy of a lamp, and the ordinary type of voltmeter is not sufficiently dead-beat to show the maximum reading at the precise instant when synchronism is attained, unless the rise and fall of voltage is slow, a condition that cannot always be obtained in daily central-station practice, when it is so often necessary to get a fresh plant into commission with the least possible delay. The writer has found a Cardew voltmeter with its open scale and dead-beat action to be by far the most suitable for this purpose. When the machines have visible rotating pole-pieces or coils, a useful guide to the engine-driver is the light of an arc lamp fed from the machine already in commission. As the frequency of the incoming alternator approaches that of the other, its poles or coils will appear to move more and more slowly, until at synchronous speed they appear stationary.

Two or more alternators may be said to run well in parallel when the load taken by each can be readily

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adjusted by controlling the supply of steam to its associated engine, and when little or no motoring current passes between them—that is to say, when the sum of their respective ammeter readings is sensibly equal to the current passing through the 'bus bars.

Turning now from the type and design of the alternator to the power which drives it, the point that requires most attention to secure good results is that the turning moment applied to the alternator shaft should be extremely even. It has often been said that rope or belt driving was a necessary condition for good parallel running, because only by the use of such flexible connection between the engine and alternator could the small variations of speed required to maintain co-phasal working be rapidly performed. But belt and rope driving is rapidly becoming obsolete, probably because the loss involved in such gearing is too high a price to pay for a hypothetical advantage, and, with the advent of the direct-coupled set, the "steam alternator" of present-day specifications, it has been found that when the necessary conditions are complied with, excellent running may easily be obtained when the engine and alternator are mounted on the same shaft. Consequently we find that the great majority of recently installed units of plant are of this type.

These modern direct-coupled sets may be grouped into three classes. The first and earliest of these comprise a slow-speed horizontal engine and an alternator of the "fly-wheel" type, usually set between the high and low pressure engines. In the second class the engine is vertical, and commonly runs at a somewhat higher speed, the alternator being placed either between the engines or, in the case of triple-expansion engines, on a prolongation of the engine shaft. The third class consists of an engine made up of two or three separate tandem compound or triple sets driving an alternator set at the end of the engine shaft, at as high a speed as is consistent with the size and weight of the moving parts.

Without entering into the question of the economical use of steam which has led engineers to adopt these various types of engine in different cases, it is to be noted that it is not possible in the first two classes to secure such steam distribution in the two or three cylinders as will give an even turning moment to the shaft under all conditions of load, or, if possible, it is a matter of considerable difficulty, requiring special design which may not be conducive to economy. At the same time, however, the adoption of a slow-speed engine naturally leads to a slow speed, and, therefore, large and heavy alternator, which, by the inertia of its moving parts, may sufficiently overcome the irregularity of the engine, at any rate at low loads, when the engine is usually most deficient in this respect. When two or more exactly similar sets are installed, it is possible, though perhaps not easy, to connect the alternators in parallel at the moment when the corresponding engine cranks are approximately in synchronism, and to the writer's knowledge this has been done in one station with excellent results.

In the third class this difficulty is entirely obviated by the employment of three separate engines with cranks set at 120deg. The engines being exactly similar, the turning moment remains almost perfectly even throughout the full range of load. Moreover, though the revolving parts of this type are far lighter for a given output than in machines of the first two classes, their high speed of rotation gives them a very powerful flywheel effect, which explains why one type of high-speed engine having but two cranks set opposite to each other is being largely adopted with, it is understood, uniformly good results.

A final point worthy of note is the advisability of selecting a suitable type of ammeter for machines intended to run frequently in parallel. Unless the motion of the pointer is considerably damped, the small unavoidable surgings of synchronising current tend to set up an altogether disproportionate swing of the ammeter needles. In many stations it is almost impossible to gauge within 20 or 30 per cent. the amount of current actually flowing through the machines by an inspection of their respective ammeters.

In conclusion, the writer hopes that the foregoing remarks, though presenting nothing novel, may yet be of some interest to the large and increasing class of engineers whose daily duty it is to supervise and watch with tender care the performances, always interesting, and not infrequently, it is to be feared, exciting, of alternators connected in parallel.

NOTES ON ACCUMULATOR CONSTRUCTION.

BY DESMOND G. FITZ-GERALD.

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VI.

Cannot we use, as the support for the active materials, a conductor of lower specific gravity than lead, with a view to reducing the weight of the accumulator? In regard to the support for the peroxide, experiment shows no probability of our being able to substitute another conductor for lead. The most likely material seemed to be some form of carbon prepared at a very high temperature. I recently obtained some samples from "Le Carbone" (formerly Lacombe and Co.); but in every case the material soon disintegrated when in contact with peroxide of lead. In fact, a slab of the latter material (lithanode) in an electrolyte of dilute sulphuric acid formed, with every sample of carbon tested, a couple in which the carbon corresponds to the zinc in the zinc-copper couple.

In the case of the support for the spongy-lead active material, it is quite probable that, in traction batteries at least, lead will be replaced by a lighter material. Copper has been used; it was perfectly protected from chemical action by the more electro-positive lead, so long, and only so long, as any of the latter remained in contact with it. A battery with copper supports for the spongy lead cannot safely be left idle for many days; but if it be charged and discharged regularly, or at least prevented from running down completely, it can be maintained perfect so far as the spongy-lead element is concerned. In designing a cell of this kind, care should be taken to give to the spongy-lead element its full complement of active material, bearing in mind that the capacity of the peroxide plate usually increases by use, which is not the case with the other element. Such a battery may be very considerably lighter than one in which lead alone is used for the supports.

If it were not for certain difficulties in establishing contact with this material, carbon might advantageously be used as a support for the spongy lead in traction batteries. Comparatively small plates of carbon may readily be united together to constitute plates of any required size. An efficient carbon support was found to be only one-fifth of the weight of the lead support it superseded.

Another likely material for the support of the spongy-lead active material is an alloy of aluminium and tin.

VII.

By using slabs or plates of peroxide of lead in the form of lithanode, supports, properly speaking, may be dispensed with. Contact, however, must be established with the material, and the only conductor which has been found available for a safe and permanent contact is platinum. But this metal, even as an attenuated strip, is too costly to be used in accumulators for ordinary purposes. Where low first cost is not an essential condition, the platinum-mounted lithanode element, with a suitable spongy-lead element, is undoubtedly the most perfect known form of the lead accumulator, being altogether free from the destructive effects of local action.

VIII.

The specific gravity of rolled lead is 11·4; that of cast lead being slightly less. The specific gravity of spongy lead, in its best condition as an active material, may be taken as 8·2, though it may be as high as 8·5. The specific gravity of the lead peroxide on a Planté plate, and frequently in other accumulator plates, may be taken as 9·4; but a lower density is desirable. A beautiful crystalline sample of lithanode, showing no tendency to "shed" or to warp when charged on one side only, had a specific gravity of 6·82. Lithanode of specific gravity 8 was reported upon as "too dense." The peroxide of lead

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in accumulators is usually formed under great pressure, no room being allowed for expansion.

The linear expansion of lead in becoming converted into peroxide of high density is 11·9 per cent. Thus: 1 cubic inch of Pb weighs 6·56oz., its specific gravity being 11·4. Converted into PbO_2 by accession of oxygen, its weight becomes 6·56 × 1·155* = 7·57oz. of peroxide, having the specific gravity 9·4. Now the increase of volume will vary directly as the weight, and inversely as the specific gravity.

$$\frac{6{\cdot}56 \text{ oz.}}{11{\cdot}4} : 1 \text{ cubic inch} :: \frac{7{\cdot}57}{9{\cdot}4} : x.$$

That is, ·575 : 1 :: ·805 : x.

$$x = \frac{805}{575} = 1{\cdot}4 \text{ cubic inch} = \text{the volume of peroxide.}$$

1·4 is therefore the coefficient† of cubic expansion, and $\sqrt[3]{1{\cdot}4} = 1{\cdot}119 =$ the coefficient of linear expansion. A useful value is $1{\cdot}119^2 = 1{\cdot}253$, which gives the two-dimensional expansion—*i.e.*, the increase of area in a plate or slab.

The linear expansion of reguline lead in becoming converted into spongy lead of specific gravity 8·2 is also 11·9 per cent. nearly. Thus: the weights being equal, the volumes will vary inversely as the specific gravity; and the volume of spongy lead (that of reguline lead being unity) $= \frac{114}{82} = 1{\cdot}4$ nearly, which may be taken as the coefficient of cubic expansion.

IX.

Amongst the various systems of producing or preparing the active materials in lead secondary batteries are the following:

1. The original Planté system, in which the active materials are produced from reguline lead, by successive reversals of the charging current.

2. A modification of the above—suggested and subsequently abandoned by Planté—in which the plates are, in the first instance, corroded by the action of very dilute nitric acid, usually at a boiling temperature.

3. The system of electrolytically depositing and consolidating spongy lead upon both lead plates or supports, and subsequently converting the spongy lead on one of the elements into peroxide of lead.

4. The electrolytic deposition of peroxide of lead (or of a lower oxide) from a solution of the metal upon one of the plates, whilst spongy lead is deposited upon the other.

5. The Faure system, in which the peroxide support is pasted with a mixture of red lead (Pb_3O_4) and sulphuric acid, whilst the spongy-lead support is pasted with a mixture of litharge (PbO) and sulphuric acid. The compounds formed by these mixtures are respectively the red "lead salt" and the "buff lead salt" of Frankland.

6. The "Lithanode No. 1" system, in which PbO is made into a paste with a solution of sulphate of ammonia $[(NH_4)_2SO_4]$ with a view to the *gradual* production of a compound of oxide and sulphate of lead, accompanied by the evolution of ammonia, during the process of "seasoning." This compound is subsequently converted by electrolysis into peroxide of lead in the case of one element, and into spongy lead in the case of the other.

7. The "Lithanode No. 2" system, in which litharge is mixed with a certain proportion of sulphate of lead ($PbSO_4$) with the production, as in the last case above, of a compound of PbO and $PbSO_4$, which "sets" (like plaster of Paris) into a strongly coherent mass, which does not disintegrate in water or in dilute sulphuric acid.

8. The "Lithanode No. 3" system, in which litharge is mixed with a solution of caustic potash, forming an alkaline plumbite with excess of oxide of lead ($K_2PbO_2 + x$ PbO). By exposure to the air, the alkali becomes converted into carbonate; and the precipitated lead hydrate ($2PbO,H_2O$) produces the "setting" of the mass.

9. The Marchenay system, formerly used by the Chloride Electrical Storage Syndicate, Limited, in the manufacture of both elements of their accumulator; but now reserved mainly for the spongy-lead element. In this system, a mixture of chloride of lead ($PbCl_2$) and chloride of zinc ($ZnCl_2$) is fused and cast into tablets. A number of these tablets are combined together in the form of a plate by casting lead around their edges on the Frankland system. The zinc chloride, being freely soluble in water, is removed by this menstruum, and the nearly-insoluble lead chloride is reduced electrolytically to spongy lead, the latter being, according to the original process, converted into peroxide in the element of that name.

* See III., p. 457, where the multiplier is given as 1·153. The present value is more accurate, as is ·866, instead of ·867, for its reciprocal.

† This term is usually applied to the increase of unit volume—*i.e.*, in this case ·4.

WATER POWER, WITH REFERENCE TO ITS APPLICATION TO ELECTRICAL MACHINERY.

BY J. HERMANN FIELD.

II.

In cases where the fall of water to be utilised is considerable, and extends over a gradient of some length, the employment of a conducting pipe for the headwater becomes necessary. For it will readily be seen that the construction of an open lade with an ordinary declivity, ending in a vertical flume for the turbine, is out of the question in such cases. The pipes generally in use for this purpose are of cast iron, riveted iron, or steel, coated internally and externally with pitch or coal-tar varnish, or protected from corrosion by Dr. Smith's process and mixture. Any one of these coatings appears to considerably reduce the internal friction of the water, and its preservative action renders the performance of the pipes, as regards loss

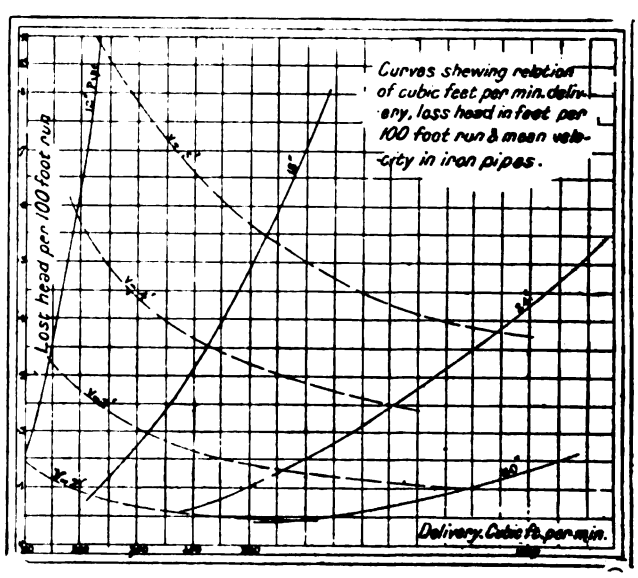
Curves shewing relation of cubic feet per min. delivery, loss head in feet per 100 foot run & mean velocity in iron pipes.
Lost head per 100 foot run
Delivery Cubic ft. per min.

FIG. 5.

of head, uniform for very long periods. Uncoated wrought-iron pipes are more subject to the corrosive action of the water passing through them than are those of cast iron.

With regard to the velocity of water allowed when conducted by pipes, practice will, of course, vary according to circumstances, as with open conduits. For small pipes the velocity should be kept as little above 2ft. per second as is practicable, while for the larger pipes 6ft. per second should be the topmost limit, except in such cases as where the abundance of water power justifies the sacrifice of a larger head than usual, with a view to keep down the initial cost of pipe line. A reference to the curves shown in Fig. 5 will show how rapidly the value of the friction rises in straight clean iron or coated pipes, when the mean velocity of flow is increased. These curves have been plotted as the result of a large number of experiments, the mean values obtained having been carefully estimated. They will be found to agree also, within a small percentage, with the figures tabulated in that exhaustive work, "Tables and Diagrams," by Messrs. Santo Crimp and C. E. Bruges (Biggs and Co., London). While these figures may fairly

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be regarded as representing the mean of ordinary practice, the variation of flow, which is caused by small differences of the internal surfaces of pipes, even those by the same maker and to the same specification, will render advisable an allowance of 5 to 8 per cent. to ensure any guaranteed performance.

The introduction of bends in pipes to be used for power purposes should be avoided, if possible at all, and where absolutely necessary the radius of curvature should be as large as can be arranged, with a minimum limit of five times the diameter of pipe. The presence of any bend in a pipe, or of any sudden enlargement of its area, with consequent eddies and "rollers" of water, results in a waste of power which seems totally disproportionate to the cause producing it, since any condition which disturbs the true *linear* motion of individual particles in the water increases the force of friction at a bound.

An empirical expression which will give the amount of head lost in a pipe with a given mean velocity is $h = k \frac{l v^2}{2 d g}$ (h being independent of pressure). Here k is a coefficient increasing with the roughness of the interior, and decreasing slightly as the values of d and v get higher. It thus varies in something the same way as $\frac{1}{c}$ for open conduits. We may thus regard it as a coefficient for friction, while c was a coefficient of discharge. Starting with a value $k = \cdot 028$ for a 6in pipe with a velocity of 1ft. per second, k increases 4·5 per cent. for each increase by 3in. of the pipe diameter, and 4 per cent. for each rise of 1ft. per second in the velocity of water flow. These figures being applicable to pipes of diameters from 6in. to 2ft., and between the limits of ordinary rates of flow, will enable calculations to be made with regard to minimum slope and sizes of pipes in given circumstances.

Turbines.

Turbines may be classed under two heads, according as they work by reaction (pressure turbines) or by impulse solely; the former corresponding with the breast and overshot wheels, and the latter with a simple undershot or Poncelet wheel, as being actuated by the momentum only of the moving water. "Barker's mill," one of the earliest experimental forms of reaction or pressure turbines, is probably known to all. It was from a consideration of the causes of low efficiency in this primitive motor that M. Fourneyron, in 1827, invented the turbine which now goes by his name, and which, being the first turbine of a really practical nature, secured to its inventor a prize of 6,000fr. as a recognition of public merit by the French Government of the day. The essential difference between Barker's mill and Fourneyron's turbine lies in the initial forward velocity given to the water by guide blades in the latter before it enters the buckets of the rotating turbine wheel, with the result that the water at the time of exhaustion has an absolute velocity which is small compared with that of the exhausted water from the Barker's mill. The loss of energy, and consequent drop of efficiency, of good modern turbines, due to the average unavoidable velocity of the discharged water, may be estimated at between 5 and 7 per cent. Turbines of the reaction class, the use of which is more general than of those which owe their motion to impulse solely, may all be classed together, in that they are completely filled with water, or, in other words, that the pressure within them, in the clearance spaces between the guide blades and the wheel, is not that due to the atmosphere only. They are also all similar, except those whose water paths are radially outwards, in that they discharge below tail-water, either directly from the turbine chamber or through the medium of a draft tube. Among reaction turbines the course of the water through the interior varies with different makers, and according to differing purposes and situations. They may be described as follows:

1. Radial { Outwards—Fourneyron (Fig. 6). Inwards—Schiele, Thomson (Fig. 7).
2. Axial — Fromont, Burdin, Jonval (Fig. 8).
3. Mixed—Waverley, Victor, Hercules, etc. (Figs. 9 and 10).

1. The Fourneyron, as stated, was the first practical power machine, having its wheel disposed outside its cylinder of guide blades, there being an internal feed and external discharge. Fig. 6 illustrates the arrangement of guide blades and wheel buckets, the arrow B showing the direction of rotation, arrow A that of the water flow. This machine is not used with a draft tube, but is allowed free vent, and is consequently best set at a level just above that of the highest tail-water likely to be met with. It has a test efficiency reaching 80 per cent., and, though extensively used, it has been found, in the smaller sizes at least,

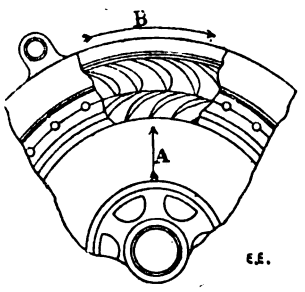

Fig. 6.

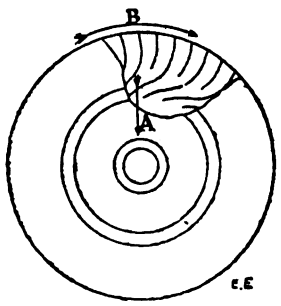

Fig. 7.

to be liable to damage from solid matter that it may attempt to pass. This turbine has been used successfully for all varieties of work, and under all heads from a few feet up to as much as 350ft., under which head the wheel at St. Blazien, of 26in. diameter, drives a large spinning factory of 8,000 spindles. With such high falls it is usual at the present day to employ wheels of the Pelton or Girard type, both on account of the slower speed obtained where "partial admission" machines of large diameter are used (the speed of ordinary turbines under such high heads being quite excessive), and also because the loss of power in pressure turbines due to the high speed of the water in the turbine case, lowers the efficiency of the machine to an extent that cannot be overlooked. Twin Fourneyron turbines of large size, developing 5,000 h.p. on each shaft, have been erected at Niagara by the Cataract Construction Company. The machines work with a fall of 140ft., and the pressure of the water is made to counterbalance the weight of the wheels and shaft by being admitted to act upward on the revolving cover of the upper turbine wheel. Since the weight of the shaft and revolving field-magnet at the top is as much as 152,000lb., the adoption of some such balancing action is rendered imperative to relieve the pressure on the bearings and footstep. A similar arrangement is in use at the aluminium works at Neuhausen-on-Rhine. These Niagara machines are so constructed

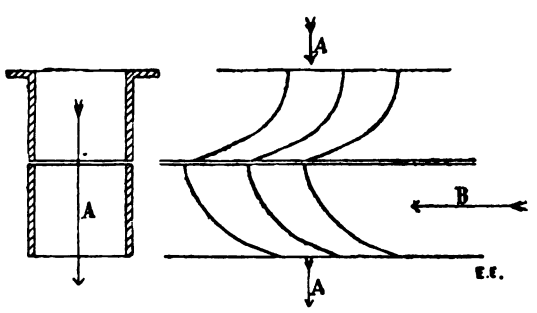

Fig. 8.

with diaphragms or separating plates that each virtually consists of three wheels on one shaft, or three tiers in one machine, and these separate wheels are, in the process of regulating the output, closed from the water supply singly, producing in effect several sizes of turbines, working always at about full load and highest efficiency under considerable variations of the total power developed. The same principle has been adopted in many turbines of other makers, such as Ritchie's excellent double-gate "Waverley" (illustrated in Fig. 9), where the difference in size of the two divisions of the wheel allow of three full-gate adjustments of different consumptions and power. Also, where two equal-sized turbines are fixed on one horizontal shaft, as is commonly done with machines of various descriptions, two such Victor turbines on same

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shaft and in one flume are shown in Fig. 10. This latter arrangement, by the way, has the further advantage, in common with those single turbines that discharge in two opposite directions, of obviating all end thrust and of running at a higher speed than would a single discharge machine of larger diameter, which itself took the whole quantity of water and gave the total power of the combination. For electric power driving, this increase of speed on a horizontal shaft, secured without recourse to gearing, is frequently a consideration of some moment. Schiele's turbine, the oldest form with circumferential feed,

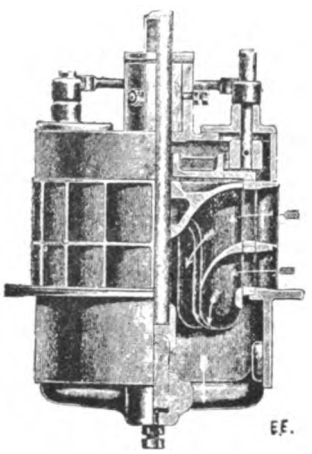

FIG. 9.

was somewhat similar to Thomson's well-known "vortex" wheel, but had no vortex chamber, and so lacked the advantages secured thereby in the way of the correct distribution of the kinetic and pressure energy of the water entering the chamber. This turbine exhausted axially, both upward and downward, as is usually the case with vortex wheels, though for certain purposes these latter are best made to discharge in one direction only, when they may be set with vertical shafts and fitted with draft tubes. The adjustable guide blades of the vortex turbine fulfil, as closely as is possible in practice, the theoretical conditions necessary for the maintenance of a high efficiency with widely varying conditions of load. In all turbines efficiency demands that,

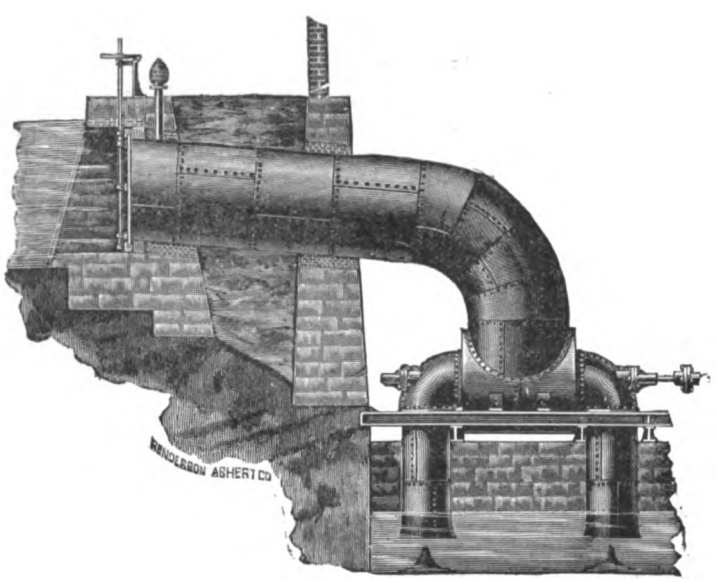

FIG. 10.

whatever be the rate of water flow, the path through the interior should be of a continuous and smooth form, and that change in the quantity of supply should be effected without throttling or sharply diminishing the area at any section. This condition is perhaps more nearly met in the vortex turbine than with any form of gate. This uniformity of efficiency with altering loads is, however, not always requisite, and there are many circumstances where a wheel of smaller efficiency at part gate, and without these internally moving blades, is decidedly preferable. A further advantage attaching to the inward radial flow of these machines, and not possessed by the Fourneyron or Jonval types, lies in the fact that automatic speed regulation is to a certain extent secured; since with varying velocities of wheel and of water in the vortex chamber, the centrifugal forces brought into play vary in such a manner as to tend to damp down any great change of speed, either above or below that at which the turbine should work. The increase of centrifugal force at such times as the wheel begins to race dams back the entering water by rise of peripheral pressure, while the contrary action follows any fall from the normal speed.

2. The Jonval turbine, the type of axial-flow machines, is much used in Continental power stations, where many situations with large quantities of water and comparatively small falls are required to be dealt with. It is built for either reaction or impulse working, the flow of water in either case being parallel with the axis of rotation, vertically downwards in machines of medium size, but where heavy wheels and shafts of weight are employed, this direction is frequently reversed by inverting the turbine upon the shaft, so that the upward passage of the water through the wheel relieves the footstep from excessive pressure. This method has been adopted at the Niagara Falls Paper Company's works, where Jonval turbines are in use, and the footstep being underneath the wheel, entirely immersed, is not readily accessible. Axial-flow machines, as before mentioned, have no automatic governing tendency, such as is inherent in inward-flow types, but are entirely dependent as to speed on the adjustment of the governors controlling the inflow of water. The disposition of guide blades and of vanes of wheel in the Fourneyron and the Jonval turbines, and the directions of water-flow through their interiors and through that of the vortex, are illustrated in the accompanying diagrams, and these may be taken as typically representing all types of simple pressure or reaction turbines. Other wheels, known as mixed-flow machines, inasmuch as that they are compounded of inward and axial flow, having a more complex configuration of vanes, have been evolved as a direct development of these fundamental forms.

3. Mixed-flow turbines, as a development of the inward and axial flow machines, embody to a certain degree the advantages of both. Their discharge areas are not so limited as those of inward-flow machines, and the water is under the influence of the vanes up to the moment of vent. They possess to a certain extent the automatic governing properties which are lacking in turbines of axial flow, and, as regards their size, weight, and cost for output, they compare favourably with the simpler forms of wheel. The downward direction given to the water by the lower part of the wheel buckets has a sensible balancing action, such as was obtained by inverting the Jonval wheel, relieving the pressure on the footstep. Although these turbines are generally classed under the head of "pressure or reaction" wheels, the action of the water on the buckets is not exclusively by pressure, since the relation of the peripheral speed of wheel and of the velocity of the entering water is so arranged that the primary action is rather one of impulse. The value of the proportion of pressure rises as the water approaches the centre of the wheel, and it is desirable that there should be, just before exhaustion, as large a proportion as possible of reaction, so that the water, on leaving the wheel, may carry away as little kinetic energy as will suffice to remove it. In order to reduce as far as practicable the velocity at discharge, the areas of discharge are made in practice 15 or 20 per cent. larger than those of intake.

In the setting of turbines it is important to provide a space below the vertical turbine of ample size for the water discharged to flow away slowly and evenly, without rush or eddy, as all such action in the tail-race below reacts injuriously on the turbine, greatly reducing the efficiency of its action. With mixed-flow turbines of small size, when set in a wheel pit or in a built flume, the depth of discharge space below the bottom of the draft tube should not be less than 2ft., and for the larger sizes this space should be so proportioned that easy and continuous discharge is secured. If this depth requires that the pit be excavated to a lower level than that of the bottom of the tail-race, the floor should be

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gradually sloped up to that level at some distance away from the issuing water. Generally speaking, as much care should be bestowed on the proper design of the discharge pit and channel as is necessary with the head-race, water approaches, and flume. Since the loss of head, and consequently of power, rises very quickly with increase of water velocity in the channels leading to and from the turbine, it is important to so adjust dimensions that the loss of head incurred is as small as the cost of the works will justify. The speed of the water approaching and leaving the wheel will be best kept below 1·5ft. per second, and the tail-race should be of sufficient depth, and of inclination small enough, for the standing water to be upwards of 2ft. in depth when the turbines are not running. This depth will not be appreciably increased on starting the turbines if the tail-race be of sufficiently large cross-section. All mixed-flow wheels, inasmuch as that they may be classed as pressure turbines, can be used with an extended draft tube, kept closed at its lower end by the tail-water. The possibility of thus placing the wheels at any height up to 30ft. (the height of the column of water that will balance the natural atmospheric pressure) above tail-level, is frequently of service, especially where direct coupling to horizontal driving shafts is desired. It should be noted, however, that it is very seldom that practice shows a draft tube of greater length than 20ft. The difficulty of *maintaining* a perfectly airtight tube with greater lengths than this is considerable, and should access of air be imperfectly prevented, the efficiency of the turbines while running would necessarily be affected. In addition to this, the draining away, during hours of rest, of the water from the *lignum vitæ* footstep in such turbines as use this form of bearing, renders this latter liable to burn out.

The arrangement shown in Fig. 10 of two Victor turbines on one shaft, obviating end thrust as before explained, is in use at the works of the Cowles Electric Smelting and Aluminium Company. The illustration, from a block kindly lent by Mr. Frederic Nell, shows one of three such pairs of 35in. wheels, giving a total output of 3,000 h.p. under a head of 40ft.

(To be continued.)

THE MECHANICAL CONSTRUCTION OF ELECTRICAL MACHINERY.

BY F. M. WEYMOUTH.

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The Dynamo.

(Continued from page 457.)

Armatures (continued).—Figs. 299 and 300 herewith show two cores respectively for wire-wound and bar-wound drum

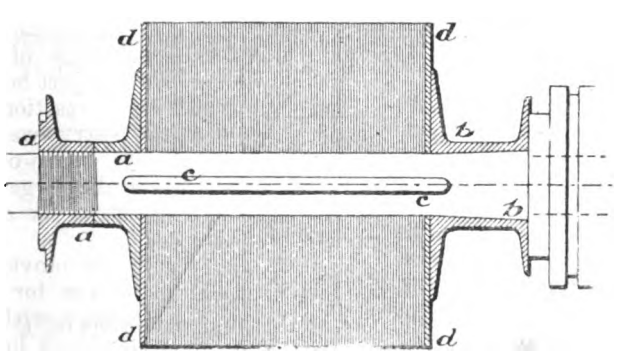

Fig. 299.

armatures. These are designs by the Newton Electrical Engineering Works, Taunton, for their "Taunton" dynamo; and we have to thank that company very much for the drawings from which our diagrams are produced.

A leading feature in these designs, which is a respect in which they become typical of a class, is the combination with the end-plates of sleeves whereon to centre the end winding. These, indicated in both cases by letters *a a* and *b b*, are gunmetal castings; and at *a a* the outer end is separate, forming a circular nut which engages with threads on the shaft. As in Fig. 292, the soft-iron discs of the core are carried on the shaft direct, though driven by a feather, *c c*. At *b b* (Fig. 299), for the wire-wound armature, the shaft is coned: a very tight fit is thus secured on screwing up the nut at *a a*, and is the more practicable here inasmuch as the sleeve, *b b*, has a wide flange at each end preventing any possibility of its expanding on being forced up the cone. In the case of the bar-wound core this simply butts against a collar, *i*, in the usual manner. The discs in Fig. 299 are of No. 26 S.W.G. (18 mils), and are insulated with paper.

In Fig. 300 the nut, *a a*, is originally cast with a

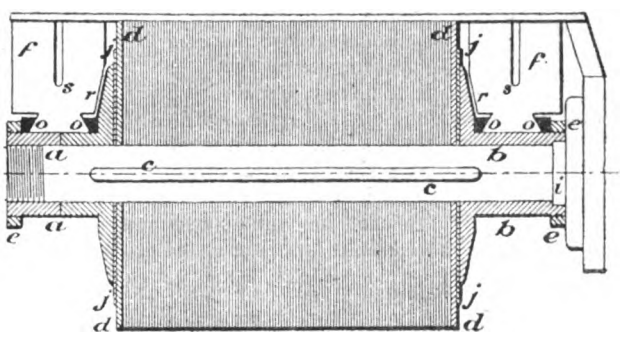

Fig. 300.

hexagon head to enable it to be screwed up on the shaft: when firmly secured this head is taken off in the lathe, and so does not show in the drawing. Other nuts, *e e*, at both ends, are substituted for the outer flanges in Fig. 299, so as to allow of the building up of the end winding, which latter is indicated, on the upper side only, at *f f*. To utilise the space gained by the slope of the end-plate, as at *r j*, the inner edges of the end-winding conductors are chamfered or sloped to correspond. Such a method, of course, causes some slight loss of section from *r* to *s*: but as this is confined to such a limited length in each conductor, it is apparently considered of less importance than the gain in compactness; and its effects as a resistance to the current are presumably not perceptible in practice.

In both designs circular plates of fibre, *d d*, are interposed between the iron discs and the end-plates, with the addition

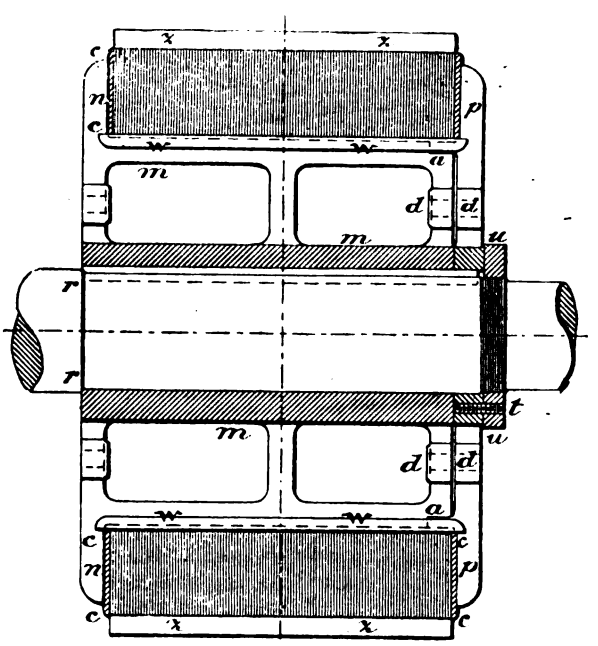

Fig. 301.

in the bar-wound core of a wrought-iron plate, *j j*, $\frac{1}{8}$in. thick. Black blocks, *o o*, in the diagram indicate rings of insulating material whereby the end-winding is dovetailed into place; and this latter is, of course, also insulated from the sleeves *a a* and *b b*. It will be observed that these cores both belong to the class of unventilated armatures.

Figs. 301 and 302 herewith represent a design of core for a four-pole drum armature by Messrs. The India Rubber,

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Gutta Percha, and Telegraph Works Company, Limited, whom we have thus again to thank very much for drawings. There is here introduced an example of that type of armature whose construction is in one sense independent of the shaft. It will be observed to consist mainly of a four-armed spider, *m m*, each arm having a projecting finger, *n*, at one end. At the other end a four-armed, star-shaped casting, *p p*, is stepped on to the four arms of the spider, as shown at *a a*, and is held thereto by bolts through the bosses, *d d*. The core, indicated as heretofore by the perpendicular hatching, is enclosed between wrought iron plates *c c* at either end, which take the immediate pressure of the fingers *n* and *p*. These plates being thin, and consequently liable to spring outwards between any two fingers, *p p* or *n n*, they are further supported by insulated bolts, *v v*, penetrating the length of the core half-way between the fingers, as seen in the end view, Fig. 302. This is not, however, the case where in practice the armature as a whole is put on or off the shaft; for we are informed by the makers that the spider is made so tight a fit on the shaft that they would not dismount the armature except in detail.

A noticeable feature in the construction of this core consists in the use of steel shoes, *w w*, laid along the outer edges of the arms to take the bite

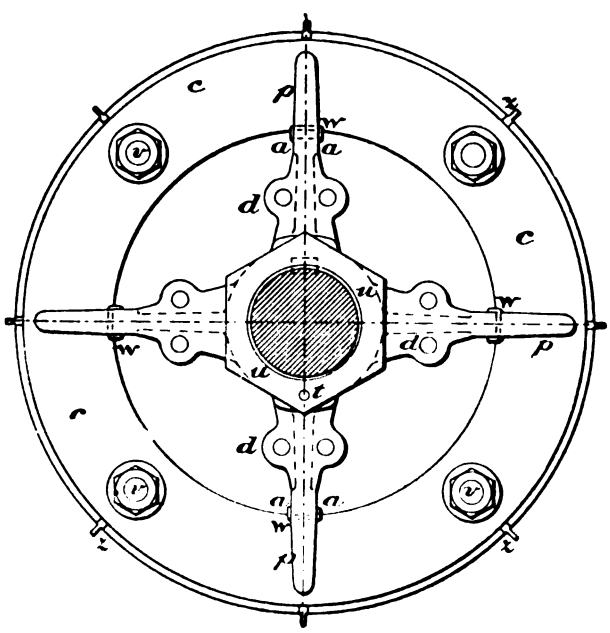

FIG. 302.

of the edges of the iron discs. These shoes have a "channel" section, being planed out of solid bar; and while the inside of the channel fits the spider arm, the outside is a fit in the slot in the core: and this latter is thus practically carried by the shoes. The use of these steel shoes was adopted because this company found that in some of their earlier armatures, in which the core discs were carried direct by the gunmetal spider, the edges of the discs worked into the gunmetal, so that there was a tendency for the core to become loose on the spider. This was found to have happened in some tramcar motors where the constant changes of load and of direction of running, and the vibration to which such machinery is subjected, tend to increase the cutting of the gunmetal by the edges of the core discs. The shoes were thus adopted to prevent this evil. An incidental advantage attending their use is that they bridge over the joint between the star casting, as at *a a*, and so form an unbroken seating for the core.

The armature butts against a shoulder, *r r*, on the shaft, and is held by a wrought-iron hexagon nut, *u u*; and this latter is then locked by a small set screw, *t*, penetrating the star casting as shown. Slots in the outer periphery of the core receive strips of fibre, *z z*, having a tee section for driving the conductors: and it will be noted that in Fig. 301, the section through the core is taken through the slots, both external and internal, thus leaving the fibre strips, *z z*, and the shoes, *w w*, in full view. It may be further remarked, that though in this case the armature is not long, yet the principle of having a cylindrical hub or centre to the spider, fitting closely to the shaft for the whole length of the spider, tends to stiffen the shaft in proportion as this fit is made tight.

Fig. 303 illustrates a construction of drum armature core

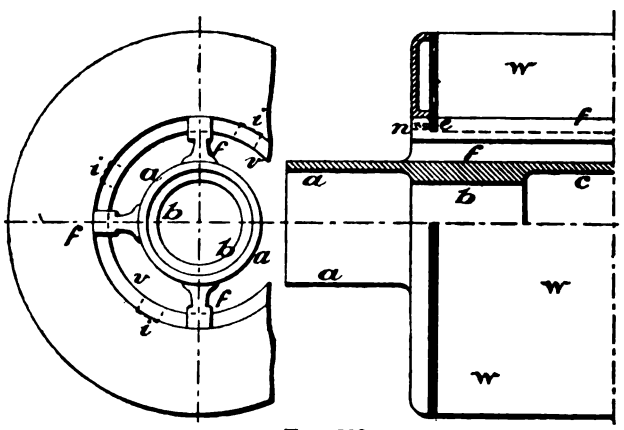

FIG. 303.

patented by Messrs. P. R. Jackson and Co., Manchester (Patent No. 6,791, 1895). This is shown in part end view, and a quarter longitudinal section, and a quarter side elevation, and forms another example of an armature complete without the shaft. Being for a two-pole machine we find here a more contracted diameter than in the last we descanted on. It will be observed also to consist of a spider having a central hub, *a b c*, which immediately rides on the shaft. Unlike the last described, however, this central hub does not fit the shaft for its whole length, but only toward the ends at the small diameter, *b*. Consideration will thus make it clear that in this method of construction, the armature, howsoever tight the core may be, does not afford any material assistance in stiffening the shaft, unless the fit at *b* is extremely tight: and the narrower the annular facings, *b*, and the further apart they are, the less stiffening will the spider and core afford to the shaft, inasmuch as this latter will be free to deflect within the spaces, *a* and *c*. This argument, however, would, of course, not hold good with a central annular facing fitting the shaft in addition to those toward the extremities.

The ends, *a a*, project so as to form a central seating for the end-winding, as in Figs. 299 and 300. From the hub four ribs, *f f*, project radially, the outer edge of each of which is continuous for its whole length, except for a gap, *e*, near each end. A peculiarity in the construction of the end-plates is here to be noted. The core discs, with their interior diameter as at *v v*, are gapped internally in the usual manner, so that they may pass over the ribs, and be thereby carried and driven. To form the end-plates, as many of the discs as can be got side by side in the gap, *e e*, are taken, and being passed over the ribs till they cover these gaps, *e e*, they are rotated a few degrees round the shaft axis, so that the gaps in these discs, as shown dotted at *i i i*, cease to coincide with the ribs. This group of discs

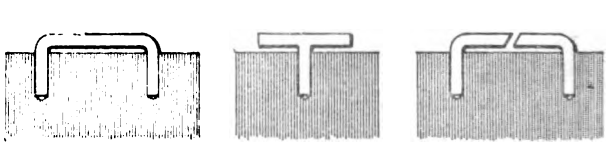

FIG. 304.

is thus held by the gaps, *e e*, so that it cannot come off the spider. For extra strength the discs may be riveted together as illustrated. The remaining discs being added from the other end so as to occupy the space, *w w*, are tightly compressed by exterior means so that the other end-plate may be put on in a similar manner to the first. As a further security against the possibility of the end-plates creeping round so that their gaps once more coincide with the section of the rib, leading to their coming off, set screws may be added as shown at *n*.

A method patented by this company (Patent No. 2,674, 1896) for driving the conductors is illustrated in Fig. 304.

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German-silver staples are struck into holes drilled into the core; and these staples are depicted in three varieties, *A*, *B*, and *C*. Strips of fibre are placed each side to protect the insulation on the conductor bars; and the staples are arranged so that they come under the binding and are thereby kept from flying out. This method has the advantage of simplicity, and avoids slots in the core: but as compared with that shown at *z* Fig. 302, for instance, the stout wire and fibre each side will take more room in the circumference.

Reverting once again to the general construction of the core, we may note that from a mechanical standpoint, this method does not admit of such solidity in the core as others that we have described; and, especially near the ends, there must be a tendency for the plates to spring outwards towards the periphery, and to become dished in shape, unless further means are added for compressing them all together, or unless, indeed, the compound end-plates employed are made thicker in proportion than that illustrated, which latter is reproduced from the patent drawing. We are informed, however, by this company that in their more recent practice the cores are built directly on the shaft without the use of a spider: the staples also, though found highly satisfactory, are supplanted by other means of driving; but we advance these as typical of one general method of achieving this end.

As may be noted both in this case and the last, spider-built cores possess the advantage that they permit ample ventilation.

(*To be continued.*)

RAILWAY MOTOR DESIGN.*

BY ALFRED E. WIENER, E.E., M.E., M.A.I.E.E.

The construction of motors used for railway propulsion deviates in many respects, electrically as well as mechanically, from that of ordinary motors. The principal conditions that must be fulfilled in the design of a railway motor are the following: (1) The motor should be extremely compact so that it may easily be placed in the space available within the truck, yet it must be easily accessible, and all parts subjected to wear must be readily exchangeable. All parts of the machine must furthermore be so designed, and the windings so executed, that the continual vibrations due to the motion of the car are unable to loosen the same or to get them out of working order. (2) It must be so designed that with minimum weight a maximum output is obtained. (3) The speed of the armature must be properly chosen with regard to the minimum and maximum load, to the speed of the car, to the diameter of the car wheels, and to the ratio of speed reduction. (4) The regulation of the speed should be simple, reliable, and perfectly adapted to all grades and curvatures of the track. (5) The type of the motor should be so chosen and the design so carried out that there is no external magnetic leakage, that at the same time all the vital parts of the motor are protected from mechanical injuries, and that it can be so supported from the truck that, if possible, none of its weight is resting directly upon the car axle. Particular care must also be bestowed upon the selection of insulating materials and the manner of insulation, in order to guard the machine against the influences of dampness, mud, and water.

1. *Compact Design and Accessibility.*—It is usual practice to equip each car with two motors which are directly suspended from the car axles and the frame of the truck; hence the extreme dimensions of the motors are limited by the diameter of the wheels, their distance apart longitudinally, and by the gauge of the track. The trucks most commonly used have 30in. or 33in. wheels, a wheel base of 6ft. to 7ft., and the standard rail gauge of 4ft. 8½in. The height of the motor is further limited by the condition that a space of at least 3in. should be left between the lowest point of the motor and the top of the rails, in order to enable the motor to pass over stones or other small obstruction accidentally upon the track. With regard to accessibility, the arrangement should be such that the working parts can be easily inspected during the trip from a trap-door in the floor of the car. If it is impracticable to provide the car barn with pits below the tracks, the motor should be so designed that the armature, the field coils, and the brushes can be taken out through the same trap-door. In order to facilitate the quick replacing of an armature, it is advisable to split the motor frame horizontally and to make one half revolvable by means of strong hinges.

2. *Maximum Output with Minimum Weight.* — Since for the propulsion of every additional pound of the weight of the car a proportionate extra amount of energy has to be taken from the line, it must be the aim to make the entire equipment as light as is consistent with strength and durability. In order to reduce the weight of the motor to a minimum, it is of the utmost importance to use only the best materials suitable for the respective parts—namely, the softest annealed sheet iron for the armature core, silicon bronze or drop-forged copper for the commutator segments, and wrought iron or softest cast steel for the field frame. If reduction gears are used, the pinions should be of hard bronze or of good tool steel, and the gear wheels of cast steel or of fine-grain cast iron. In order to attain the maximum possible output, the magnetic circuit of the motor should have as small a reluctance as possible, and the magnetic leakage should likewise be reduced as much as possible. The former object is attained by the use of toothed or perforated armatures with very small air-gaps, and the latter by proper selection of the type and by judicious design. The armature should be made most effective by providing it with a great number of turns; the sparking which would thus result under ordinary conditions is checked by the use of carbon brushes, which are set radially in order to enable reversibility in the direction of rotation of the motor.

3. *Speed and Reduction Gearing.*—The speed of the motor naturally depends upon the car velocity desired, upon the size of the car wheels, and upon the method used for the mechanical transmission of the motion from the armature shaft to the car axle. The maximum speed of the car, according to local conditions (size of town, amount of traffic in streets, etc.), varies from 8 to 15 miles per hour; the greatest speed of the car axle, therefore, provided that 30in. wheels are used with the slow and 33in. wheels with the fast running cars, ranges between 90 and 150 revolutions per minute respectively. The methods of transmission most commonly employed in electric railway cars are the double and single spur gearing and the direct coupling; worm gearing, bevel gearing, link chains, and crank rods being used only in single cases. The employment of double spur gearing was necessary with the earlier railway motors, which were run at from 1,000 to 1,200 revolutions per minute, and which, therefore, had to have their speeds reduced in the ratio of from 1 : 10 to 1 : 15. High-speed railway motors, however, on account of the noise and wear connected with the presence of four gear wheels for each motor—that is, eight gears per car—proved too inconvenient and too expensive to maintain, and low-speed motors of from 400 to 500 revolutions per minute, necessitating but a single spur gearing with a ratio of from 1 : 4 to 1 : 5, were next resorted to. If the spur gears for such single-reduction motors are provided with broad and carefully cut teeth, and are run in oil, both noise and wear are very small, and the efficiency is comparatively high. Worm gearing can be employed for any speed ratio within the limits of railway motor reduction, and by proper design very high efficiencies may be attained. Thus, if the worm is carefully cut of a solid piece of tool steel, and the rim of the worm-wheel of hard phosphor-bronze, and if the dimensions are so chosen that an initial speed of 20ft. to 40ft. per second is obtained, the efficiency, when running in oil, may reach 90 per cent. and over.* If no speed reduction at all is required—that is to say, if the motor is to be directly coupled with the car axle, its normal speed must be between 100 and 150 revolutions per minute. From tests made by Prof. S. H. Short† the saving of power consumed in operating a directly-coupled gearless street-

* From the *American Electrician*.

* See "Schneckengetriebe in Verbindung mit Elektromotoren," by Emil Kolben, *Elektrotechnische Zeitschrift*, vol xvi., p. 514 (August 15, 1895).

† "Gearless Motors," by Sidney H. Short, *Electrical Engineer* vol. xviii., p. 386 (April 16, 1892).

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TABLE I.—General Data of Most Common Railway Motors.

Name of motor.	Capacity horse-power.	Weight complete, including gears. Pounds.	Weight efficiency. Pounds per horse-power.	Speed at normal load. Revolutions per minute.	Ratio of speed reduction.	Kind of gearing.	Type.	Number of poles.	Dimensions of field frame. Inches. Length, ∥ axle.	Width, ⊥ axle.	Height.	Space occupied by field frame. Cubic inches.	Space efficiency. Cubic inches per horse-power.	Size of armature Inches. External diameter.	Length of core.	Kind of armature. Sm. = smooth. T = toothed.
General Elec. No. 6 Edison	15	1,765	117·7	1,130	9 : 1	D. spur.	Horseshoe.	2	10¼	24½	15	3,770	251	9¾	10½	Sm. drum.
,, No. 14 ,,	20	1,600	80·0	450	5 : 1	S. ,,	Iron-clad.	4	11½	26	18½	5,530	277	15⅞	11⅜	T. ring.
,, No. 16 ,,	30	2,270	75·7	410	4·78 : 1	,, ,,	,,	4	13¼	30½	23½	9,500	317	18¼	13⅜	,,
,, G. E. 800 ...	25	1,685	68·6	590	4·78 : 1	,, ,,	,,	2	20¼	18	24	8,740	350	16	8	T. drum.
,, G. E. 1,000*.	40	2,185	54·4	500	3·94 : 1	,, ,,	,,	4	16⅝	23¼	24	9,270	232	14½	8½	,,
,, G. E. 1,200..	45	2,975	66·2	425	3 53 : 1	,, ,,	,,	4	24⅜	23½	24	13,800	307	16	13⅛	,,
,, G. E. 2,000...	100	4,650	46·5	790	3·18 : 1	,, ,,	,,	4	25½	22½	33	18,900	189	18	13¼	,,
Oerlikon Works, 12 P.S.† ..	12	1,975	164·5	1,150	14 : 1	Worm.	Horseshoe	2	22	24	10¾	5,670	473	10½	7½	Sm. drum.
,, ,, 17 P.S.†...	17	1,950	114·7	450	4·9 : 1	S. spur.	Radial M.P.	4	24	22½	22½	12,150	715	15	11	T. drum.
Short, single reduction.....	20	2 220	111·0	550	5 : 1	,, ,,	Axial M.P.	4	32½	24¾	23¼	18,700	935	21⅜	5⅜	T. ring.
Walker No. 3	25	2,100	84·0	500	4·78 : 1	,, ,,	Iron-clad.	4	19⅞	21	22⅝	9,430	377	12⅜	7½	T. drum.
,, No. 4	30	2,250	75·0	500	4·78 : 1	,, ,,	,,	4	22	21	22¼	10,270	342	12¾	8	,,
,, No. 5	35	2,400	68·6	500	4 78 : 1	,, ,,	,,	4	22½	21	22¼	10,500	300	12¾	10	,,
,, No. 10	50	3,040	60·8	550	3·90 : 1	,, ,,	,,	4	26¼	23⅜	25¾	16,050	321	15	10	,,
,, No. 15	75	4,100	54·7	600	3·29 : 1	,, ,,	,,	4	29½	24¾	31	22,600	301	18	8⅝	,,
,, No. 20	100	4,700	47·0	600	3·375 : 1	,, ,,	,,	4	24½	26	33¾	21,500	215	18	13	,,
Westinghouse No. 3‡	30	2,750	91·7	300	3·45 : 1	,, ,,	Radial M.P.	4	21	22⅞	22⅞	11,000	367	11⅝	15	,,
,, No. 12A	30	2,200	73·3	685	4·86 : 1	,, ,,	,,	4	21½	23½	23½	11,350	378	11⅝	8½	,,
,, No. 38	50	2,200	44·0	520	3·56 : 1	,, ,,	,,	4	22¾	24	24	13,100	262	13⅞	11	,,

* Curves showing the performance of this motor are given in *Electrical World*, vol. xxviii., p. 176 (August 8, 1896).
† The dimensions given for the Oerlikon motors are rough approximations only, the correct figures not having been at hand.
‡ For description and test of this motor, see "Dynamo-Electric Machinery," by Silvanus P. Thompson, fifth edition, p. 542.

car motor is found to be from 10 to 30 per cent. as compared with double spur gearing, and from 5 to 10 per cent. as compared with single spur gearing, according to the load. In order to show what has been done in the way of compact design and weight efficiency of railway motors of various speed reductions, the writer has prepared the foregoing Table I., giving the specific weight, the speed, kind and ratio of reduction, the type and dimensions of the frame, the space efficiency, and the size of the armature of the most common railway motors in practical use. The figures given for the dimensions of the field frame do not include any supporting or suspension brackets, lugs, or other extensions that may be attached to or cast in one with the frame, but relate only to the magnetic portion of the field casting. This is done to bring all the space efficiencies to a common basis, thus enabling a fair comparison of the various types.

4. *Speed Regulation.*—In order to enable the variation of the speed of railway motors within wide limits, their field magnets should be series wound. The strength of the magnetic field can then be regulated either by the resistance method in connection with partial short-circuiting of the field coils, or by the combination method, or by the series-parallel method. In the resistance method the insertion of rheostat resistance into the main circuit by reducing the effective E.M.F. causes a decrease in the speed of the motor. In this case the cross-section of the field wire must be dimensioned to carry the maximum current, but the number of turns must be chosen far greater than is required for the production of the requisite number of ampere-turns at maximum current and maximal speed. For almost the full field strength must be obtained with a comparatively small current intensity, and it is therefore necessary to short-circuit a portion of the magnet coils at maximum load—that is to say, in order to raise the torque of the motor for increased loads only one of the two factors determining the same is increased—namely, the current in the armature—while the field current remains the same. In order to do this without excessive sparking caused by the fact that the brushes not being adjustable are never at the neutral points of the resultant field, carbon brushes must be used whose large contact resistance considerably reduces the current in the coils short-circuited by the brushes. The combination method of speed regulation consists in suitably changing the grouping of the magnet coils. For this purpose it is necessary to wind the magnet coil in sections, equal portions of which are placed on each magnet, and to connect the terminals of these sections, usually three in number, to a switch, or controller of proper design. At the maximum load of the motor the three sections are connected in parallel, and for this combination, therefore, the cross-section of the magnet wire is to be calculated; but for starting the car all coils are connected in series, and if no precautions were taken, the magnet winding would in consequence have to carry the full starting current, which may be four to six times the maximum normal current. In order to avoid overheating and damage due to this starting current, a starting rheostat must be placed in circuit, the resistance of this rheostat being so dimensioned that the starting current is brought down in strength to that of the maximum working current. While with the two former

Fig. 1.

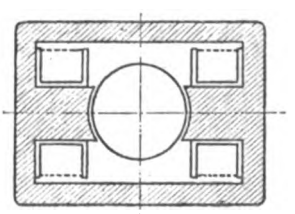
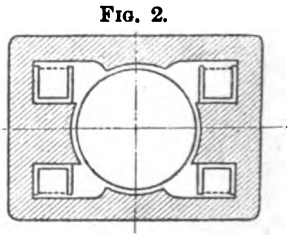


Fig. 2.



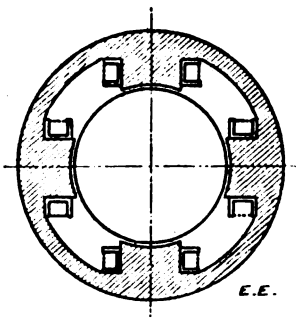


Fig. 3.

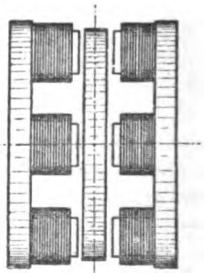


Fig. 4.

methods of speed regulation the two motors of the car are permanently connected in parallel, in the series-parallel method of control, finally, both the armatures and magnet coils of the two motors can be grouped in any desired combination. The same number of combinations is, therefore, possible with less elements, and only two sections per magnet coil are necessitated. Since by placing both armatures and all field coils in series the starting current is considerably reduced, less resistance is needed in the starting rheostat, and a saving of energy is effected by this method. For

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calculating the carrying capacity of the magnet wire the last two positions of the series-parallel controller are essential; for maximum speed the two motors, each having one coil cut-out, are placed in parallel, and in the position for the next lower speed both motors with their two coils in series are grouped in parallel.

5. *Selection of Type.*—The most important consideration in the selection of the type for a railway motor is the condition that there should be no external magnetic leakage, as otherwise the neighbouring iron parts of the truck may seriously influence the magnetic distribution, and, furthermore, small iron objects, such as nails, etc., may be attracted into the gap space and may injure the armature. In order to protect the motor from dampness and mechanical injuries such types are to be preferred in which the yoke surrounds the armature, and which therefore can easily be so arranged that the frame completely encases all parts of the machine. The types possessing the latter feature are the iron-clad types (Figs. 1 and 2), the radial outer pole type (Fig. 3), and the axial multipolar type (Fig. 4), and as can be seen from Table I., these are indeed the forms of machine that are used in modern railway motor design.

Calculations Connected with Railway Motor Design.

1. *Speed of Motor for given Car Velocity.*—The speed of the motor required to move the car at a given velocity with a given reduction gear is:

$$N = \frac{\text{ft. p. min.} \times z}{\frac{d}{12} \times \pi} = \frac{5{,}280 \times 12 \times z \times v}{60 \times \pi \times d} = \frac{304 \times v \times z}{d} \quad . \quad (1)^*$$

in which N = speed of motor, in revolutions per minute.
v = speed of car, in miles per hour.
z = ratio of speed reduction—*i.e.*, ratio of armature revolutions to those of the car axle.
d = diameter of car wheel in inches.

Example.—A motorcar which has 30in. wheels is fitted with reduction gearing of ratio 1 : 4; what speed must the motor be wound for in order to give a car velocity of 12 miles per hour? Here we have $d = 30$in., $v = 12$in., and $z = 4$; hence by (1):

$$N = \frac{304 \times 12 \times 4}{30} = 485 \text{ revolutions per minute.}$$

2. *Horizontal Effort and Capacity of Motor Equipment for given Conditions.*—The power required to propel a car depends upon five things: friction, grade, condition of track, curvature of track, and speed. No accurate formula can be given for the resistance due to friction, condition of track, or curvature, for this resistance will vary largely at different times with the same car, depending upon the care with which the bearings and gears are oiled, and on whether the track is wet or dry, clean or dusty, or muddy. A good average practical value of the specific traction resistance, verified by numerous tests, is 30lb. per ton of weight on the level, and $(30 \pm 20 \times g)$ pounds per ton on grades, g being the percentage of the grade—that is, the number of feet rise, or fall, respectively, in a horizontal length of 100ft. The horizontal force necessary to overcome the traction resistance caused by a total weight of W tons, therefore, is:

$$f = W \times (30 \pm 20\,g) \text{ pounds} \quad . \quad . \quad . \quad (2)$$

and the power, in watts, required to exert this horizontal effort, or draw-bar pull, at a speed of v miles per hour will be—

$$P = \frac{f \times \text{ft. p. min.} \times 746}{33{,}000} = \frac{f \times \frac{5{,}280}{60} v \times 746}{33{,}000} = 2 f \times v \quad (3)^\dagger$$

In order to facilitate the calculation of the propelling power, or of the motor capacity required for given conditions of traction, the following Table II. has been prepared, which gives the power required to propel one ton at different grades and speeds, and which, therefore, furnishes P in horse-power by simply multiplying the respective table value by the total weight, W, to be propelled—*i.e.*, the weight of car plus passengers (average weight per passenger equal 125lb.):

Table II.—Specific Propelling Power Required for Different Grades and Speeds.

Percentage of grade, g.	Horse-power required to propel one ton if rated speed of car, v, in miles per hour is							
	8	10	12	15	18	20	25	30
0	·64	·80	·96	1·21	1·45	1·61	2·01	2·41
1	1·07	1·34	1·61	2 01	2·41	2·68	3·35	4·02
2	1·50	1·88	2·25	2·82	3·38	3·76	4·69	5·63
3	1·93	2·41	2·90	3·62	4·34	4·83	6·03	7·24
4	2·36	2·95	3·54	4·42	5·31	5·90	7·37	8·85
5	2·78	3·48	4·17	5·22	6·26	6·97	8·71	10·44
6	3·22	4·02	4·83	6·03	7·23	8·05	10·04	12 06
7	3·65	4·56	5·47	6·84	8·20	9·12	11·40	13·67
8	4 07	5·09	6·11	7·63	9·15	10·18	12·73	15·28
9	4·50	5·62	6·75	8·43	10·10	11·25	14·07	16·89
10	4·93	6·16	7·39	9·24	11·07	12·32	15·40	18·50
12	5·78	7·23	8·68	10·84	13·01	14·47	18·10	21·70
15	7·07	8·84	10·60	13·25	15·90	17·70	22·10	26 55

From (3) the horizontal pull required to exert a given power at given speed is found thus:

$$f = \frac{33{,}000 \times 60}{5{,}280} \times \frac{P}{746} \times \frac{1}{v} = 375 \times \frac{\text{H.P.}}{v} \quad . \quad . \quad (4)$$

Giving to H.P. values from 15 h.p. to 16 h.p., and to v from 8 to 30 miles per hour, the following Table III. is obtained, which at a glance gives the horizontal effort, or draw-bar pull, exerted by any motor capacity at a given speed, whereupon from (2) the load, W, in tons can be computed which the equipment under consideration is able to propel at any given grade.

Table III.—Horizontal Effort of Motors of Various Capacities at Different Speeds.

Rated capacity of motor equipment, H.P.	Pull at periphery of wheel, f, in pounds, at rated speed of car, v, in miles per hour, of							
	8	10	12	15	18	20	25	30
15	703	563	469	375	313	281	225	188
20	938	750	625	500	417	375	300	250
25	1,172	938	781	625	521	469	375	313
30	1,406	1,125	938	750	625	563	450	375
40	1,875	1,500	1,250	1,000	833	750	600	500
50	2,344	1,875	1,562	1,250	1,043	938	750	625
60	2,812	2,250	1,875	1,500	1,250	1,125	900	750

Examples (Showing Use of Tables II. and III.).—1. An electric railway car of a seating capacity of 34 passengers weighs 2½ tons, and its electrical equipment, 1¼ tons; to find the power required to propel this car at a speed of 15 miles per hour on a grade of 5 per cent. Including the conductor and motorman, the full carrying capacity of the car is 36 persons, which, at an average of 125lb. per head, make a total load of 2¼ tons; the maximum weight to be propelled, therefore, is W = 2½ + 1¼ + 2¼ = 6 tons. The value of the specific propelling power corresponding to $v = 5$ and $g = 5$ is found from Table II. to be 5·22 h.p.; the required propelling power, consequently, is P = 5·22 × 6 = 31·32 h.p.

2. The cars of a road are equipped with two 20-h.p. railway motors; how many passengers can they carry up a 12 per cent. grade at a speed of 10 miles per hour? From Table III. we find, for H.P. = 40 and $v = 10$, a draw-bar pull of $f = 1{,}500$lb. Inserting this value into formula (2) we obtain $1{,}500 = W \times (30 + 20 \times 12)$, from which $W = \frac{1{,}500}{270} = 5{\cdot}56$ tons. Subtracting from this the weight of the car and equipment, say four tons, the weight of the passengers is received, and from the latter their number is derived $\frac{(5{\cdot}56 - 4) \times 2{,}000}{135} = 25$, which includes the attendants of the car.

* $\frac{5{,}280}{60}$ = multiplier to convert miles per hour into ft. per min.; $\frac{5{,}280 \times 12}{60 \times \pi} = 304$.

† $\frac{5{,}280}{60}$ = multiplier to convert miles per hour into feet per minute;
746 = multiplier to convert horse-power into watts;
33,000 = multiplier to convert horse-power into foot-pounds;
$\frac{5{,}280 \times 746}{60 \times 33{,}000} = 2$, nearly.

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FREE WIRING.

This subject seems to be creating as much interest in Australia as in this country, and in the discussion on Mr. Callender's paper to the Electrical Association of New South Wales, Mr. Hesketh puts forth his views. He says that he favours "the system by which the wiring is carried out by the electric authority, who insists on the payment of, say, 33 per cent. of the total cost on completion, the remainder being paid in periodical instalments. The extra price per unit for limited time is only another form of the deferred payment system." Mr. Callender, in the paper referred to, suggested "the supply company to instal the wiring free of charge on the consumer giving an undertaking to consume a stated minimum number of units for a term of three years." Mr. Hesketh sums up the matter thus: "The various propositions naturally divide themselves into, first, those which regard the outlay on the wiring as a temporary loan to the consumer to be repaid at certain fixed periods; second, those which regard the cost of wiring as a permanent investment, the interest on which is to be looked for from the supply. . . . I incline to regard the outlay as a loan to the consumer, and not as part of the capital outlay of the station." The whole subject has been discussed again and again in England with the result, we should imagine, of most people agreeing with the first conclusion of Mr. Hesketh—that the cost of wiring should take the shape of a temporary loan to the consumer. Unfortunately, when companies are concerned, the two conflicting interests—that of the consumer and that of the shareholders—cannot well be brought into line. The object of a company is to pay dividends, and a very good object, too; but the case is different when a municipality is the undertaker. The making of a profit ought not then to be the main object. Their object should be the greatest good to the greatest number of inhabitants, and so far as electric lighting is considered, this is obtained only by distributing electrical energy at the lowest possible rate to pay expenses, and while loans exist, the interest and repayments upon such loans. It must not be forgotten that a good many of the troubles relating to wiring will gradually cease. In districts where central stations exist, the new buildings will probably be wired, so far as the house mains are concerned, at the time of construction, so that all the tenants would have to trouble about would be the fittings. The cost of such fittings would depend upon the tastes of the tenants. Of course, the great difficulty is in old houses and shops changing from gas to electricity, and the whole question seems to resolve itself into one of three courses: (1) free wiring by a wiring company; (2) free wiring by the supply undertakers with an extra cost per unit till interest on capital cost and capital cost itself is repaid; or (3) a definite quarterly repayment till capital is repaid. In our opinion the last is the best. The quarterly bills would show cost of energy supplied per unit and repayment on account of cost of wiring. The latter might be on a one, two, or three years' system. The difficulties in the way of any system are principally due to the law of landlord and tenant.

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ELECTRIC LIGHT LOANS.

The progress of electric lighting may be seen by the amount of loans annually sanctioned by the Board of Trade. During last year the amount sanctioned was £796,588, divided among some thirty-five local authorities, as follows:

District.	County.	Period in years.	Amount.
Bath City (C.B.)	—	20	£44,578
Blackpool (B.)	Lancaster	25	30,000
Bradford (C.B.)	—	25	37,391
,,	—	25	2 609
Brighton (C.B.)	—	25	27,100
Bristol City (C.B.)	—	25	75,000
Cardiff (C.B.)	—	25	12,000
Cheltenham (B.)	Gloucester	25	23,355
Coventry City (C.B.)	—	20	13,000
Derby (C.B.)	—	20	11,134
Ealing (U.D.)	Middlesex	25	20,978
Exeter City (C.B.)	—	15	7,500
,,	—	15	3.500
Fareham (U.D.)	Hants	20	6,681
Halifax (C.B.)	—	25	20,000
Harrogate (B.)	Yorks (W.R.)	25	25,246
Hastings (C.B.)	—	20	6,871
Huddersfield (C.B.)	—	25	50,000
,,	—	23*	43,715
Leyton (U.D.)	Essex	25	15,600
,,	,,	50	1,250
Manchester City (C.B.)	—	25	100,000
Monmouth (B.)	Monmouth	25	8,115
Newport (C.B.)	—	25	11,000
Nottingham (C.B.)	—	25	40,000
Oldham (C.B.)	—	25	10,000
Portsmouth (C.B.)	—	25	2,215
,,	—	25	180
St. Helens (C.B.)	—	25	10,000
Salford (C.B.)	—	25	5,000
Southampton (C.B.)	—	50	5,300
,,	—	25	28 900
,,	—	15	21 100
Southport (B.)	Lancaster	25	4,000
South Shields (C.B.)	—	25	800
Sunderland (C.B.)	—	25	16,000
Torquay (B.)	Devon	25	22,300
Wakefield City (B.)	Yorks (W.R.)	25	25,000
Walsall (C.B.)	—	25	2,500
Worcester City (C.B.)	—	20	6,670
			£796,588

C.B., county borough; B., borough; U.D., urban district other than a borough. * This period dates from March 11, 1896.

In 1890-1 the amount of loans sanctioned was only £10,000, the next year it was £100,997; there was a slight increase in 1892-3 to £115,248, and a jump in 1893-4 to £572,645, and though 1894-5 showed a little diminution, being £559,299, it increased again in 1896, as shown above. This loan account is being gradually repaid, so that at the end of any year the outstanding total is not the sum of the loans as received, but that sum less the repayments. Thus the outstanding loans at the end 1890-1 amount to £56,942, 1891-2 to £155,521, 1892-3 to £273,548, 1893-4 to £835,263, and 1894-5 to £1,378,818. The amount expended on what may be termed capital account yearly during the five years ending 1894-5 was respectively £14,057, £81,315, £165,465, £445,645, and £704,278. These amounts do not include sums paid in interest or in repayments.

TECHNICAL EDUCATION AND ELECTRICITY.

The Corporation of Manchester has recently sent a deputation to the Continent to visit the various Continental technical colleges, and to collect information such as will be useful in connection with the new municipal technical school now in course of erection at Manchester. The report in question is a most comprehensive one, but at present we are more particularly concerned with the debate on the same which took place on Wednesday last. It is extremely difficult to dismiss from one's mind the conditions obtaining in England, when visiting foreign towns and viewing engineering and other works. Thus anyone reading the speeches would gather that we are much behind America and the Continent in electrical engineering practice. This impression is due to the fact that more electric lighting and transmission of power plants are to be seen abroad. It would be well in this respect if the question of the cheapness of our excellent coal supplies were always borne in mind when making comparison. This results in cheap power, and also in cheap gas supply, which our engineers have developed to their utmost capacity. Thus electricity in England has had to compete, and has competed successfully, with two rivals twice as powerful as those found in other countries. As regards electrical machinery *per se*, the direct-current dynamos made in England are much more efficient than those to be found anywhere abroad, and of single-phase alternators much the same applies. The multiphase system is the great feature of the progress abroad, and this system is an essential outcome of dear coal and cheap water power. We trust that our manufacturing firms will move ahead in this department, as there are signs that they are doing, to enable us to compete successfully in the Colonial market.

COMMUNICATION WITH LIGHTHOUSES.

The fifth and final report of the Royal Commission has been issued. The value of the work of the Commission may be gauged by a glance through Appendix B of the report, which details the use made during two years of the means of communication provided. We take one of these items at random. It reads: "28th December, 3.40 p.m. Message to coastguard at Totland Bay that a vessel had just gone on the Shingles. Answered that the lifeboat had been called. (The lifeboat went to the assistance of the vessel and took the crew off)." Under the auspices of the Commission, some fifty light-vessels and lighthouses have been connected electrically with the telegraphic system of the kingdom, and the report recommends that other nineteen should be connected at an estimated cost of a little over sixteen thousand pounds. We are told that the only difficulties arise in connecting the light-vessels. In the five connected there have been twenty-seven breakages of connections since first made to the end of 1896; eight of these were not due to any defect of the system, while the remainder were caused by formation of kinks in the veering cable (three cases), the threshing of the veering cable on the bottom (twelve cases) and the chafing of the veering cable at or near the swivel (four cases). These failures occurring, attention was directed to the possibilities of a non-continuous system, the experiments with which failed; then attention was directed to the Marconi system, the preliminary experiments with which "proved satisfactory," and

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a practical trial is to be made. On this system the report says "there seems reason to hope that it may solve the difficulty of connecting light-vessels with the shore by electrical communication."

THE POST OFFICE.

The forty-third report of the Postmaster-General has just been issued. It shows that 79,423,556 telegrams were dealt with by the telegraph branch of the Department, an increase of 0·74 per cent. over the previous year. The revenue for the inland telegrams was £2,070,045, giving the average value of 7·58d. per telegram, as against 7·61d. for the previous year. The Press telegrams numbered 5,837,701. The rise of telephony has of course had considerable effect upon the number of telegrams, and undoubtedly has reduced the number sent. The Post Office has now 52,800 miles of trunk lines, counting the 4,180 miles in course of construction. It took over from the National Telephone Company 29,000 miles, and has constructed 19,620 miles. The system now consists of 800 separate trunk circuits, supplemented by about 2,000 circuits between post offices and the company's exchanges. An estimated expenditure of £165,000 for underground telegraph cables has been sanctioned. This line is to connect London and Birmingham, and on it some £65,000 will be spent during the current year. It is expected this new line will obviate the risk of total interruption, such as sometimes happens during heavy storms.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

PLYMOUTH REFUSE DESTRUCTOR.

With reference to the report on the above subject, which we published last week, we have been asked by Mr. G. Watson to insert the following letter:

SIR,—Referring to your interesting report of the debate in the Plymouth Town Council respecting the destructor question, I cannot refrain from pointing out some inaccuracies in Mr. Debnam's able attack upon the various systems for burning town's refuse.

First, respecting the Hamburg plant, which was erected by my firm, the Horsfall Furnace Syndicate, Limited, Mr. Debnam says that the cost of working it has amounted to 1s. 9d. per ton. I have before me a very able report by the chief engineer of Hamburg, Herr F. Andreas Meyer, in the *Deutsche Vierteljahrschrift fur offentliche Gesundheitspflege*, recently published. In this report a complete estimate of the cost of working the whole plant is given as follows:

	Marks per ton burnt.
Interest and repayment of first cost	0·243
Maintenance of works	0·203
Sundries	0·051
Salaries and wages	1·265
	1·762

The total returns for residuals are then deducted, amounting to 0·925 mark per ton of muck burnt. It should be stated that in these residuals the value of 100 i.h.p. is reckoned as well as the value of the clinker utilised. This gives a total net cost for burning the muck of 0·837 mark, including everything.

But Herr Meyer goes on to point out that the 100 h.p. reckoned above has not yet been fully utilised, and, further, that owing to the arrangements in the town the works have not been in full employment for the whole of the year—that is, that enough muck cannot be brought to them to keep them going, and consequently some of the cells have been stopped for a portion of the year to which the figures refer, consequently the actual cost, including interest and repayment of first cost, has amounted in 12 months' working to 1,441 marks per ton (equal to 1s. 5¼d.), or excluding interest and repayment of first cost 1·035 (equal to about 1s. 0¼d.). The saving to the town, as compared with the old system of disposal, is 1s. per ton.

This is a very different thing from Mr. Debnam's figure, and it must be borne in mind that there is no means of utilising the spare power at the Hamburg installation except for such purposes as breaking clinker or mortar grinding, while at Plymouth the whole of the power available might be utilised, and might easily yield a return of 6d. per ton burnt, even without using any method, such as accumulators, for instance, of storing power during the hours of light load.

Mr. Debnam further refers to the rate of wages at Hamburg. On referring to the same report I find that the ordinary stokers are paid over 26s. per week, which does not compare unfavourably with many English towns. It may also be mentioned that they work on the eight hours' system in three gangs. Finally, I submit that Mr. Debnam is not justified in referring to the Hamburg plant as experimental, seeing that for 18 months it has dealt successfully with the refuse of a population of 350,000 people. There is no need for me to deal with Mr. Debnam's strictures on the Oldham plant, which were well dealt with by Mr. S. J. Page, who defended us both justly and ably. Hoping you will be able to find space for the above facts, which are capable of verification by anyone interested.—Yours, etc.,

G. WATSON.

Athenæum-buildings, Park-lane, Leeds.

BLACKPOOL, LYTHAM, AND ST. ANNES TRAMWAY.

SIR,—The tramway lines referred to at p. 508 in your last issue as having been in use for several months with great success, and as having been extended from St. Annes to Lytham by a line recently inspected by the Board of Trade, are not electrical tramways, as your readers would be likely to infer, but are gas traction lines. The charging station referred to is the gas compression and storage station, and the part of the line, Blackpool to St. Annes, which you particularly mention, has been in successful and very profitable operation since July, 1896.—Yours, etc.,

W. WORBY BEAUMONT.

Outer Temple, 222, Strand, London, W.C.,
October 20, 1897.

REVIEWS.

The Calculus for Engineers. By JOHN PERRY, M.E., D.Sc., F.R.S., etc. London: Edward Arnold. Price 7s. 6d.

"This book is not meant to supersede the more orthodox treatises: it is rather an introduction to them." Thus says the author in the introduction to this volume, and truly those who are familiar with De Morgan, Todhunter, Williamson, Hall, and other orthodox writers, will find no similarity. Others before Prof. Perry have written practical treatises, but with very little success. This, however, seems destined to meet a different fate, and merits it. There are points upon which we should differ considerably with Prof. Perry—simple points. We are not so enamoured about quickness, and care nothing that a man should find the value of 3·216 × 4571 to four significant figures by a quicker method than logarithmically. Indeed, he may multiply in the good old-fashioned way so long as he does it correctly, and we should be inclined to back ourselves in a good round sum to get a correct answer by multiplication as quickly as one who uses the slide rule or table of logarithms. There is far too much rush nowadays. However, we are so much in accord with what Prof. Perry says that we willingly put aside all minor points of difference in order to congratulate him upon the production of a work that should be of immense value to engineers. Prof. Perry's method is to take a large number of practical examples, and then to say, "That's the way to do it." An edueationist would say this

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is not education; it is blindly following a leader. Still, if the examples given are sufficiently numerous, it is easily seen that hardly a practical problem can present itself which is not solved according to one or other of the examples given. The value of such a book is incalculable to practical men who have not obtained a thorough grounding in the subject by orthodox methods, and to those who have such a grounding but have never been shown how to apply their knowledge to practical work. Prof. Perry will, we think, agree with us in saying this book is in the nature of a tool to be used in practical work, and not in academic training. From this point of view the third chapter is redundant; it is to a large extent academic. Chapters I. and II. are excellent, dealing as they do with functions of x represented by x^n, e^{ax}, and sin $(ax+c)$. With all his views as to the use of squared paper and the study of graphs we cordially agree, as we do the looking upon b in the expression $y=a+bx$ as representing the slope of the line. The idea of a limit is well introduced in discussing the phrase, "We are going at 30 miles an hour." We must confess to a sneaking liking for the method of explaining a limiting value used in the course of mathematics for the Royal Military Academy issued about the year 1852, but must not forget that ancient history as well as ancient methods are superseded. Having accepted Prof. Perry's book as auxiliary to more orthodox books, we will only say further that his examples are diverse and far reaching, and the careful student who religiously works through them will be excellently equipped for the solution of almost every practical problem that comes before him. It must not be thought that this book is easy to study; it is not. The student will have to buckle down to his work and give his whole attention to every word said, assisting himself by finding and working similar problems to those given in the book.

Manual of Electrical Undertakings, 1897. By EMILE GARCKE, M.I.E.E., F.S.S., etc. Second year. P. S. King and Son, 12 and 14, King-street, Westminster, S.W. Cloth, 7s. 6d. net.

Mr. Emile Garcke issued the first annual volume of this manual in October, 1896, and the second number comes to hand containing many improvements. The historical matter contained in the first volume has been omitted, but the volume even now is about a third larger than its predecessor. It contains particulars of 274 undertakings, as compared with 172 in the previous volume, and it is unnecessary to point out how much this increases the value of the book. The information has been classified under telegraph, telephone, electricity supply, electric traction, electrical manufacturing and miscellaneous electrical undertakings, and each of these sections is preceded by some general notes and figures applicable to the particular branch of the industry. There is also a directory of officials, and lists, arranged alphabetically, of electrical companies registered since 1856, giving the year of registration and the amount of the capital. Maps of the electricity supply areas, and of the constructed and authorised electrical railways in London, are included, and will be found very useful. The editor informs us in his preface that the whole of the data are derived from official sources, and for the most part have been verified by responsible officers of the undertakings concerned. Having thus enumerated the contents of the book, little remains for us to say. The foregoing lines will show not only the great value of the book to the whole of the electrical profession, but will indicate the immense amount of labour involved in its production, and we have no hesitation whatever in recommending it.

AUTOMATIC ALTERNATE-CURRENT SWITCH-GEAR.

We have referred several times* to the switch-gear in use at Hastings, which has been designed and perfected by Mr. L. Andrews, the engineer of the Hastings Electric Light Company. The most recent notice of this gear was the paper read before the Northern Society of Electrical Engineers last January, which paper we reproduced in full. We have now received an addition to this paper containing a description of the most recent details of the automatic switch, which is the principal feature of the system devised by Mr. Andrews. The author refers to a statement made in his original paper to the effect that he did not altogether like the idea of using water for breaking a high-tension arc. It appeared to him at that time that the water would have to be contained in non-conducting vessels, such as porcelain or glass, and he feared that there would be a risk of these breaking and allowing the water to escape, thus causing one of those displays of high-tension fireworks which we are all so anxious to avoid. It has since been suggested to Mr. Andrews that the water-vessels might be made of gunmetal and enclosed in earthenware pots. A diagram of a switch embodying this idea is shown in Fig. 1. The gunmetal pots, A, are cemented by a sulphur compound into the earthenware pots, B. The contacts, C, and high-tension terminals, D, are screwed and brazed directly on to the metal pots; the latter are insulated by the ebonite sleeves, E. When the switch is closed, the contacts, C, are connected together by the U-shaped piece, F; this is fixed to the cast-iron arm, G, by a pair of ebonite insulators, H. The rest of the details of the release gear and connections are similar to those used in the previous switches

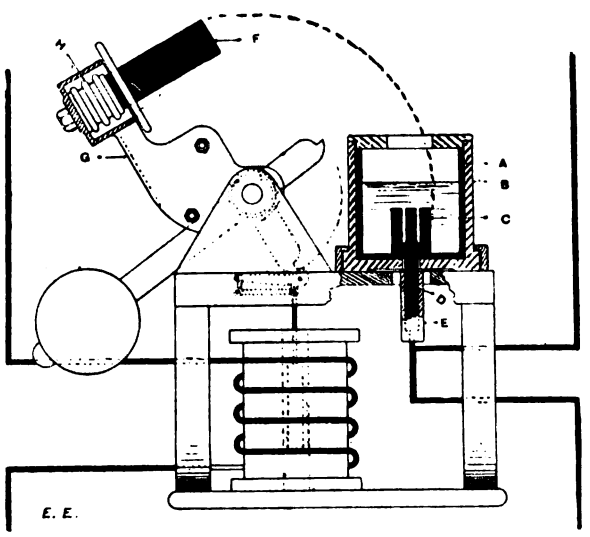

FIG. 1.

The author states that this new cut-out is almost entirely the outcome of a number of suggestions made to him by engineers who have been to see the switch-gear at Hastings. Its essential features are: It can be added to any existing switch-gear in a very short time without disarranging anything, all the high-tension parts are entirely covered in, and an attendant cannot possibly get a shock from them; consequently it may quite safely be bolted to a wall in any position. It is cheap, simple, and takes up very little room—the base of a 400-kw. switch being only 12in. square. There is no delicate mechanism about it liable to get out of order.

Some of the engineers visiting Hastings have stated that the switching arrangements appear to be perfect so far as they go; but, to be complete, the system of disconnecting a machine only when it proves unable to take its share of the work should also be applied to the continuous-current generators or exciters, to the transformers, and even to the mains. Acting upon this suggestion, Mr. Andrews has already applied his differential winding to a low-tension cut-out, suitable for use either with continuous-current generators or transformers, and he hopes next year to have an opportunity of extending the system to the high-pressure feeders.

The scheme for this purpose is illustrated in Fig. 2. The central generating station is represented by the large double circle, the transformer sub-stations by the smaller circles, and fuses or excess current cut-outs by the crosses. The figures over the crosses denote the amount of current required to cause these cut-outs to act. They are adjusted in the illustration for an assumed maximum output at each of the transformer stations of 50 primary amperes. The arrow heads represent return current cut-outs; these will

* Vol. xix., p. 151, and vol. xviii., p. 407.

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carry as much current as the mains, so long as the energy is being supplied in the direction in which the arrow heads are pointing, but will cut out with a comparatively small current returning from the sub-station to the generating station. It appears to be possible, by this arrangement, to provide against a short-circuit on any feeder interrupting the supply to any transformer station. For instance, if a fault occurs at E, Fig. 2, current will be supplied to it through this feeder's station fuse, which will, of course, blow and disconnect it at that end, and through the return current cut-out, which will disconnect it at the sub-station end. Mr. Andrews proposes connecting each of the sub-stations to the generating station by telephone, and the opening of a return current cut-out will automatically signal the approximate position of the fault to the works.

Mr. Andrews has a working model illustrating this scheme, which he will be delighted to show to anyone sufficiently interested to pay him a visit. In this the transformer stations are represented by incandescent lamps, and the feeders by bare copper wire. He has found it possible to short-circuit these model feeders in any position without extinguishing any of the lamps.

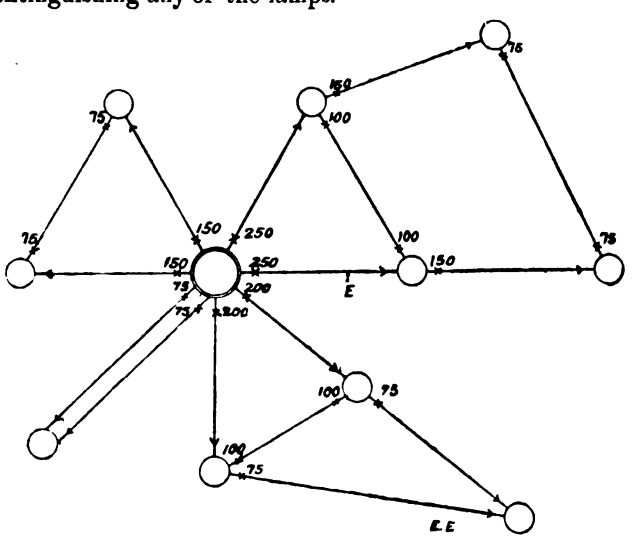

FIG. 2.

In the conclusion of the appendix Mr. Andrews submits for general criticism the opinion that central-station engineers would greatly reduce their own responsibilities by impressing upon manufacturers the desirability of so designing their switch gear that no high-tension metal can accidentally be touched; and, further, that since any modern make of alternator will stand short-circuiting, it is not advisable to provide cut-outs that will disconnect a healthy generator just at the time when all its energies are required to assist in burning out a short-circuit on the mains, but that it is advisable to use some safety device to disconnect a faulty machine, transformer, or feeder, immediately it ceases to do its share of the work, and becomes instead a drag upon the other machines, transformers, or feeders.

QUESTIONS.

In our issue of October 8 we announced our intention of offering *one shilling* for each suitable question as to the working and management of electricity supply stations. We also offered a further sum of *ten shillings* for the best replies received to each question. The first two questions were inserted last week, and the best replies will be published in our next issue. Two further questions are given below, answers to which must reach us not later than November 2.

QUESTIONS.

3. What is the best and most practical method of determining the calorific and relative cash values of samples of coal supplied for central stations. (H. T. M.)
4. A water-gauge shows a "full glass." After blowing it through the water rises again as before. Might not the gauge be showing a false level! How would you find out? What generally are the indication failings of a gauge, and how can they be known? (Nemo.)

RELATIVE VALUE OF 220-VOLT AND 110-VOLT LAMPS.

BY FRANCIS W. WILLCOX.

The subject of 220-volt lamps has been given considerable attention in the past year. Although many articles and discussions on the subject have appeared in the electrical papers of late, there seems to have been no attention paid to the practical question determining when it is economy to adopt 220-volt in place of 110-volt, and when not.

Mr. John Howell has written on some special features of 220-volt lamps and their production. A very interesting account of the practical operation of a 220-volt system, by A. H. Perkins, was given in the *Electrical World* of July 10. More recently Prof. Shepardson has read a paper before the N.W. Electrical Association on the subject, giving results of some tests made by him. In the June number of the *American Electrician* an English engineer gives an account of the practical operation of 220-volt lamps in England, in which he pays a flattering tribute to the 220-volt lamp as follows: "Without going into the entire history of the development of the 220-volt lamp, I may say at once that many manufacturers are now making them quite as efficient and satisfactory as those for 110 volts. Indeed, it would be difficult to detect by mere inspection in what the difference consists. They are made in a similar size of bulb, have similar terminals, may be obtained for all range of candle-power, and are equal in life and reliability. If there is any perceptible difference it is in the form of the filament."

This statement, while not an incorrect one as applied to English makes of lamps, since low-economy 4-watt lamps are the ones generally used abroad at all voltages, is very misleading in the impression it conveys. The extract serves to show the imperfect knowledge, even among engineers, of what constitutes the real merits of an incandescent lamp, and what is the relative standing of 220-volt lamps and 110-volt lamps. Because such lamps "have similar sizes of bulbs and similar terminals" and are equal in life, it by no means follows that 220-volt lamps are the equal of 110-volt lamps.

All these articles and descriptions of 220-volt lamps have unqualifiedly praised the 220-volt system, and have shown the influence of the reasoning that because a saving in copper is effected, and since 220-volt lamps are successfully operated, that, therefore, the 220-volt system must of necessity be better than either a 110-volt two or three wire system.

There are several other important questions besides those considered in such reasoning, and it is the purpose of this article to point them out and show how they enter into the proper consideration of the question. It is the writer's desire to touch upon the practical engineering phase of the subject as it concerns economical lighting service, and to determine, as far as possible, a definite answer to the question when does it pay to instal a 220-volt system. The discussion is, of course, made on the basis of what is best from the standpoint of a correctly engineered lighting service, and assumes that there is sufficient capital to adopt and properly instal whatever system is best.

In the first place, it is evident that the one consideration suggesting and recommending the 220-volt system for lighting purposes is the saving in copper it effects over the 110-volt system. This is three-fourths in case of the 110-volt two-wire system, and about one-eighth in case of the 110-volt three-wire system. On the other hand, the objection to the 220-volt system is the lower efficiency of 220-volt lamps as compared with 110-volt lamps of the same stability as to candle-power, average useful life, etc. This lower efficiency of 220-volt lamps means that there must be extra capacity of steam and electric machinery, and extra power consumption over what is necessary with a 110-volt system, supplying the same number of lamps. Where do these considerations for and against the 220-volt system balance one another? It is evident that, with other things equal, such a point determines which system it is best to adopt.

Before actually determining this point, it will be necessary to consider the relative values of 110-volt and 220-volt

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lamps, as this has an important bearing on the solution of the question.

A 220-volt lamp, as now furnished in the United States (there is nothing made abroad which is equal to it), is of 4 watts per candle efficiency (the English parliamentary standard candle). In average life, maintenance of candle-power and general performance, it stands between the 3·1 watts and 3·6 watts per candle 110-volt lamps. If the value in candle-hours of the 110-volt 3·1-watt lamp be represented by 1, then that of the 220-volt 4-watt lamp will be $1\frac{1}{2}$.

The difference in power consumed is nine-tenths watts per candle, the 220-volt lamps requiring and consuming 30 per cent. more power than the 110-volt 3·1-watt lamps. The difference in quality gives the 110-volt 3·1-watt lamps two-thirds value of 220-volt lamps. This means that a station operating a 220-volt system could obtain two-thirds of the average results in lighting as to the life of lamps and maintained candle-power with 30 per cent. less capacity of steam and dynamo machinery, and 30 per cent. saving in power were the system changed to a 110-volt system, furnishing the same number of lamps, and operating at the same line loss. This is the substance of the whole situation, and must be understood and kept in mind. It is beside the mark to argue that 110-volt plants use 3·6 watts, and in some cases 4-watt lamps, instead of 3·1-watt lamps, and that, therefore, a 220-volt system, with its 4-watt lamp, takes practically no more power. If a 110-volt plant uses 3·6 or 4 watt lamps, then to get the same results on a 220-volt system, 5 or 6 watt lamps should be used. Plants operating at 110 volts will not use 3·1-watt lamps, considering it too fine a lamp for their service, and yet the same company will operate at 220 volts and use the 4-watt lamps without any hesitation, doing practically the very same thing in the latter case that they refrain from doing in the former.

The merit of the question is simply to determine what system is best for any given installation from the standpoint of obtaining equal results in light obtained to power expended. As stated above, the determining considerations are, on the side of the 220-volt system the saving in copper, and on the side of the 110-volt system the saving in capacity of the steam and electric machinery and power required for lighting.

The general law governing the conditions can be stated as follows: Interest and depreciation on cost of copper saved by 220-volt system over 110-volt system must be equal to or greater than the interest and depreciation on the cost of extra capacity of machinery and copper, plus the annual cost of extra power required by 220-volt lamps over the corresponding 110-volt lamps. In deducing the equations under this law we will assume 110-volt 3·1-watt lamps and 220-volt 4-watt lamps are equal in quality, and then after reducing to the simple formula we will introduce the factor of two-thirds, which represents the ratio of their qualities as to candle-hours given.

As depreciation of copper is very small, it may be considered negligible. The 110 and 220 volt systems considered may be either two-wire or three-wire systems. We will consider each case separately. In the following discussion the line loss is assumed to be the same percentage for the 220-volt and 110-volt systems in each case considered. Each system is of sufficient capacity to supply an equal fixed number of lights over the same area.

Let a = cost of copper necessary for 110-volt two-wire system in dollars.
Let a' = cost of copper necessary for 110-volt three-wire system in dollars.
Let a'' = cost of copper necessary for 220-volt two-wire system in dollars.
Let a''' = cost of copper necessary for 220-volt three-wire system in dollars.
Then $a' = \frac{3}{8}\,a$ and $a'' = \frac{1}{4}\,a$ and $a''' = 3/32\,a$.
Let b = cost of steam and electric machinery for 110-volt two-wire system in dollars.
Let b' = same for 110-volt three-wire system in dollars.
Let b'' = same for 220-volt two-wire system in dollars.
Let b''' = same for 220-volt three-wire system in dollars.

If first cost of machinery bore always the same ratio to capacity, then $b'' = 1{\cdot}30\,b$; since 220-volt lamps require 30 per cent. more power than the corresponding 110-volt lamps. First cost increases at a less ratio than capacity, and b'' therefore $= g\,b$, in which g is a factor always less than 1·30. Assuming that first cost increases at two-thirds rate of capacity, we would have $g = 1{\cdot}20$, and $b'' = 1{\cdot}20\,b$, which will be the assumption in this deduction.

Let d = annual cost in dollars of extra power required by 220-volt lamps over 110-volt lamps.
Let e = interest in per cent.
Let f = depreciation (in per cent.) of steam and electric machinery, depreciation of copper considered negligible.

First.—For the 220-volt two-wire system *versus* the 110-volt two-wire system. From the general law noted above under the assumption stated we have the equation,

$$e \times 3/4\,a = \text{or} > e \times 1/5\,b + f \times 1/5\,b + e \times 3/10 \times 1/4\,a + d$$

or
$$e \times 15\,a = \text{or} > (e+f)\,4\,b + e \times 3/2\,a + 20\,d.$$

Assuming interest at 6 per cent. and depreciation 4 per cent., then $e = 6/100$ and $f = 4/100$ and reducing we have $90\,a = \text{or} > 40\,b + 9\,a + 2{,}000\,d$, or practically $a = \text{or} > 1/2\,b + 25\,d$.

Multiplying the last member of the equation by two-thirds, which represents the ratio of light-giving quality of 110-volt and 220-volt lamps considered, we have $a = > 1/3\,b + 16\frac{2}{3}\,d$, which means that for equal results as to light obtained and same percentage loss in line, the 220-volt system should be used only when cost of copper required by the 110 volt two-wire system is greater than one-third first cost of steam and electric machinery, plus $16\frac{2}{3}$ times annual cost of extra power for 220-volt lamps.

Second.—The case of the 220-volt two-wire system *versus* the 110-volt three-wire system. From the general law noted above we have the equation,

$$e \times 1/8\,a = \text{or} > (e+f)\,1/5\,b' + e \times 3/10\,a'' + d;$$

or, reducing and substituting for a'' its value $3/8\,a$, $e \times 10\ a = \text{or} > (e+f)\ 16\ b' + e \times 9\ a + 80\ d$, or assuming $e = 6$ per cent. and $f = 4$ per cent., this reduces practically $6\,a = \pi > 160\,b + 8{,}000\,d$.

Introducing factor two-thirds as in former deduction, and reducing equation becomes practically $a = \pi > 18\,b' + 886\,d$.

This means that on the basis of equal results as to light obtained and equal percentage of loss in line, it will pay to adopt the 220-volt two-wire system, as against the 110-volt three-wire system, when the cost of copper as estimated for 110-volt two-wire system is greater than 18 times the first cost of machinery of the 110-volt three-wire system plus 889 times the extra annual cost of power for 220-volt lamps.

The saving in copper as between 220-volt two-wire and 110-volt three-wire systems is $\frac{1}{8}\,a = \text{or} > 2\frac{1}{4}\,b + 111\,d$, and the above result can be expressed.

The saving in copper effected by 220-volt two-wire system over 110-volt three-wire system must be greater than $2\frac{1}{4}$ times first cost of 110-volt three-wire machinery, plus 111 times extra annual cost of power for 220-volt lamps.

This shows that the 110-volt three-wire system has generally the advantage over the 220-volt two-wire system, and that it will be rather an exceptional case when, as far as lighting service is concerned, it will pay to adopt the 220-volt two-wire system in preference to the 110-volt three-wire system.

Third.— The 220-volt three-wire system *versus* the 110-volt two-wire system. The first cost of the 220-volt three-wire plant machinery will be somewhat greater than for 220-volt two-wire plant, and it will be safe to assume $b''' = 1{\cdot}50\,b$, including cost of extra capacity, and the increased cost for three-wire system machinery.

The equation in this case becomes

$$e \times 29/32\,a = \text{or} > (e+f)\,5/10\,b + e\,3/10 \times 3/32\,a + d,$$

which reduces, after introducing values for e and f, practically to $a = \text{or} > b + 20\,d$. Introducing factor 2/3 as before, $a = \text{or} > 2/3\,b + 13\frac{1}{3}\,d$, which shows there is a limiting case even here.

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Fourth.—The 220-volt three-wire system *versus* the 110-volt three-wire. Here, as the plants are both three-wire plants, we have $b''' = 1{\cdot}20\ b'$, similarly to the case of the 220-volt and 110-volt two-wire systems. The equation in this case becomes

$$e \times 9/32\ a = \text{or} > (e+f)\ 1/5\ b' \times e + 3/10 \times a''' + d;$$

reducing and substituting for a''' its value $3/32\ a$ we have $e \times 90\ a = \text{or} > (e+f)\ 64\ b' + e + 9\ a + 320$ or $e \times 81\ a = \text{or} > (e+f)\ 64\ b' + 320\ d$; substituting $e = 6$ per cent. and $f = 4$ per cent, we have practically $a = \text{or} > 1\frac{1}{3}\ b' + 66\ d$.

Introducing the quality factor 2/3, this equation becomes $a = \text{or} > 8/9\ b' + 44\ d$. The saving in copper effected as between 220-volt and 110-volt three-wire system is $9/32\ a = \text{or} > 1/4\ b' + 12\frac{3}{8}\ d$—that is, the saving in copper effected by the 220-volt three-wire system over the 110-volt three-wire system must be greater than one-quarter first cost of 110-volt three-wire machinery, plus $12\frac{3}{8}$ times extra annual cost of power for 220-volt lamps, to make it profitable to adopt the 220-volt system, as far as equal results in light obtained are concerned.

Any of the above results can be expressed in a different way as a function of number of lamps.

Take the first equation, $a = \text{or} > 1/3\ b + 16\frac{2}{3}\ d$. The cost of copper is proportional to the square of the average length of lines, D^2, and to the number of lamps, L, and can be written $P\ L\ D^2$, in which P is a factor equal to cost in dollars of unit cross-section of wire. The first cost of machinery, b, is a function of the number of lights, and Q L, in which Q is the cost per light of machinery in dollars. The annual cost of extra power for 220-volt lamps, d, is also a function of the number of lamps, and can be expressed as R L, in which R is the annual cost per lamp in dollars of extra power required by 220-volt lamps. Substituting these values in the foregoing equation, we have $P\ L\ D^2 = \text{or} > 1/3\ Q\ L + 16\frac{2}{3}\ R\ L$, or striking out L we have $P\ D^2 = \text{or} > 1/3\ Q + 16\frac{2}{3}\ R$, from which we see that the conditions are independent of number of lamps, and depend only on the square of the average distance from station to lamps.

Similarly, equation in case of three-wire 110-volt system *versus* two-wire 220-volt system can be expressed $P'\ D^2 = \text{or} > 18\ Q' + 889\ R'$, in which P, Q', and R' are factors corresponding to P, Q, and R in the preceding case.

The foregoing results are, of course, applicable only when an economical and properly designed lighting service is the chief consideration. Where distribution of power is desired in conjunction with lighting, the advantage of the 220-volt system over the two-wire 110-volt system are greater than the results deduced herein allow. It is to be noted, however, that in the case of the 220-volt two-wire system as against the 110-volt three-wire system, the relative positions of the two systems are not changed from what is determined above, whether light alone or light and power both are furnished, since, as far as power is concerned, the two systems are on a par.

Taking lighting installations in general, however, the equations deduced herein will be found applicable, and where other considerations besides lighting service enter, they can be considered separately, and balanced against the results obtained by these equations. As the distance over which current is supplied is the determining factor, it will be found that 220-volt installations will be more generally of value for central-station installations than for isolated plants. With the three-wire 110-volt system it would be a very exceptional case where it would pay to instal a 220-volt two-wire isolated plant.

Of course the 220-volt system has important advantages over 110-volt systems where only a fixed amount of money is available and it is desired to make it go as far as possible, but such cases are not the ones considered in this discussion. We have here considered only the cases where there is sufficient money available to instal a plant from a correctly engineered lighting standpoint.

The status of the 220-volt lamp will not, of course, remain where it is. Improvements will be made, and the efficiency be made better. On the other hand, improvements will also be made in 110-volt lamps, and in fully as great a degree, so that the relative status of the two lamps will be about the same as stated and assumed herein. The deductions herein can therefore be assumed as generally safe from much change.

The 220-volt three-wire system cannot at present be generally accepted as a practical one, as underwriters' requirements do not permit exceeding 330 volts pressure in buildings. This prohibits the system for isolated plants, and limits it in central-station work to such an extent as to practically prevent balancing of the system.

There is no good reason why the underwriters should not permit 220-volt three-wire systems, provided satisfactory wiring and safety devices are used. Several such devices, including a magnetic cut-out, have been developed and placed on the market. It will probably, therefore, be only a question of time until the underwriters agree to permit 220-volt two-wire installations.

Until this permission is given, however, the 220-volt system can be considered, as far as economical lighting service is concerned, a competitor of the 110-system only in case of two-wire installations in both cases.—*The Electrical World* (New York).

DOUGLAS.

REPORT OF THE COMMITTEE ON ELECTRIC TRACTION.

(Continued from page 471.)

With regard to the second objection—the expense involved in maintenance and keeping the system in a thorough state of efficiency and good working order—here again there is a great diversity of opinion and testimony. However, judging from the somewhat limited information available in relation thereto, this objection appears to be equally fatal with the first. According to the testimony of Mr. Martin, in Berlin the underground or conduit system is certainly more costly to maintain and keep in a thorough state of efficiency than the system of overhead wires, and it will be observed that Mr. Martin states approximately the cost of maintenance is increased to the extent of from 10 to 15 per cent. The responsible managers of tramways companies are agreed that the cost of maintenance is increased, but to what extent is not stated. Herr von Siemens, however, does not entertain the opinion that there is much difference in the cost of maintenance. It will be apparent that unless a common basis for calculation is mutually agreed upon with regard to the exact items of particulars of expenditure to be included in any relative comparisons as to the cost of maintenance of both conduit and overhead systems, no agreement will ever be arrived at, and these differences of opinions are sure to be maintained. The different conclusions to which reference has been made are undoubtedly arrived at owing to their being based upon different data. That there is a difference distinctly in favour of the overhead system is, however, generally conceded and acknowledged. With regard to the cost of operating the different systems, it may not be out of place at this point to incidentally refer to the opinion of an eminent expert, based upon actual experience and actual results. Mr. F. S. Pearson, who is engineer in chief of the largest street traction corporation in New York, and who has constructed and laid down systems of mechanical traction in several of the largest cities of America, in a recent valuable report to the Corporation of the city of Liverpool, states that he estimates the cost of operating per car mile as follows: overhead trolley system, 3·68d.; and underground or slotted conduit system, 4·00d. Although the circumstances affecting Liverpool and Douglas are vastly different, the figures just quoted are adequate for the purpose of affording reliable data for purposes of comparison. The cost of running, however, must depend to a large extent on the price of coal and the wages paid to the employés both on the cars and at the generating station.

Referring to the third objection, Herr von Siemens is of opinion that the underground conduit system does not take longer time in construction. The time occupied in construction of conduit lines undoubtedly varies very much according to circumstances, and such circumstances would also govern to a large extent the amount of public inconvenience which would be occasioned to vehicular traffic during the period of interference with the thoroughfares. Evidence with regard to the nature of the inconvenience which would be caused in Douglas should it be necessary to do any part of the constructive work at certain seasons of the year is not wanting, seeing that the laying of the cable tramway during the season of 1896 disorganised the whole of the vehicular traffic on the line of route. The construction of a conduit line of electric tramways on the Loch Parade, or any part of the sea-front, would occasion but trifling inconvenience in the event of the work being carried out during the winter months, but the amount of inconvenience which would be occasioned if work of

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a similar character was undertaken during the summer months is quite beyond realisation. It will be seen, therefore, that the objection which is urged as to the prolonged interference with street traffic during the work of construction is only pertinent and applicable when the local circumstances and local surroundings of each place are under consideration. The deputation was afforded an opportunity of witnessing the progress of the work during the laying of a portion of the underground system in some of the streets in Dresden. The vehicular traffic was completely disorganised owing to the excavations in the roadway and the quantity of rails, yokes, and other material lying scattered about the streets. The footpaths in one thoroughfare in Dresden appeared to be laid out for an "obstacle race," being blocked with excavated earth and *débris*, setts, baulks of timber, etc., and considerable difficulty was experienced by the deputation in getting through the particular street referred to. Again, a similar state of things appeared to exist in Brussels, though not so distinctly visible as in Dresden, as the Brussels conduit was inspected on Sunday, when the workmen were not working. In large and populous cities, with enormous vehicular and pedestrian traffic all the year round, the inconvenience must be great and real. That this condition of things must and does prevail in such cities, and has a depreciating effect on the conduit system, may be judged from the fact that in Berlin, although the authorities will not sanction overhead apparatus in the streets in the inner circle or centre of the city, they have likewise decided not to permit the construction of any more conduit lines on account of the great inconvenience arising as indicated. Whilst, however, circumstances certainly govern constructive work, they cannot govern repairs, which may be necessary at any time, irrespective of the claims and exigencies of the season. In Douglas the maximum inconvenience—an inconvenience of a very serious character—attending the execution of repairs would certainly be experienced should repairs of any kind to underground work be rendered necessary at any time during the season, and this factor, in considering the merits and demerits of any particular system, must not be lost sight of, but should be most carefully remembered in connection with any system which may be adopted.

The fourth objection, referring to the difficulty which is experienced in speedily locating any defect in the underground part of the system is very important, and one which demands earnest consideration. If the apparatus in the conduit should need repairing—and repairs at times are imperative—the work is of necessity rendered much more difficult and more expensive than with the overhead wires, and the utility of the tramways system is frequently seriously imperilled. In order to get access to the conduit, the provision of a very large number of manholes, etc., is rendered absolutely necessary. The conduit system needs a quick means of getting at the underground conductors to remedy defects of insulation and for cleansing of the conduit, which is specially necessary in order to prevent accumulations of dirt or water, which at once stops the work by "short-circuiting." To provide this means of easily getting at the tube, the Budapest system has two courses of brick in mortar laid under the rails on the top of the concrete conduit, and when any stoppage occurs a rail is taken up, the bricks pulled out, and the necessary repairs executed, after which the bricks and rails are replaced. This is no doubt a somewhat clumsy way of working, and if it had often to be resorted to during the summer season would certainly become an intolerable nuisance in the busy and crowded promenades. Such a system might possibly answer in a town like Budapest, where the streets are so exceptionally wide that the ordinary street traffic is afforded room to avoid the chasm laid open without experiencing any serious inconvenience, but on the Douglas promenades, where every foot of the street width is extensively used and required during the season, and the ordinary traffic, especially on the Loch Parade, uses and must of necessity use the tramlines quite freely, such a system would be quite unworkable. The public inconvenience which was occasioned on Whit Monday and on several other recent occasions during the very busiest portion of the present season—the month of August—owing to the cessation of traffic on the Upper Douglas cable tramway will not soon be forgotten; the extent of the inconvenience caused by the temporary suspension of the traffic to visitors and residents and business men can indeed scarcely be estimated. It will be within the recollection of the members of the Council that on at least two occasions, at the very busiest season of the year, the dislocation of the traffic and the disorganisation of the service was prolonged unduly owing to the difficulty experienced by the workmen in locating the defect. The effect of a similar occurrence on the Loch Parade, or on any other portion of the Douglas Bay section of tramways during any part of the season, but especially during the month of August, may be better imagined than described. In addition to the enormous public inconvenience which would be occasioned should such an unfortunate circumstance arise and interfere with facilities of locomotion and transit, the monetary loss to the shareholders of the company would be considerable, and in this loss the Corporation would participate to the extent of 15 per cent., seeing that the receipts in respect of which the percentage is payable would be materially diminished. The system of traction which the Corporation may determine to adopt for operating the tramway system has consequently such a very serious bearing, not only upon the general convenience of the community, but also upon the finances of the borough, that its importance cannot possibly be over-estimated.

The difficulties and expense involved in carrying out the work relating to laying of gas and water mains, house drain connections, and main sewerage pipes is an objection which does not need much emphasing, the experience acquired in constructing the Upper Douglas cable tramway being sufficient to demonstrate the great inconvenience which might arise under this head. The testimony received from other places shows that the difficulties and expense incurred is a very serious matter.

In many instances it will have been observed that strong objection is taken with regard to the possibility of danger and inconvenience arising from the slot, which is an indispensable adjunct and vital part of the conduit system. It will be remembered that the width of the slot in the Upper Douglas cable tramline is 11-16in. and $\frac{3}{4}$in. at curves. From actual measurements taken by the borough surveyor, the slot of the Berlin conduit measured at different points 1$\frac{1}{4}$in., 1 3-16in., 1$\frac{1}{8}$in., and 1 9-16in., and at one place, at the junction of points where the ordinary rail and the slot rail unite, the slot and groove measured 3in. across. In Brussels the slot measured from 1$\frac{3}{8}$in. to 1$\frac{3}{4}$in. wide, and at the points it measured 3$\frac{1}{2}$in. In the experimental line of the Simplex system, as laid down at Prescot, the slot measured about 1in., but as one of the rails projects slightly in order to form a groove, the actual width of the slot is reduced to $\frac{3}{4}$in., or even $\frac{5}{8}$in. In Blackpool, where the electric lines running along the promenade—exposed to the full force of the wind and tide from the Irish Sea—belong to and are operated by the Corporation, the conduit, instead of being under one rail, as in Budapest and other Continental cities, is placed in the centre of the rails, and the slot is much narrower than any seen by the deputation elsewhere—namely, $\frac{5}{8}$in. and $\frac{7}{8}$in., $\frac{7}{8}$in. being the greatest width of slot allowed by the Board of Trade. The slot in the centre channel being only about $\frac{5}{8}$in. wide, wears away the collector, which, when worn, is liable to get wedged and has to be removed, but any mishap of this kind can be rectified in about two or three minutes. In making comparisons with regard to the width of the conduit slot with the cable slot, it may be stated that the width required to allow the electric collector to pass is larger than is needed for the cable "gripper." All the power of the gripper may be conveyed by a plate $\frac{1}{2}$in. thick, but the electric collector, though thinner, has to be protected on each side by insulators, and these again require to be defended from wear by iron plates on either side. The inevitable result of this is that the original width of the electric slot, to be effective, must be at least about 1$\frac{1}{4}$in. or 1$\frac{1}{2}$in., rather more than double the width of the cable slot. As a matter of fact, in Budapest, to which reference has been already made as possessing an excellent conduit system, the slot is in no case less than 1$\frac{1}{2}$in. in width, while in many cases, and especially at curves, this width has been increased owing to enlargement caused by the wear of the wheel flanges to 2in. The wide slot, which is endurable in Pesth, where the chief streets are 150ft. and 250ft. wide, and where the ordinary traffic need not cross the tramlines, except at an angle perfectly safe, would be a nuisance on the Douglas promenades, even to ordinary carriage traffic of the lighter kind, while bicycle wheels of certain makes and types would drop through altogether, with the risk of "short-circuiting" the conductors and stopping the traffic on the line within that particular section.

The difficulties experienced in keeping the conduit clean and interference with the working through dirt and mud and road detritus getting into the slot have proved serious drawbacks in other places, and have materially affected the success of the system, but it is acknowledged that better construction and the exercise of greater care in cleanliness might possibly avoid these difficulties. Many devices have been arranged either to cover the slot or to protect the cable within the culvert, but so far as they have been tried they have been failures.

In Blackpool, owing to the pressure of the tide, it was considered necessary to make such arrangements that any dirt or shingle entering the slot in the centre channel might fall through freely to the bottom, and also of providing for its early removal. Sump holes and traps for the purpose were therefore placed at intervals, and these have drains connecting directly with the sea, advantage being taken of the town drains used for running off surface water. These precautions, notwithstanding, it cannot be said that the system has given that satisfaction which was at one time anticipated.

In connection with the conduit system, the hitherto insurmountable difficulty in securing and maintaining efficiency in all weathers has also to be carefully considered. In this connection it may be stated that it is not necessary to flood a conduit to bring down the insulation of the cable and so cause leakage, The insulators by which the cable is held in position are composed of either earthenware or porcelain. These in

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themselves, when clean, are perfect insulators—that is to say, there is, practically speaking, no leakage over them, but whenever they become covered with even a slight coating of moisture, the insulation immediately falls and leakage begins. Whilst it is argued that wet weather does not affect the working or impair efficiency, it is generally admitted that it will cause more leakage of current at the insulators. On the other hand, the contact on the conductors is improved. Again, the traffic is likely to be interrupted through the lines being blocked by snow, but it is said by some that a snowstorm will only interrupt the working of the lines if the snow is small and it is freezing. That with the conduit system there is a certain liability to stoppage through the snow is amply proved by the fact that in Budapest the lines have for two entire days been so blocked, and the traffic has had to be carried on by horses.

(To be continued.)

GLOUCESTER AND THE ELECTRIC LIGHT.

COMMITTEE'S RECOMMENDATIONS.

The special committee of the Gloucester City Council, appointed to further enquire into the subject of an electricity supply for the city, has presented their report and recommendations, which have been approved and adopted by the Council. The committee (accompanied by Mr. R. Hammond, the town clerk, and surveyor), visited the electricity works at Cheltenham, Newport (Mon.), Reading, St. Pancras, Islington, Leyton, Tunbridge Wells, Brighton, Shoreditch, St. James, Manchester, and Leeds, and their visits generally confirmed the accuracy of the information contained and the views expressed in Mr. Hammond's report to the Council. As to the wisdom of the Corporation establishing and managing electricity works there appears to be no question; and it appears that corporations which allowed companies to obtain provisional orders and establish works are finding out their mistake—*e.g.*, Liverpool has paid £400,000 for works which cost a company £264,000, Sheffield recently determined to take over works established by a company, and Leeds proposes to acquire a company's undertaking by paying about £200 for each £100 of capital. There appears to be no doubt as to undertakings being profitable if well laid down and properly managed; the only doubt is as to whether a profit will be made in the first, or not until the second or third year. Most of the works visited have high-speed engines and the high-tension system, but St. Pancras has high-speed engines and low-tension continuous current; Newport, Reading, Islington, Leeds, and Manchester have slow-speed engines, the first four with high-tension and the last with low-tension; and Brighton has high-speed engines with a combination of high and low tension. The works at Cheltenham, Newport, Reading, and Tunbridge Wells are smaller, and most like which would be required at Gloucester, but many of the other works have special features worthy of consideration. Those at Reading are well arranged and well kept, and, like the Islington works, have the switchboard, etc., on an upstairs platform open to and overlooking the engine-room. Experience shows that the generating station should be as central as possible. Some have railway sidings into or near to the works, and in several cases the works have been erected near to a river or stream, so as to provide water suitable for the boilers and condensing purposes. These are important points to consider, but with low-tension plant it is most important that the site should be central, because a low-tension supply is only satisfactory within a limited distance, and a station in a central position also saves the cost of long feeding mains, which are very expensive. In some cases, as at Brighton, the difficulty as to distance has been got over by using some high-tension plant for supplying electricity to sub-stations in outlying districts, where it is transformed and made available for supplementing the low-tension current from the main station at the period of maximum load; but it is desirable to avoid the need for sub-stations if possible. Having regard to the size, compactness, and character of the Gloucester district to be supplied, the committee are quite satisfied that it would be best to adopt the low-tension continuous current carried closely to the limit allowed by the Board of Trade, as recommended by Mr. Hammond. The Lancashire and the Babcock and Wilcox tubular boilers are those most generally used; but in some cases, as at Islington, the Lancashire boilers in general use are supplemented by some of the others, in order to provide for the period of maximum load or any exceptional demand in case of fog, etc. Both kinds appear to give satisfaction, but the Babcock boiler is preferred when quick generation of steam is required. There is a great difference, says the committee, of opinion in regard to engines and the relative advantages of high and slow speed, but that is partly due to the fact that individuals get to like the type they are accustomed to use. High-speed engines have often been put down for the simple but sufficient reason that the space available is not sufficient for slow-speed engines. At St. Pancras there are three kinds of high-speed engines—viz., Willans, Belliss, and Peach's—all of which are considered satisfactory; but the Willans engine was most frequently met with, and was generally considered equal, if not superior, to every other. Most of the engines inspected were of recent date, but cases were mentioned in which the Willans high-speed engines had been worked for six and eight years without costing more than about 30s. for repairs. At Brighton the engines and fittings are always taken to pieces and thoroughly overhauled every year, and the committee had an opportunity of examining the bearings of one which had been in use over six years, and found the same in excellent condition. The engineer spoke very strongly in favour of the Willans engine. For lighting purposes high-speed engines appear very satisfactory, but some doubt their suitability for traction or power purposes when the load is subject to great variation, and at Bristol the tramway company have given up using the Willans engine. As to slow-speed engines, some think that rope driving gives an elasticity which is advantageous for the alternating current, though direct driving is quite satisfactory for continuous current. At Reading there are excellent slow-speed direct-driving engines with a special arrangement of the exciters which charge accumulators, the alternating dynamos being excited from the accumulators. The flywheel is combined with the revolving field magnets, and the armature is built up outside. As there should be no difficulty with regard to the size of site at Gloucester, "first cost" and subsequent "cost for maintenance and working" become important items for consideration; and although the slow-speed plant involves a larger first cost, it will be seen from the following table, furnished by Mr. Hammond, that the "costs of working" are very low:

Comparative table of costs of electricity supply at four electricity works upon similar outputs:

	Leeds	Bradford	Bristol	Glasgow
System of feeding—tension	High	Low	High	Low
Type of engines—speed	Slow	High	High	High
	1896	1895	1894	1893
Output in units	701,409	673,699	650,758	702,248
	d.	d.	d.	d.
Coal and other fuel	·29	·56	·76	·59
Oil, waste, and stores	·07	·16	·08	·12
Wages	·38	·52	·53	·66
Repairs and maintenance	·22	·24	·26	1·20
Total works costs	·96	1·48	1·63	2·57
Rents, rates, and taxes	·03	·27	·37	·16
Management expenses	·69	·49	·50	·55
Total costs	1·73	2·24	2·50	3·28
Profit before deducting interest and sinking fund or depreciation	£10,475	£7,461	£7,590	£8,424

In consequence of the question raised as to the suitability of high-speed engines for traction purposes, and the fact that the Bristol tramways gave up using the Willans engines, and having regard to the satisfactory working of the slow-speed engines at Newport, Reading, Islington, Manchester, and Leeds, and the very low "works costs" at Manchester and Leeds, the committee were somewhat inclined to favour the slow-speed engines; but the Bristol Tramways Company appear to have adopted a fairly high-speed engine of American make, and the committee are informed that Belliss's improved high-speed engine is found to be satisfactory for tramway and power purposes, and that a London tramway company has recently arranged to lay six sets of Belliss's high-speed engines for tramway purposes. Moreover, the committee find that the low "works costs" at Leeds are partly due to the very low price paid for coal and other special items. The committee have therefore asked Mr. Hammond to present further information, and advise more definitely upon the question of adopting high or slow speed engines for the Gloucester works. With regard to the capacity of the engines and generating plant, the committee aprove of Mr. Hammond's suggestion that the first equipment should include one small set—say 150 kw.—but that the second and reserve sets should be larger—say 300 or more kilowatts. In one case the committee saw five very small sets, each of which had been added as required, but it is evident that the multiplication of small sets must take up unnecessary space in the engine-room, and involve additional expense, labour, and risk, which may be avoided by carefully providing for the future, as suggested by Mr. Hammond. The experience of other places confirmed Mr. Hammond's recommendation that in laying down a new system it is wise to make a liberal expenditure on mains, and shows that they should be laid down in streets where there is likely to be a demand. At Brighton the cost of putting in the house fittings amounts to about 20s. a lamp, and occupiers of houses find that the saving effected by using electricity instead of gas pays them for incurring this cost after two years, and this induces them to put in their own fittings. The arc lamp undoubtedly offers the best means of lighting the principal streets and other open places, but some incandescent lamps, when fitted in reflectors or special globes, are suitable for lighting narrow streets or for lighting the principal streets after the arc lamps are turned out. The committee think arc lamps about 18ft. high and 70 or 80 yards apart would be satisfactory

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for lighting the main streets of Gloucester. Mr. Wright, of Brighton, advised that the initial charge made in the first instance should be such as to make the undertaking pay during the first year, but a high charge in the first year may cause occupiers to wait for a reduction in price before laying on the electric light, and the committee think it would be wise to adopt a scale of charges which would encourage occupiers to lay on the light at once, and at the same time make sure of a profit in the second or even the third year, if not in the first. Brighton now (after six years) sells 17 units per inhabitant, or nearly 2,000,000 units per annum. In Gloucester that rate would amount to over 700,000 units a year. Among other recommendations the committee suggested, which were approved, was one that all streets in which mains are laid, and which are not lighted with arc lamps, be lighted with incandescent lamps, two 16-c.p. lamps being used for each pillar. The committee also inspected dust destructors at the electricity works visited, and their investigations seem to show that some of the most modern destructors are thoroughly effective for destroying refuse and providing heat for power purposes, and do not cause any nuisance. Mr. Hammond has been instructed to prepare detailed plans, specifications, and estimates for carrying out the work on the lines proposed. The committee are not yet in a position to make any recommendation as to a site for the proposed works, as many points have to be considered, and Mr. Hammond (who is now abroad) will be asked to further advise on this point.

The above report was considered at the special meeting of the Town Council held last Wednesday, and, after an interesting and full discussion, was carried unanimously. The speeches at the meeting showed that the subject was well understood, and that the Gloucester Corporation were willing to profit by the experience gained in other towns. Thus, in opening the meeting, the **Mayor** protested against the way some electricity works have been put up at the least possible cost, and hence require additions almost before they are opened. These towns could not adopt a comprehensive scheme because of the opposition shown, and hence they had incurred additional costs. This fault would be avoided in Gloucester.

Alderman Mousell, the chairman of the Electricity Committee, proposed the adoption of the report, and afterwards referred to the vexed question of free wiring. He said the committee never intended to do the wiring themselves. They made enquiries with regard to free wiring, and were not at all satisfied with the result, and they had quite abandoned any idea of adopting any such plan. The city of Gloucester abounded in tradesmen of considerable merit and energy, and when the work was wanted to be done there would be plenty to do it.

The Deputy Mayor, in seconding the resolution, took up the financial elements, and commended the fact that the Corporation were taking up the matter themselves. In visiting various towns, the committee found that in many places, like Brighton, where the electric light had been laid down, the endeavour was not so much to make a profit as to share all the benefits among those who used the light, but even in doing that they had also said that the electric light should be no burden to the citizens generally, and that the principal and interest having been paid, the profits should go to the users of the electric light. At Brighton they produced the electric light at a cost equal to about 2s. per thousand for gas. As far as Gloucester was concerned, there was a certain amount of responsibility in taking it up on the part of the Corporation, and therefore if any profits were made they should be shared by the ratepayers. They would try to put the cost of the electric light as low as possible, and at the same time, if there were any profits the ratepayers, who had to take the initial risks, should share them. He thought they would be able to put it at such a reasonable price that a large number of the citizens would be able to take it in their private house as well as in the shops, for it was better than gas in every way, was cleaner, and gave a more brilliant light.

COMPANIES' MEETINGS AND REPORTS.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY, LIMITED.

The report for the half-year ended June 30 states that the revenue amounted to £79,133 and the expenses to £20,505. After providing for debenture interest and sinking fund, etc., there remained a balance added to the sum brought forward of £69,221. A quarterly interim dividend, amounting to £19,500, has been paid, and £10,000 transferred to the reserve fund. The directors now recommend a final dividend of 3s. per share, making a total dividend of 6 per cent. for the year, and also the payment of a bonus of 2s. per share, both tax free, leaving a balance of £7,221 to be carried forward.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY, LIMITED.

The report for the half-year ended June 30 states that the gross receipts, including Government subsidies, amounted to £290,749, against £313,914 for the corresponding half-year; the working expenses absorbed £99,425, against £87,256, leaving a balance of £191,323. From this is deducted £4,308 for income tax, £31,895 for interest on debentures, debenture stock, and contribution to sinking fund, and £1,605 for special donations, leaving £153,514 as the net profit for the half-year, which, with £18,798 brought forward, shows an available balance of £172,312. Two quarterly interim dividends of 1¼ per cent. each have been paid for the half-year, leaving £109,812, of which £75,000 has been transferred to the general reserve fund and £34,812 carried forward. The Government of Queensland having decided to join the other Australasian Governments in the guarantee arrangements entered into with the Company, the tariff between Queensland and Europe was reduced on July 1 last from 9s. 5d. to 5s. 1d. per word. From the same date the reductions of tariff announced for China, Japan, the Straits Settlements, etc., were also brought into force.

MANCHESTER CARRIAGE AND TRAMWAYS COMPANY.

The report of the directors of the Manchester Carriage and Tramways Company for the half-year ended August 31 last, to be presented at the meeting to be held in Manchester on the 26th inst., states that the receipts from all sources were £278,866, against £268,610 in the corresponding half-year. The average number of horses was 5,215, and the number of tramway cars 514. It will be noted that both the Corporations of Manchester and Salford have, by Bills promoted during the last session of Parliament, obtained powers (subject to existing leases) to work and use the tramways respectively within the city and borough. The directors opposed these Bills, but in the face of the ruling of the House of Commons' Committee subsequently withdrew their opposition. The Acts, however, do not in any way apply to the tramways outside the city and borough, and no feasible scheme has as yet been suggested for carrying on in the future the tramway service now existing and worked by the Company. The lease of the Salford tramways expires on May 1, 1898, but arrangements are about to be completed for the extension of the lease to April 27, 1901. At the meeting held in October, 1896, the shareholders gave consent to an application for an order for certain tramway extensions. The order has been obtained, and the directors are proceeding with the works. To the net profit of £37,630 must be added £9,267 brought forward, making a disposable sum of £46,897. The directors propose to pay a dividend of 2½ per cent. to the preference shareholders, and of 5 per cent. for the six months to the ordinary shareholders, to set aside £20,000 to the reserve fund, and to carry forward the balance of £6,798.

SUSSMANN ELECTRIC MINERS' LAMP COMPANY.

The report of the directors of the Sussmann Electric Miners' Lamp Company, Limited, for the period ending June 30 last, to be submitted to the first general meeting, to be held at the works, 100-110, Kentish Town-road, on Monday next, states that shortly after commencing business the directors, in view of the many enquiries as to foreign patents, deemed it advisable to extend them to several countries in which they had not been originally taken out, and taking advantage of certain improvements to the battery plates to practically prolong the life of the original patents for a further period of three years. In this connection it may be stated that negotiations for the sale of some of the foreign patent rights have been entered into, notably for Belgium, in which country exhaustive trials have proved the efficiency of the lamp, and where the Ministry of Mines has sanctioned its use. In addition to the miners' lamp, the directors have given much attention to the many other purposes for which the battery has been proved to be particularly applicable—that is, bicycle lamps, for which it is anticipated that there will be a large sale, hand lamps of various kinds for use by the public, policemen, postmen, and others. Experiments are also being carried on for their use in omnibuses and vehicles generally, and samples have been ordered by and supplied to the Indian Government for the purpose of being tested in the powder magazines in Bengal. The difficulties not uncommonly incidental to a new manufacture have presented themselves to the directors, who regret that the actual progress made is not equal to expectation, and that they are not able to announce a dividend. In order to give the shareholders an opportunity of inspecting the various descriptions of lamps in hand, they have arranged for the meeting to be held at the works.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Guadix (Spain).—The Corporation invite tenders for an electric light installation to supply the town. Address the Syndico, Guadix, province of Grenada, Spain. Tenders by October 25.

Santona (Spain).—The Corporation invite tenders for an electric light installation to supply the town. Address the Syndico of the above town, Spain. Tenders by October 29.

Real Sitio de Ildefonso (Spain).—The Corporation invite tenders for lighting the town by electricity. Address the Syndico of the above town, province of Segovia, Spain. Tenders by October 21.

Azuaga (Spain).—Tenders are required by November 3 for the lighting of the town; the system to consist of 250 lamps of 10 c.p. The estimate amounts to £264 per annum. Address the Syndico of the above town, Spain.

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Russia.—The Municipal Authorities of Novorossisk, South Russia, are inviting tenders for the concession for the construction and working of an electric tramway, and for the electric lighting of the town. Tenders by November 1.

Burnley.—The Corporation require tenders for the supply and delivery at their electric lighting station of lead-sheathed, armoured underground cables, particulars of which appear in our advertisement columns. Tenders by November 17.

Ploesti (Roumania).—Tenders are invited for lease of lighting the town by electricity for a period of 40 years, also for power transmission purposes. Particulars may be obtained on application to the Municipal Authorities at Ploesti. Tenders by Nov. 27.

Paris.—A public adjudication of tenders will take place at the Tribunal of Commerce, Paris, for the installation of electric light into the barracks of the fire brigade now being constructed in the rue Jean Saques Rousseau. The estimate is £549. 14s. 2d. Tenders are to be sent in by October 23.

St. Pancras.—The Vestry of St. Pancras are inviting tenders for supplying and fixing additional plant at the Regent's Park electricity works, comprising dynamos, engines, and switchboards, for full information of which we refer readers to our advertising columns. Tenders are to be sent in by 12 noon on November 2.

Sheffield Prize Competition.—The Tramways Committee of the City Council of Sheffield invite designs for centre standards and side posts for use in connection with their proposed electric tramways and offer a prize of £10. 10s. for the design which, in their opinion, is the best submitted. Particulars as to dimensions can be obtained at the City Surveyor's Office, Town Hall, and designs must be deposited with the City Surveyor, endorsed "Designs for Tramway Standards," not later than the 30th inst.

Melbourne (Victoria).—The Agent-General for Victoria, 15, Victoria-street, Westminster, invites tenders for the supply of electric light cables and fittings, for the Railway Department of the Colony. The specifications and conditions of contract can be obtained at above address, where tenders must be delivered by November 10, addressed to the Victorian Railways Commissioner, accompanied by a preliminary deposit of £20 enclosed in a separate envelope addressed to the Agent-General. The tenders will be opened at Melbourne on December 20.

Singapore.—The Municipal Commissioners of the town of Singapore, Straits Settlement, invite proposals for the lighting of the public street lamps for five years from January 1, 1899. Tenderers may submit proposals for lighting by gas or oil, or partly with one illuminant and partly with the other. Further particulars may be obtained on application to Mr. C C. Lindsay, M.I.C.E, 167, St. Vincent-street, Glasgow, or to Mr. J. Polglase, secretary to the Municipal Commissioners of Singapore, Singapore. Tenders may be sent either to Mr. Lindsay, up to November 30 next, or to the Secretary up to December 31.

Queensland (Australia).—The Municipal Council of Ipswich, Queensland, is inviting tenders for the supply and erection of the following electric lighting plant, etc.: tubular boilers, pipes, pumps and heaters, alternators and exciters, switchboard, high and low tension mains, junction boxes, transformers, etc. Specifications and all particulars as to conditions, etc., may be obtained from Messrs. Gordon and Gotch, St. Bride-street, Ludgate-circus, London, E C., and tenders have to be forwarded to the town clerk (Mr. Albion Hayne), Council Chambers, Ipswich, Queensland. Tenders by November 15.

Harrogate.—The Corporation are inviting tenders for the supply and erection of the following plant at their electricity works: (Section A) Lancashire boiler, fittings, and accessories; (B) vertical compound condensing engine, steam pipes, and accessories; (C) 300-kw. flywheel alternator, exciter, and accessories. Persons are at liberty to tender for any section or sections, but not for part of a section. Specifications may be obtained on application at the Electrical Engineer's Office, Montpellier-gardens, Harrogate, on payment of £2. 2s., which sum will be returned on receipt of a bona fide tender. Tenders, sealed and marked "Tender for Electric Lighting," must be addressed to the Town Clerk, Municipal Offices, Harrogate, and be delivered by 12 noon on 25th inst. Mr. Geo. Wilkinson, M.I E.E., borough electrical engineer.

London, E.C.—The Shoreditch Vestry invite tenders for the supply and erection of additional engines and high tension continuous-current generators, with an extension of the existing switchboard. Specifications and forms of tender can be obtained at the offices of the engineers, Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, on payment of a fee of £5. 5s., which sum will be returned on the receipt of a bona fide tender. The contractor whose tender is accepted will be required to enter into a formal agreement, under seal, with sufficient sureties, for the fulfilment of contract. Trade union rates of wages and hours to be observed. Sealed tenders, endorsed "Electricity Supply, Tender for Contract No. 10," to be sent at or before noon on November 2 to Mr. H. Mansfield Robinson, vestry clerk, Town Hall Old street, E.C.

Hull.—The Corporation are advertising for tenders for the electrical equipment of their tramways, to the extent of about nine miles double track and half mile single track. It will be open to contractors to submit tenders for various systems, and the contract, which will not be divided, will include engines and generators, switchboards, feeders, poles, brackets, trolley wire, rail bonding, and all accessories, also the first instalment of cars (15 motorcars and five trailers). It is expected that the specification, lithographed plans of the routes, and other particulars will be ready for issue early in September, and copies, when ready, may be obtained from Mr. A. E. White, city engineer, Town Hall, Hull, by persons proposing to tender, upon payment of a deposit of £10, which will be refunded upon receipt of a bona fide tender and return of the papers and plans supplied. Cheques to be made payable to Mr. Thos. G. Milner, city treasurer. Tenders, endorsed "Tender for Tramway Equipment," are to be addressed to the Chairman of the Works Committee, and delivered at the Town Clerk's Office, Hull, before noon on November 5.

Madras.—Tenders are invited for the utilisation of water flowing from the Periyár Lake for purposes other than irrigation and not incompatible with the use of the water for drinking. The irrigating season extends over nine to ten months, during which time the discharge is likely to be from 1,100 to about 500 cubic feet a second, according to the demands for irrigation and the available quantity in the lake. Subject to the risk of interruption by accident or drought, supply can be given throughout the irrigation season. No supply can be guaranteed at other times, but, so long as water is available, the Government will be prepared to issue it in such daily quantities as may seem to it advisable with reference to the time which is likely to elapse before the supply is replenished by the setting in of the rains. The fall from the tunnel to the foot of the hills is approximately 900ft., and the distance measured along the course of the stream about 6,800ft. One cubic foot per second falling 900ft. is estimated to produce over 60 effective horse-power. Intending lessees should state the quantity of water required in cubic feet per second and the annual rent offered for each cubic foot per second. No rent will be charged for the first year from the date of the concession; for the second year the charge will be one-fifth, and an additional charge of one-fifth will be made every year until the full rent is reached. The whole or part of the concession may be surrendered on a year's notice being given. Lessees will construct at their own expense, on plans to be approved by Government, all the weirs and other works required to divert the water from the river below the tunnel. For further information, application may be made to the Chief Engineer for Irrigation, Madras, by whom tenders will be received up to July 1, 1898.

RESULTS OF TENDERS.

Heywood.—The Town Council have accepted the tender of Messrs. W. A. Shaw and Co. for the provision of electric light during the alterations to the higher reservoir.

Liverpool.—The City Council have accepted the tender of Willans and Robinson for the supply and delivery of five sets of steam dynamos, at £1,749 per set. The Council have also accepted the tender of Tetlow Bros. for the supply and delivery of three steel Lancashire boilers, at £1,530.

Carlisle.—The following tenders have been accepted by the Corporation for works, etc., in connection with their electric lighting station in Carlisle:

Oldham Boiler Works Company, Limited, Oldham, boilers	£1,600
Siemens Bros. and Co., Limited, London (Willans engines), engines and dynamos	8,391
Chloride Electric Storage Company, Manchester, storage batteries	680
Electric Construction Company, Limited, Wolverhampton, switchboard and motor-dynamos	1,318
Crompton and Co., Limited, London, arc lamps	203
Callender's Cable and Construction Company, Limited, London, mains	3,767

BUSINESS NOTES.

Watford.—The Council have decided to apply for sanction to borrow about £20,000 for carrying out an electricity supply scheme.

Brierfield.—The Council have agreed to a resolution that the Electric Lighting Act be adopted, but that the area be defined afterwards.

Dover Tramways.—Since the opening of the line—that is to say, during the last six weeks—200,000 persons have been carried at the rate of 1d. each.

Dingwall.—The Town Council have now approved of a scheme for the electric lighting of the burgh, which will be done conjointly with Strathpeffer.

Ludlow.—A special committee of the Town Council has under consideration several suggested schemes in connection with the proposed electric lighting.

Ilford.—The Urban District Council are taking steps to obtain from the Board of Trade a provisional order under the Electric Lighting Acts, 1882 and 1888.

West India and Panama Telegraph Company.—For the half-month ended October 15 the receipts were £1,691, as against £1,913 for the corresponding period of 1896.

Lowestoft.—We believe that Mr. Hawtayne has just presented his report upon the electric lighting to the Town Council, and that the same is now under consideration.

Blackpool.—The system of electric light charges was severely criticised at the last meeting of the Tradesmen's Association. The same will be fully discussed at the next meeting.

Photographic Exhibition.—The Eastman Photographic Exhibition will open at the New Gallery, Regent-street, on the 27th inst. The exhibition will remain open until November 16.

St. Andrews.—The Town Council have, after a lengthy discussion referring to the telephone poles, ultimately agreed to request the Government to place the wires underground.

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Institution of Junior Engineers.—The members of this institution will on Saturday, October 30, at 3 p.m., visit the Queen's-road station of the Central London Railway works.

St. James's and Pall Mall Electric Light Company.—The sale of electricity for the quarter ended September 29 amounted to £11,693, as against £10,084 for the corresponding period of 1896

Civil Service Commission.—An examination will be held shortly for a clerkship in the operative department of the Royal Mint, for further particulars of which we refer to our advertising columns.

Callender's Cable and Construction Company, Limited.—The directors of this Company have declared an interim dividend of 4s. per share, being at the rate of 8 per cent. per annum, payable on November 1.

Long Eaton.—Notice of motion has been given at the District Council to consider the question of putting down electric lighting plant for lighting the streets, and to supply the same to manufacturers and others.

Godalming.—The fight on the electric light question was fought out at the last meeting of the Town Council, and resulted in a victory for the supporters of the new form of lighting by a somewhat small majority.

Western and Brazilian Telegraph Company.—The receipts for the week ending October 15, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, amounted to £2,720.

Ostend.—The electrical coast tram is now running double lines, which allows of departure every three minutes. The tram is to continue running until November 1, and next season the line will be continued as far as Nieuport.

Blackburn.—A report issued by the town clerk of Blackburn shows, amongst the public works to be undertaken for that town, as necessity arises, tramway purchase and conversion to electricity, £100,000, and refuse destructors, £15,000.

Larne.—At an adjourned special meeting of the Larne Town Commissioners, a committee was nominated to confer upon the matter, with power to employ an expert to assist them in making arrangements for a provisional lighting order.

Oriental Telephone and Electric Company, Limited.—The directors have declared an interim dividend of 4d. per share, free of income tax, payable to those shareholders whose names are on the register at this date. The warrants will be posted 30th inst.

Eastern Telegraph Company.—This Company announces the payment by warrants on 1st prox. of interest for the half-year ended 31st inst. on its 4 per cent. mortgage debenture stock. The transfer-books will be closed from 26th inst. to 1st prox., both days inclusive.

Change of Address.—Mr. Appelbee, electrical engineer of the Corporation of Cardiff, writes to say that as the offices of his department are now at the works, Eldon-road, Canton, Cardiff, all letters, etc, should in future be addressed there instead of to the town hall.

Edinburgh.—We are informed that the electric light in Edinburgh is so rapidly becoming popular that the Town Council have requested Prof. Kennedy, the city's chief electrical engineer, to prepare a report upon a proposed new electric lighting station at the east end.

Lewes.—The Town Council have agreed to apply for a provisional order to supply electricity under the Electric Lighting Acts, 1882 and 1888, for public or private purposes within the area of the district of the borough of Lewes, or of some part or parts thereof.

Cork.—The city engineer has received official notice from Mr. W. H. Briggs, secretary Cork Electric Tramways and Lighting Company, Limited, that the contractor proposes to commence work at once at the bottom of Summer-hill, proceeding in a north-easterly direction.

Liverpool.—The electric light, which has been substituted for gas in St. John's Market, was recently turned on for the first time. "The light in the centre of the various avenues," says the *Liverpool Daily Post*, "was a decided improvement on the old system of gas-lighting."

Ambleside.—A meeting of the Electric Lighting Committee has been held to consider a proposal made by Messrs. Fell and Son, Troutbeck Bridge, to introduce the electric light into Ambleside, but upon the recommendation of the committee, the matter was deferred by the Council.

Eastern and South African Telegraph Company.—This Company announces the payment by warrants on 1st prox. of interest on the 4 per cent. Mauritius subsidy debentures for six months to 31st inst. The transfer-books will be closed from 26th inst. to 1st prox., both days inclusive.

Middleton.—At last week's meeting of the Town Council, the Chairman of the Gas Committee said that having procured the necessary powers, the committee was now about to proceed with the laying down of plant, and that the borough would be supplied in a short time with the electric light.

Wolverhampton.—At the last monthly meeting of the Wolverhampton Town Council it was resolved: "That the system of charging for electrical energy recommended in the report of the Lighting Committee to the Council, dated September 8, 1897, adopted by the Council on September 13, 1897, take effect from June 25, 1897, and that recommendation No. 1 in such report be varied accordingly."

Paisley.—The engineer, Mr. Francis Teague, states that the price to be charged for current has been fixed at 7d. and 3d. per B.O.T. unit on the Brighton system. Wright's rebate indicator will be used, the 7d. rate to apply to the first hour daily at maximum demand. The total expenditure of the works will be about £38,000.

Croydon.—An exchange says: "There is to be an extension of the public lighting by electricity already, additional arc lamps being placed in High-street and Park-lane as far as Coombe-street. This will be an alteration for the better, and especially will the increase of light be appreciated in Park-lane, which always seems to have been the rendezvous of loose characters."

Breakdown.—The Leeds electric tram service had to be suspended on the 18th inst. in consequence of an accident at the generating station at Crown Point. At noon the spindle of the high-pressure shaft of one of the two engines broke, and the second engine was brought into use. But at two o'clock a similar accident befell it, and the cars had to be taken to the depôt.

Bromley.—At the last meeting of the Council the following notice appeared on the agenda: "That with the view of reducing as much as possible any danger to the public health from the accumulation of house and other refuse collected in the district, the Council do without delay arrange for its destruction by heat." The debate upon the matter was adjourned for one month.

Burnley.—At the last meeting of the General Purposes Committee of the Corporation a proposal was approved for going to Parliament for powers to purchase and work the Burnley and district tramways. Sanction was also given by the committee for application for additional powers in regard to electric lighting, the markets, and certain public improvements in the same Bill.

Chatham.—The scheme, referred to in our last issue, to supply a system of electrical railways for Chatham, Rochester, and Gillingham has now obtained a promise of support from the authorities of the districts immediately concerned. The Corporations will support the application of the promoters to the Light Railway Commissioners and help it along when it comes up in Parliament.

Elland.—The members of the District Council are still prosecuting enquiries with a view to the adoption of the electric light for public lighting purposes at Elland. At a meeting of the General Purposes Committee, held on Monday evening, it was decided that a deputation should visit Bradford, Brighouse, Huddersfield, and Halifax to see how electric lighting was carried out at these towns.

Herculite.—We have received from Bell's Asbestos Company, Southwark, a sample of packing called Herculite, which they claim to be the most efficient material for making either steam or water joints. The sample in question is too small to test practically, but appears to have all the essential qualities for its purpose. Asbestos enters largely into its composition, and it does not require any preparation before use.

Crewe.—A meeting of the General Purposes Committee of the Town Council was held on the 15th inst. to consider the proposal for an electric light installation. After some discussion, it was resolved to recommend the Council to apply to Parliament for a provisional order to carry out an electric light scheme. If the Corporation do not keep this in their own hands, a speculative company will probably apply for sanction.

Darlington.—A circular has been sent out to the ratepayers, on the instruction of the Gasworks Committee, by Mr. Thos. Smith, engineer and borough surveyor, asking them to forward answers to the following questions: (1) Are you in favour of the Corporation establishing an electric lighting station in the immediate future? (2) In the event of such being done, is it your intention to become a user of electricity if the price and other conditions are satisfactory to you?

Hartlepool.—Messrs. Thomas Richardson and Sons, Limited, who are working in conjunction with Messrs. Brown, Boveri, and Co., the well-known electrical power engineers of Baden, have appointed Messrs. Geipel and Lange, of 68, Victoria-street, Westminster, as their London representatives. Messrs. Richardsons' installation at Hartlepool is creating great interest in industrial circles, and we understand the firm has already booked some orders for polyphase electric machinery.

Gloucester.—The City Council have decided to adopt the recommendation of a sub-committee for the erection by the Corporation of electricity and a dust destructor. The low-tension system will be adopted, and the works will cost something between £30,000 and £40,000; while the ash destructor, which will be erected in connection, will cost about £6,000. Mr. Hammond, M.I.C.E., has been instructed to draw up plans, and it is intended to commence and carry out the work as soon as possible.

London Lighting Extensions.—The London County Council have sanctioned, subject to the usual conditions, the laying of various mains by the Vestries of St. Pancras and Hampstead, and by the following companies: the Metropolitan Electric Supply Company, the Kensington and Knightsbridge Electric Lighting Company, the House-to-House Light Supply Company, the London Electric Supply Corporation, the Westminster Electric Supply Corporation, and the South London Electric Supply Corporation.

Dudley.—The Public Works and General Purposes Committee's report, that the purchase of the land and buildings in Vicar-street had been carried out, and recommending that the borough surveyor complete the necessary work of taking down and rebuilding the wall, has been adopted by the Council. It was stated with regard to the position of the negotiations with the electric lighting company in connection with the tramways, that the committee hoped soon to bring the negotiations to a speedy and satisfactory conclusion.

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Govan.—The Clerk read a letter at the last monthly meeting of the Town Commissioners from the Imperial Electric Company, offering, for the transfer to them of the Board's provisional order, to pay all costs incurred in obtaining it, to supply mains for electric light throughout the burgh, to charge 4d. per Board of Trade unit (including carbons) for lighting purposes, and 4d. per motor supply, thus placing the electric light within the reach of the majority of the ratepayers. The matter was remitted to Mr. Wightman and the Watching and Lighting Committee.

Electric Patents.—Mr. Justice Ridley has heard a motion in the Vacation Court on behalf of the Holophane Company, to restrain Messrs. Oscar Berend and Co., electrical engineers, Basinghall-street, London, with agencies at Manchester, Birmingham, and other large provincial towns, from infringing their patent for glass globes for electric lights. The defendants denied the infringement, and undertook to keep an account of all the alleged infringing globes. Upon this undertaking the motion stood over till the second motion day of the next sittings.

Leeds.—Mr. W. Wharam, electrical engineer, of Claypit-lane, Leeds, who recently obtained the contract from the Corporation to supply 40 electric lamps of the nominal illuminating power of 2,000 candles each for the lighting of Briggate and Boar-lane, appeared on the 18th inst. before the Lamp Committee, and reported that he could not get the whole of the lamps specified in the time stated in the contract. He had only be able to procure a dozen, and these would be used at once for the lighting of Boar-lane. The others Mr. Wharam hopes to obtain within a month.

Coseley.—An adjourned special meeting of the District Council has been held to further consider the advisability of applying to the Board of Trade for a provisional order empowering the Council to supply electricity for lighting and other purposes in the district. It was proposed that the matter be not entertained, because it would not pay at Coseley. In the course of the discussion it was stated that the scheme would necessitate an outlay of £10 000 or £12,000, with the additional cost of £1,000 annually for maintenance expenses. The motion was tarried by six votes to three.

Scarborough.—The Freemasons of Scarborough have, in commemoration of the Diamond Jubilee, presented to the Scarborough Hospital and Dispensary a complete installation of electric light. On the 12th inst. a large and representative gathering of the fraternity assembled at the Longwestgate Institution to formally make this gift to the Board of Management. Messrs. Walker and Hutton, of Scarborough, were entrusted with the work, the estimate for which was £130. Over 100 lights have been fixed in various parts of the building, and provision has been made in the wards for the use of electro-surgical instruments if required.

Bournemouth.—The Town Council on the 20th inst. considered the scheme of three companies seeking to construct tramways throughout the town and suburbs, proposing also to connect the neighbouring towns of Poole and Christchurch. The Council decided almost unanimously to inform the promoters that the Council would not recognise any but an electric system, and that in all probability if any scheme was adopted the Corporation would carry out the work themselves. It was urged that if there was any financial or other benefit to be gained by tramways, the ratepayers, and not outside speculators, should be the gainers.

Burnley.—At a meeting of the Town Council on the 20th inst. it was decided to promote a Bill in Parliament next session to confer further powers upon the Corporation to enable them to municipalise the tramways, to extend the electric lighting works, and give them additional powers with respect to other undertakings. An amendment was carried that provision be also sought to enable the Corporation to compound the rates with a discount of 10 per cent. On the recommendation of the Electric Lighting Committee plans were approved of an extension to the electric lighting station. It is proposed to increase the engine capacity from 500 h.p. to 3,500 h.p.

Chester.—At the monthly meeting of the Council held on the 20th inst. it was resolved that a further sum of £10,000 be placed at the bank, in respect of electric lighting, with authority to pay Prof. Kennedy's certificates to the contractors. The Mayor said that during the past three quarters a sum of £2,300 had accrued from the sale of the light, and that sum was exclusive of the street-lighting. The installation of the light was the greatest possible success. The minutes of the Parliamentary Committee were adopted, and the committee were authorised to secure all the information necessary from the local authorities in support of the Corporation's case of extension.

Colwyn Bay.—At the last monthly meeting of the District Council it was proposed "that a deputation be appointed to approach the owners of the land adjoining Groes site in reference to purchase by agreement land that may be required for the erection of electricity works at that site, otherwise the Council direct the necessary steps be taken under the Lands Clauses Acts." The mover referred to a remark made at the last meeting, when they appointed an electrical engineer, that this land was not extensive enough to erect these works upon, and he thought it was time for them to move in the matter. But as no member seconded the resolution, the matter dropped.

Brechin.—A meeting of the Brechin Police Commissioners has been held to consider as to whether a provisional order should be applied for to enable the town to complete their agreement with Messrs. Edmundsons, Limited, electric lighting contractors. It will be remembered that some time ago a deputation visited several places to investigate the working of the electric light, and on their reporting favourably the Council decided to take legal steps to admit of Messrs. Edmundsons laying down plant, etc., to supply the community with electricity for lighting and motive purposes. After considerable discussion, the clerk was authorised to forward the necessary forms to the Board of Trade.

Stoke.—At the last monthly meeting of the Town Council the town clerk was instructed to call the Electric Traction Company's attention to their failure to commence the extension to Hanford Bridge, and to request them to proceed with it. Attention was called to the fact that the tramway company were using setts 4in. by 4in. instead of 5in. by 5in., and the dangerous state of the extensions, by which frequent accidents were caused, was complained of. The Parliamentary Committee recommended, with respect to the proposed application for a provisional order under the Electric Lighting Acts, that steps for the obtaining of such provisional order next session should be taken. This was agreed to.

Gravesend.—From correspondence which has passed between the town clerk and Mr. Reeves, the secretary both of Messrs. Crompton and Co., Limited, and the Electric Supply Association, Limited, it appears that the town clerk insisted that the first-mentioned company should enter into a preliminary agreement that proper steps should be taken to enable the last-mentioned company to supply electricity to Gravesend, and that the Corporation are to be relieved from all costs, and this has been approved of. The committee's recommendation that the provisional order should be taken in the name of the Town Council, by and at the cost of the promoters, has been agreed to by the Town Council.

Sheffield.—With the municipalisation of the tramways and the expressed intention of the Corporation to extend the system to all parts of the city, the inhabitants of some districts have been urging that their section should be taken first. The people of Walkley have been most persistent in their efforts in this direction, and the interest in the question was evidenced by the large attendance at the meeting held on the 18th inst. to push forward Walkley's claims. The following resolution was carried: "That this public meeting of the residents of Nether Hallam Ward is of opinion that Walkley and adjacent districts, with a population of upwards of 30,000, have a prior claim for consideration at the hands of the Tramways Committee."

City of Birmingham Tramways Company.—The following circular has been issued to the shareholders: "153, Corporation-street, Birmingham, October 15, 1897. I have to inform you that your directors have decided to alter the termination of the Company's financial year from October 15 to December 31. As the earnings of the Company justify them in paying a second interim dividend at the rate of 5 per cent. per annum on the preference shares, and at the same rate on the ordinary shares of the Company, for the half-year ending October 15, a dividend warrant for your shares is herein enclosed. In consequence of this alteration of the Company's financial year to December 31 next, the accounts for the 14½ months will hereafter be presented to the shareholders in due course."

Beckenham.—At the last meeting of the Urban District Council the report of the Electric Lighting Committee was adopted. This stated that a meeting had been held to consider what steps should be taken to carry into effect the powers conferred upon the District Council by the Beckenham Electric Lighting Order, 1893. The recommendation of the Works Committee that this subject should be considered in connection with the provision of a house refuse destructor, and that both subjects be referred to a committee consisting of Messrs. Lees, C. E. Baker, Borrowman, Lendon, Lovelock, Randell, Rippengal, and Gurney Smith, with instructions to visit other districts and inspect similar works in operation, reporting thereon to the Council, was submitted. The committee concur in that recommendation.

Waterloo.—A special meeting of the Waterloo and Seaforth Urban District Council has been held in order to take into consideration the question of having tramways in the district, and to take the necessary steps with a view to obtaining the powers to carry out the work. A conference has been held recently with the representatives of the Great Crosby District Council. That body has passed a resolution in favour of applying for powers to construct tramways in their district. The Council adopted a resolution to the effect that an application be made to the Board of Trade for such a provisional order as that described, and that the solicitor be instructed to take the necessary steps in connection therewith. A further resolution was carried appointing Mr. Boulnois consulting engineer and Mr. H. F. Russell as assistant.

Bolton.—A special meeting of the Town Council will be held on the 27th inst. for the purpose of determining whether, in the judgment of the Council, it is expedient to promote in the next session of Parliament a Bill to alter and extend the boundaries of the municipal borough of Bolton, and also the boundaries of the urban districts of Turton and Westhoughton. At the same meeting a resolution will be submitted authorising an application to be made for an electric lighting order for power to supply the townships of Heaton, Lostock, Deane, Middle and Over Hulton, Great Lever and Darcy Lever, Breightmet, Tonge, Astley Bridge, and Smithills with electric light. A public meeting of the ratepayers to sanction or reject the application to Parliament for a Bill to extend the borough boundaries will be held the same day at noon.

Coatbridge and Airdrie.—A meeting of the joint committees of Coatbridge and Airdrie Town Councils as to the proposed tramways running through both burghs was held on the 18th inst., when a written offer was sent in by the New General Traction Company for the laying of the tramway on the electric trolley overhead system. The offer was in general terms, and the company proposed to undertake the work on a concession by the burghs of 15, 25, or 35 years. The company are to do the whole

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of the financing. On behalf of Coatbridge Committee it was stated that the matter had not yet been properly before the Town Council, and that they would require to report to that body. It was accordingly arranged that the two committees consider the matter independently, and then have a joint meeting to prepare a report to be submitted to the respective Town Councils.

Aberdeen.—At a meeting of the Gas and Electric Lighting Committee of Aberdeen Town Council on the 19th inst. a discussion took place as to applying to the Secretary of Scotland for powers to borrow an additional sum of £10,000 for the carrying on of the undertaking. It was reported that £42,000 had already been expended on the electric station in Cotton-street. Further extensions of the system are in contemplation, and some of the accounts already incurred are not yet paid. It was decided to make the application. The committee also considered the question of procuring a 600-h.p. engine—the largest yet obtained—in view of the increasing demand for current. It was decided to defer final consideration of the matter until the new committee had been elected. It was pointed out, however, that the order would have to be placed as early as possible, because in all likelihood the engine would not be ready before next autumn.

St. Annes.—At the monthly meeting of the Council the resolution referred to in our last issue—viz, that the electric light be adopted in the district—was moved. The mover stated that the Council had endeavoured to meet the gas company as fairly as possible, although in the subsequent struggle in Parliament they were unsuccessful. Very shortly after that had taken place they were served with a notice from a private company to the effect that it was intended to make application during the next parliamentary session for a provisional order for the electric lighting of the district. Thus the Council's hands were forced, and they ought to have the first look-in. The Clerk said the resolution, as framed, was improper, as, according to the Electric Lighting Act, one month's notice must be given to the Council of the intention to bring forward a motion of that nature. Thereupon the Clerk amended the motion to be brought up again at the next meeting.

Ealing.—The first ordinary meeting of the District Council after the vacation was held last week. The Electric Lighting Committee reported that during the vacation several large orders for electric light had come in, and there were now 12,694 lights on the books, 11,918 being actually connected. It was three years ago this month that the works were opened. Then 5,000 private lamps were provided for, and it was thought that would meet the demand for three years. The committee thought it worth while to point out that the actual number at present in use was twice the number originally estimated and provided for. The committee recommended that an economiser for use in connection with the boiler at the electric lighting station should be purchased at a cost of £700. In reply to Mr. Griffin, the Surveyor said it was estimated that the use of the economiser would result in a saving of at least £300 a year on the coal bill. The recommendation of the committee was adopted.

Manchester.—For some months past a movement has been on foot to establish a mutual telephone service in Manchester and suburbs in opposition to the National Telephone system, which has been generally reported as unsatisfactory. A syndicate has been formed with the avowed object, not of making money, but simply to found a sort of self-paying telephone. At a meeting last week it was unanimously resolved to support the mutual scheme, which needs a capital of £60,000. Of this it is said £20,000 is already secured, and 2,000 persons have expressed their willingness to join the movement.—A special committee of the Manchester City Council appointed to consider the municipalisation of the tramways in the city, have recommended to the Council that the Corporation should themselves work the tramways at the expiration of the existing lease to the Manchester Carriage and Tramways Company in 1901. They further expressed the opinion that the best system of traction to be adopted is the overhead electric.

Montrose.—A special meeting of the Montrose Town Council has been held for the purpose of considering, and, if deemed advisable, of passing a resolution to the effect that the Town Council, as the local authority of the burgh, do apply to the Board of Trade, under the provisions of the Electric Lighting Acts, for a provisional order authorising them to supply electricity for any public or private purpose within the area of the burgh, to be confirmed by Parliament in the ensuing session, and that the town clerk do take the necessary steps to carry this resolution into effect. The Chairman said that the meeting was more of a formal nature than for the discussion of business, seeing that they went fully into the matter at their last meeting. That was a statutory meeting, and he would now therefore, without further remark, move that the Council agree to apply to the Board of Trade in terms of the notice calling the meeting. In reply to a question, the Chairman stated that the order would cost somewhere about £200, and that the town would incur no expense in connection with the scheme, as the Messrs. Edmundsons' would reimburse any outlay. The resolution was adopted.

Bath.—A long discussion ensued on the proposition at the last Council meeting that the minutes of the Electric Lighting Committee be adopted. The committee, it was said, had met with difficulties not anticipated, but they were not insurmountable. An appointment made by Mr. Hammond, the engineer appointed to carry out alterations, etc., of a Mr. Collins as clerk of works was objected to, and it was proposed as an amendment that this be not confirmed, and that Mr. Metzger should undertake the duties. This was seconded and carried, 15 voting for and 13 against. A second amendment to the effect that the Electric Lighting Committee should bring up a detailed report at an early date of their proceedings, past and present, including financial matters, was carried. A third amendment instructed the committee to consider the advisability of making such an arrangement as would allow of the work being placed under the control of Mr. Metzger, the Council's own electrical engineer. This amendment was also carried, consideration of other matters being adjourned.—Mr. Gatehouse, in his report upon the electric light to the Surveying Committee, said it appeared that the old machines were now only just able to carry on the work during the longer hours of lighting.

Ossett.—The special meeting of the Ossett Town Council referred to in our issue of the 24th ult. was held last week. The following resolution was carried: "That the town clerk be and is hereby empowered to make application to the Board of Trade for an order or license authorising the local authority for this borough to supply electricity for public and private purposes, and to take all the necessary steps for carrying out this resolution." The Mayor expressed the opinion that they would be able to profit by the experience of other bodies, and the expense of carrying out an electric lighting scheme now would not be as great as it would have been a few years ago. He hoped they were not taking this matter up, as some people supposed, to cause a little talk, but that they would carry the scheme out within a reasonable time. If they fixed upon certain streets to be lighted at first, they would be able to extend the scheme without having to make another application. It had been said that it would be necessary to have three plants to light the town, but he had been informed by experts that one central plant would be sufficient. They would either have to take the question up or be pushed into a corner. After the meeting the Council in committee considered how best to proceed with the matter.

Walsall.—At the last monthly meeting of the Town Council the following report of the Electric Lighting Committee was adopted: "The total number of consumers supplied on September 30 last was 87. The machinery has been run for 160 hours during the past month. The wages paid during the month amount to £45. 15s. The value of the coal consumed was £32. 15s. The committee have recommended the payment of accounts amounting to £203. 1s. 7d. The committee have determined that for the purpose of calculating the period of two years, at the expiration of which a consumer is entitled to a return of his deposit, the time during which such consumer has been using the Corporation gas be included. The engineer has been instructed to prepare a plan showing the position of the electric mains in the streets, and to furnish a copy to the borough surveyor, so that the latter may give, where practicable, 24 hours' notice to the electric lighting department of his intention to break up any street or footway in which an electric main is likely to be interfered with. The committee are of opinion that the cost incurred in repairing electrical mains which have been damaged by workmen employed in the Streets Committee's department should be borne by that committee, and the electrical engineer has been instructed to send a claim to the borough surveyor in all such cases."

Ramsgate.—The following letter has been received by those who took part in the enquiry held in May last on the subject of the proposed Isle of Thanet light railway, from the secretary to the Commission: "Light Railway Commission, 23, Great George-street, London, S.W., October 9, 1897. Sir,—With reference to the application made by the Isle of Thanet Light Railway (Electric) Company, Limited, to the Light Railway Commissioners for an order to authorise the proposed Isle of Thanet light railway, I am directed by the Commissioners to inform you that they are prepared to recommend to the Board of Trade an order for the construction of a line from Ramsgate through Broadstairs to Margate. The Commissioners, however, are not prepared to recommend that compulsory powers should be granted for the widening of Pegwell-road to 40ft., as stipulated for by the Corporation of Ramsgate. The Commissioners, therefore, will not be prepared to sanction the line through Ramsgate further westward than to a point about two chains westward of the junction between line No. 3 and line No 2. With reference to line No. 12 and line No. 13 in Margate, I am to add that, owing to the narrowness of the streets through which these lines would run, it is necessary that they should first be inspected by the Commissioners before any decision can be come to regarding them.—I am, Sir, your obedient servant, BRET INCE."

Ashton.—The Ashton Town Council met on the 20th inst., and adopted the report of the Electric Lighting Committee. The report stated that they had received the formal approval of the Board of Trade of the system adopted for the supply of electrical energy both for lighting and traction purposes, also the formal approval of the Board of Trade, given with the concurrence of the Postmaster-General of the connection by the undertakers of certain parts of their electrical circuits with earth; and also the formal sanction of the Local Government Board to the borrowing of the sum of £1,750 for the provision of a refuse destructor, to be repaid with interest within 20 years. The question of laying cable in and along the Market-avenue, for the supply of electric light to the shops therein in the event of the tenants desiring to be supplied, was considered, and the committee being of opinion that the work should be proceeded with in conjunction with the work now in operation, it was resolved that the tender of the British Insulated Wire Company for providing and laying the said cable, also providing casing and boxes, etc., and doing all work in connection therewith in accordance with the specification of the engineers, be accepted. It is anticipated that the laying of the whole of the wires will be completed in a few weeks. The progress of the buildings has also been satisfactory, but the erection of the engines and dynamos has been much delayed by the engineers' strike. It might be practically considered that the whole of the time occupied

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by that strike would be entirely lost, and the opening of the works delayed for that period.

Maidenhead.—A special meeting of the Town Council was held on the 18th inst. for the purpose of considering a resolution as to electric lighting. The following resolution was carried: "That application be made to the Board of Trade, on or before December 21, 1897, for a provisional order under the Electric Lighting Acts of 1882 and 1888, to authorise the mayor, aldermen, and burgesses of the borough of Maidenhead to supply electricity for public and private purposes within the said borough." It was pointed out that the estimates approved in April included £250 for purposes connected with the procuring of the provisional order, and the cost to Maidenhead for the public lighting and gas used for the sewage station being about £1,200 a year, a similar outlay would be sufficient to enable the Council to borrow £24,000 if required to lay down the plant. The following formal resolutions were also passed: "(1) That the town clerk be authorised to instruct parliamentary agents and to take all other necessary steps to give effect to the foregoing resolution. (2) That Messrs. Sharpe, Parker, and Co., of 9, Bridge-street, Westminster, be instructed to act as such parliamentary agents. (3) That the borough surveyor be requested to prepare the map required by the Board of Trade. (4) That the development of the general scheme, together with all other matters affecting the question, be referred to a special committee to be called the Electric Lighting Committee, comprising all the members of the Council who are not shareholders in the gas company."

Huddersfield.—A special meeting of the Town Council was held on the 20th inst. to consider the expediency of applying to the Board of Trade for the promotion of a provisional order to be confirmed by Parliament authorising the Council to construct new tramways. The Council agreed to apply for powers to make tramways from the Salendine Nook terminus to Outlane, and from Paddock Head to Quarmby Clough Mill, Longwood. A deputation from the Linthwaite Urban District Council was introduced to lay before the Corporation a request with reference to the construction of a tramway in the Linthwaite district in conjunction with the Huddersfield tramway system. It was also decided that a resolution of the Council, passed on September 15, which negatived the proposed extension of the tramway from Birkhouse lane, Crosland Moor, to Pinfold Well be rescinded, and that the town clerk should take the necessary steps to apply for powers to make the extension. The Tramways Committee reported that letters had been received from the District Councils of Warley and Greetland suggesting an extension of the Corporation tramways to those districts, and the town clerk had been instructed to reply to the effect that it was too late to include the suggested extension in the new Bill; that application for powers, however, might be included in the next Bill or provisional order promoted by the Corporation The Board of Trade had returned the plans showing the mode of construction of the tramways authorised, with the approval of the Department signified thereon, subject to the condition that the width of the groove of the rail must not exceed 1in.

York.—The Electric Lighting Committee of the Corporation state, in the report referred to in our last issue to be presented at a special meeting on the 25th inst., that a canvass of the compulsory area shows that the total number of units which the Corporation may rely upon being used annually, as soon as they could be supplied, amounted to 93,480. It had been ascertained that a demand of 100 000 units at 6d. per unit would ensure a surplus income over outgoings, and from information supplied by other towns the demand invariably exceeded the promises made at a canvass. The committee had come to the conclusion that no scheme would be satisfactory that did not include a destructor, and the utilisation of the heat to be obtained from burnt refuse. They had asked a number of firms to state definitely on what terms they were prepared to take over the electric lighting of the city, and were of opinion that none of the offers were such as they could recommend the Council to accept. The only alternative was for the Corporation to undertake the work themselves. They believe that if the Corporation undertake the work there is every prospect of the undertaking proving a commercial success, and of a satisfactory profit in reduction of the rates of the city being secured. The committee therefore recommend the Council to accept the tenders as recommended by Prof. Kennedy in his report of January 7 last, and to instruct the town clerk to apply for leave to borrow the requisite amount—namely, £20,000. No work will be commenced, or any money spent, until the consent of the Local Government Board has been obtained to the borrowing of the money.

Polytechnic Institution—The opening night and social reunion of trade classes of photography and photo engraving for the winter evenings 1897-8 took place on Tuesday evening, October 19, in the large hall of the Polytechnic, Mr, Frederick Ives in the chair The programme contained an exhibition of Röntgen rays and phenomena of the anode and cathode by Prof. W. Hibbert, F.I.C., A I.E.E., who gave a short lecture with demonstrations, photographs being taken and projected on the screen. A limited number of visitors were shown their own bones. Various selections of vocal music were rendered, and Mr. Beckett showed an animatograph specially constructed for him, which was connected direct with the dynamo providing the current for the electric light of the building. The pictures projected were remarkable for their absence of flimmering, and showed strong contrasts of bright lights and deep shadows. We understand that this apparatus, which was shown for the first time, will be exhibited every afternoon at the institution. Mr. Hogg, the president of the institution, then, in a very happy speech, introduced the chairman, who read a paper on "The Present Aspect of Three-Colour Work." Medals and prizes were distributed. Instrumental music by the Polytechnic orchestral band concluded the entertainment. The syllabus of evening classes on physics and electrical engineering is under the direction of Messrs. W. Hibbert, A.I.E.E., F.I.C., J. Dexter, B.Sc., W. J. Thorrowgood, A.I.E.E., and T. Sewell. These classes include lectures and laboratory work; magnetism and electricity; sound, light, and heat; electric engineering (preliminary, intended for wiremen); electric light and power transmission; and electroplating and deposition. The courses are arranged to meet the requirements of engineering students, of teachers in schools, as well as of those connected with the many industries which depend on the application of electricity and other sciences. The fees range from 5s. to 10s. per session. Special railway facilities are offered to students.

Yarmouth.—The Surveyor reported to the Town Council at its last meeting that the total number of customers was now 229 for 11,059 lamps. The income for September was £384. 8s. 4d., and after defraying working expenses a balance was left of £185. 5s. 10d. to meet capital and other charges of £180 per month. The A.B.C. Company have applied for a supply of current for crane motors at their wharf. The Surveyor stated that the special apparatus required would cost £200, and suggested that the company should guarantee to take a supply for £40 per annum for five years. The Council offered to provide the apparatus at a cost not exceeding £250, subject to the company guaranteeing an annual payment of £30 for six years. The Electric Light Committee are to call a special meeting to consider the desirability of altering the present scale of charges and the purchase and letting out on hire of motors, etc Mr. W. A. Ranken, electrical engineer, reported that he had tested the quality of the 20-ton sample of Welsh coal, and found that a ton of Welsh coal at 19s. cost £3. 12s. 6d. per 1,000 units, the percentage of ash being 19, while Midland coal at 14s. cost £3. 10s. 3d. per 1,000 units, the percentage of ash being 6. In a year's output of 300,000 units this Welsh coal would thus cost £30 more than the other, the sole advantage being that it was smokeless. The percentage of ash was very high, and the coal rather slaty; it was not in his opinion a fair sample of good Welsh steam coal. It was resolved to consider the question at the date of inviting tenders for the supply of coal next year. The Borough Surveyor presented a report as to the lighting by electricity of St. George's Park, which was at present lighted only by a large Sugg's burner in the centre, the light in the surrounding roads being unable to penetrate through the trees, and he recommended that three arc lamps should be placed there. The capital cost of the work would be £110, the annual additional expenditure being £20. The Council resolved to carry out the work.

Cardiff.—At the last meeting of the Cardiff Public Works Committee several letters with reference to the doubling of the tramlines in St. Mary-street and other parts of the town were read. One firm stated there would be much inconvenience to the traffic opposite their premises if the lines were allowed to be doubled. Very often they had the railway trolleys being loaded with goods at the same time for their several branches, and they pointed out there was also a cabstand opposite their building. The borough engineer read three letters which had been received from Mr. John Glenn, the engineer to the tramways company, who applied for permission to double the existing lines in St. Mary-street, Cowbridge-road, and Working-street, and to make a new line connecting the docks section through Custom House-street, with the Canton section in St. Mary-street. The Chairman stated that as far as St. Mary-street was concerned the Council decided not to allow any interference with the wood pavement. The Town Clerk, who had been previously requested to obtain counsel's opinion in reference to the position in which the Corporation would be regarding the transfer of the lines, providing the company were allowed to double certain portions of them, stated that he had not yet obtained that opinion, and the question was consequently deferred to a special meeting of the committee.—At a meeting of the Electric Light Committee of the County Council the question of delay in obtaining the new plant came up for discussion. Mr. Appelbee, the electrical engineer, reported that the new plant was very slow in coming. It was asked if penalties could not be enforced. The Engineer said that the time to do this would come when a further demand came for payment on account The Chairman asked if any reason for delay had been assigned. The Engineer said that no doubt the strike hampered the manufacturers now, but they had wasted a deal of time earlier in the year.—The National Telephone Company wrote stating that, in consequence of the increasing number of subscribers, it would be a convenience to the subscribers and the company if the wires could be placed underground It was mentioned that some two or three years ago, when the company were requested to put the wires underground, they refused, and the committee could not now see their way to allow the necessary disturbance of the streets.

City of London.—At the meeting of the City Commission of Sewers on the 19th inst., the Streets Committee submitted an application from the Central London Railway Company for permission to proceed with the staircase at the corner of Queen Victoria-street and Poultry in the position agreed to by the Commission in 1895. A letter was read from Messrs. Mappin and Webb's, whose premises are close to the spot where the staircase is to be constructed, asking the Commission to take steps to prevent their windows being closed up. The Commissioners agreed to the report of the committee, and instructed the engineer to take every precaution to prevent the firm's windows from being hidden by hoarding. The same committee reported relative to the works of the Central London Railway beneath

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Holborn Viaduct, and recommended that officials be appointed to supervise the mode in which the plans of the company were carried out. This was agreed to. A letter was read from Sir J. D. Marwick, town clerk of Glasgow, thanking the Commissioners for the valuable assistance they had afforded to the Corporation by appointing Mr. Morton to give evidence at the recent telephone enquiry. Mr. Morton presented his report, in which he referred to the fact that the London County Council had, instead of insisting upon reductions of charges as a concession for easements, given every facility to the company. A special vote of thanks was accorded to Mr. Morton for the trouble he had taken in the matter. A long letter was read from the St. James's, Westminster, Vestry, stating that it had adopted the action of the Commissioners, and declined the applications of the National Telephone Company in respect of underground wires, as the company was not prepared to make any proposals for the benefit of the parishioners. An application was made from the General Post Office for permission to take up footway pavement on south side of Holborn for the purpose of laying telegraph wire pipes from opposite 19, Holborn, and from the north-west corner of Ludgate-circus into 109, Fleet street, and the clerk was instructed to write giving the necessary permission provided the wires were not for the use of the National Telephone Company.

Linthwaite.—A very largely-attended meeting of ratepayers of the township of Linthwaite, called by the Urban District Council, was held in Christ Church School, Linthwaite, on the 18th inst., for the purpose of considering the advisability of constructing and working a tramway from Spring Mill, Milnsbridge, to Hoyle House, or as far as the Star Hotel, Manchester-road, near the boundary of the township at the Slaithwaite end, in connection with the Huddersfield tramway system. The Chairman explained that a deputation of the Council had laid before the Huddersfield Council facts which showed that the extension would be in itself a good paying line, and that if Linthwaite carried the lines further the district would be a splendid "feeding ground" for passenger traffic to Huddersfield. The deputation expressed an opinion in favour of constructing tramways in Linthwaite provided the Corporation would construct a line as far as Spring Mill, Milnsbridge. The Tramways Committee had since intimated a desire that their chairman should at the meeting of the Town Council on Wednesday, the 20th inst., give notice of motion rescinding the last resolution of the Council on the subject asking the Corporation to proceed with the extension; and that the Linthwaite deputation should appear before the Council at that meeting for the purpose of supporting such motion. The deputation promised, if the proposal on further consideration were approved by the Linthwaite Council and ratepayers, to give a definite undertaking to promote a provisional order this next session, providing the Corporation would do the same in regard to the Milnsbridge portion of the tramway. The Council had since discussed the matter, and passed the following resolutions: (1) "That a meeting of ratepayers for the township of Linthwaite be held to consider the tramways question, and providing that meeting agree, the Council apply for a provisional order to lay tramways from Spring Mill to Star Hotel"; and (2) "That the chairman, Messrs. Quarmby, Lockwood, and Taylor interview the tramway manager upon his report in order to satisfy themselves of its soundness." The meeting having agreed as above, the members of the Council afterwards met to appoint a deputation to support the motion in favour of the scheme at the Town Council.

Tramways.—The following report by the Board of Trade of their proceedings under the Tramways Act, 1870, and the Gas and Waterworks Facilities Act, 1870, during the session 1897 has just been issued. The number of applications to the Board of Trade for provisional orders under the Tramways Act, 1870, made in December, 1896, was 19—viz.: Blackpool Corporation, Cardiff extensions, Carlisle, Great Grimsby street extensions, Great Yarmouth and district, Huddersfield Corporation, Liverpool, Bootle, and Litherland, Manchester Carriage and Tramways Company, Manchester Corporation, Middlesbrough Stockton-on-Tees, and Thornaby, Morecambe Urban District Council, Moss Side Urban District Council, Penarth, Perth and district (extensions), Stirling and Bridge of Allan, Withington Urban District Council, Worcester, Yarmouth and Gorleston (extension), York. With the exception of the Liverpool, Bootle, and Litherland, and the York applications, which related to the use of electrical or mechanical power on existing tramways, the orders contained powers for the construction of new lines. The aggregate length of such tramways was 28 miles 69 chains of double line and 43 miles 54 chains of single line, and the estimated cost of construction was £434,228. Four of the schemes related to new systems, and 13 were extensions of existing lines. Four applications were not proceeded with by the promoters for want of the consents of the local and road authorities—viz., Cardiff extensions, Great Yarmouth and district, Penarth, and Worcester; a fifth, the Liverpool application, was withdrawn by the promoters; and the Carlisle order, although granted by the Board of Trade, could not be proceeded with owing to a non-compliance with the Act. In the remaining cases, 13 in number, provisional orders were made by the Board of Trade and submitted to Parliament for confirmation. The routes of the proposed lines were in every case inspected by Major Sir Francis Marindin, R.E., K.C.M.G., one of the inspecting officers of the department; and in no case was it necessary to dispense with the consent of any local or road authority. Three Bills to confirm the tramway provisional orders were introduced in the House of Lords on May 3. The Huddersfield Corporation order, in the Tramways Orders Confirmation (No. 2) Bill, was petitioned against in the House of Lords by the London and North-Western Railway Company, but the opposition was withdrawn on terms being arranged between the railway company and the promoters of the order. A petition was also lodged in the same House against the Middlesbrough, Stockton-on-Tees, and Thornaby order, in the Tramways Orders Confirmation (No. 3) Bill, by the Corporation of Middlesbrough, but the petitioners failed to appear before the Select Committee in support of their objection. The Bills were then passed without further opposition. The three Bills received Royal assent on August 6.

The Proposed Derbyshire Light Railway.—The Light Railway Commissioners have held an enquiry at the town hall, Derby, with respect to the proposal to construct a light railway between Derby and Ashbourne. The Commissioners were the Earl of Jersey and Colonel Boughey, with Mr. Alan Erskine as secretary. The promoters of the scheme were represented by Messrs. Cooper and Co., parliamentary agents (instructed by Messrs. Eddowes and Son, Derby). The Corporation were represented by Mr. J. H. Etherington Smith, the Derby Tramway Company by Mr. Hextall. Mr. A. G. Taylor appeared for Mr. F. N. Mundy, of Markeaton, and Mr. W. R. Holland for the Ashbourne Rural District Council. Mr. Govett appeared for the Great Northern Railway Company, and there was a large attendance. Mr. Cooper said that the Great Northern Railway Company had withdrawn their objection, and were now present to give the scheme their moral support. He did not know exactly why the Derby Corporation opposed it. A consultation then took place between the promoters and Mr. Hextall, as representing the tramways company. Mr. Cooper, at the close of it, said that the Derby Tramways Company had asked for what the promoters of the scheme could not reasonably grant, and, therefore, the clause referring to the junction with the tramway in the borough of Derby would be withdrawn. Under the circumstances, the promoters would have to come again for an order to construct a light railway in Derby. He took it that on that point the Commissioners would go into the question of competition, but would not say that because one set of rails already existed a second set would not be put down. The promoters asked that the Commissioners should act as arbitrators between them, but this the tramways company declined. He then proceeded to describe the line, remarking that the company would be incorporated with a capital of £70,000 and borrowing powers of £20,000. The railway was to consist of a single line with wharves and depôts for goods, and the line would be constructed along the road on one side only. The motive power would be electricity by the overhead system, which was being used in many large towns, and was being installed in other places. At the present time access by railway from Derby to Ashbourne could only be obtained by the North Staffordshire line, after changing once and sometimes twice. This caused passengers a journey of 33 miles, against 11 miles of the proposed tramway. When the new railway was made the goods would be delivered on the day of consignment, probably within an hour or so. Milk would be one of the chief consignments carried over the line, and a great deal of coal was also carried on the line of route. Farm produce, grains, and various other goods would also be carried on the railway. There was every prospect of the railway being a paying concern. One of the objections to the line from Ashbourne was that there would be danger to the inhabitants under the proposed arrangement by which the railway entered Ashbourne, where there were four or five roads. The promoters were prepared to widen the road at that point, and give the town of Ashbourne the benefit of that widening. He contended the line would open out building estates, and controverted the objections which he had heard with reference to overheard wires. Evidence was given by Mr. Crompton, electrical engineer, of London, who described the line and the cars, and answered numerous questions on various points. The promoters would be prepared to agree to a rate of 10 miles an hour being run through the town. This point gave rise to some discussion, but nothing definite was decided. A number of gentlemen then gave evidence in support of the scheme, after which the Earl of Jersey said that, subject to the introduction of certain other clauses agreed upon by the Corporation and the promoters of the project, the application would, no doubt, be granted.

TRAFFIC RECEIPTS.

Bristol Tramways.—The traffic returns for the week ending October 15 were £2,543. 0s. 1d., compared with £2,108. 2s. 10d. for the corresponding period of last year, being an increase of £434. 17s. 3d.

Birmingham Tramways.—The traffic receipts for the week ending October 16 were £3,643. 18s. 8d., as compared with £3,212. 2s. 11d. in the corresponding week in 1896, being an increase of £431. 15s. 9d.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended October 17 amounted to £1,296, as compared with £1,081 in the corresponding week of the previous year, being an increase of £215.

City and South London Railway.—The returns for the week ended October 17 were £960, compared with £1,012 for the corresponding period of last year, being a decrease of £52. The total receipts for the half-year 1897 amounted to £14,550, compared with £14,692 for the corresponding period last year, being a decrease of £142.

S.D. Tramways, Dublin.—The traffic receipts for the week ending October 15 were £474. 15s. 7d., as compared with £479. 1s. 8d. in the corresponding week in the previous year, being a decrease of £4. 6s. 1d. The number of passengers

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carried was 74,329 in 1897 and 68,752 in 1896. The aggregate returns up to date are £11,298. 1s. 5d., as compared with £12,036. 5s. 0d. last year, being a decrease of £738. 3s. 7d. The mileage open is the same as last year—viz., eight miles. There were 299 cars running, against 203 in 1896; the number of miles travelled being 24,336 (20,379 in the same period of 1896).

South Staffordshire Tramways.—The traffic returns for the week ending October 15 were £680. 3s. 0d., as compared with £599. 9s. 1d. in the corresponding week of the previous year. The aggregate receipts so far this year were £26,184 0s. 0d., as compared with £25,455. 1s. 6d. in the corresponding period in 1896.

PROVISIONAL PATENTS, 1897.

OCTOBER 11.

23296. Improvements in indirect regulation of dynamo-electric machinery. Wallace Fairweather, 62, St. Vincent-street, Glasgow. (The Crocker-Wheeler Electric Company, United States.)

23304. Improvements in magnetic circuit and its use. Reginald Wood, 35, Nightingale-road, Harlesden, London.

23329. Improvements in and connected with substances to prevent polarisation in electric batteries. Gustav Platner, 18, Fulham-place, Paddington, London. (Complete specification.)

23332. Improvements in secondary battery plates or electrodes. Edward Alexander Paris, 38, Chestnut-road, West Norwood, London.

23342. A combined electrical alarm and automatic switch. Frederick Coutts Bourne and James George Stidder, 75, Chancery-lane, London.

23352. Improvements in the manufacture of electrodes for electrolytic processes. August Zimmermann, 24, Southampton-buildings, Chancery-lane, London. (The Chemische Fabrik auf Actien vormals E. Schering, Germany.)

23369. An improvement in electric safety fuses. Henry Charles Gover and Charles Faraday Proctor, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

OCTOBER 12.

23394. The screw-plug grip insulator. John James Croxton, 1, Littledale-road, Seacombe, Cheshire.

23415. Improvements in dynamos. John Liddle, 154, St. Vincent-street, Glasgow. (Edward Wilson Farnham, United States.) (Complete specification.)

23418. Improvements in electromotors and dynamos. Thomas Blackwood Murray and George Johnston, 121, West George-street, Glasgow. (Complete specification.)

23422. Improvements in electromagnetic clutches. William George Heys, 70, Market-street, Manchester. (The Singer Industrial Company, United States.) (Complete specification.)

23442. Improvements in electrolytical current-directing devices and transformers. James Yate Johnson, 47, Lincoln's-inn-fields, London. (Charles Pollak, Germany.)

23470. Improvements in electric incandescence lamps and apparatus or appliances in connection therewith. Walther Nernst, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

23489. Improvements in electric storage cells. Chaimsonovitz Prosper Elieson, 4, South-street, Finsbury, London.

OCTOBER 13.

23513. Improvements in telephone receivers and the like. Guillaume Arnaud Nussbaum, 29, Ludgate-hill, London. (La Société Industrielle des Téléphones, France.)

23514. Improvements in or relating to electric tramways or railways. James McKenny and Arthur Edward Porte, 116, Stephen's-green West, Dublin.

23530. Improvements in bicycle holders and their combination with electrical contact makers. Francis Elliott Stuart and Arthur Pilcher Ford-Moore, Victoria Electrical Works, Ealing, London.

23623. An improved process of manufacturing electric incandescent lamps. Charles Howard and Richard Mayer, 45, Southampton-buildings, Chancery-lane, London.

23625. An electrical time switch. Arthur John Wheatley, John Melville James, and Tom Bosquet Browne, 39, Victoria-street, London.

OCTOBER 14.

23680. Improvements in and relating to dynamos and electric motors. John Evelyn Liardet, 9, Warwick-court, Gray's-inn, London.

23681. Improved mechanism for operating or controlling electrical motors at a distance. Giulio Martinez, 52, Chancery-lane, London.

23705. Improvements in electric motor engines. Cecil Burman Callow, 24, Southampton-buildings, Chancery-lane, London.

23717. Improvements in or connected with prepayment meters for gas or other fluid and electricity. Wesley Webber, 4, South-street, Finsbury, London.

23713. Improvements in dynamo-electric machines. Richard Fabian, 18, Buckingham-street, Strand, London.

OCTOBER 15.

23792. Improvements relating to the electric propulsion of vehicles. Friedrich Wilhelm Schneider, 18, Buckingham-street, Strand, London. (Complete specification.)

OCTOBER 16.

23858. A method for winding flexible electric wires. Charles Thomas Arnold Henshaw, 104, Spring-gardens, Waverley Park, Edinburgh.

23886. Improvements connected with electric motors and in the manner of connecting batteries to same. Frederic O'Connor Prince, 37, Cursitor-street, Chancery-lane, London.

23896. A high and low water alarm (electrical). Frank Proctor, 50, Burma-road, Green-lanes, London.

SPECIFICATIONS PUBLISHED.

1896.

21273. Electric storage batteries. Liardet.

23696. Electrical governors. Northey.

23706. High-insulation tumbler switch. Heaton and Smith.

25242. Electrical discharge apparatus. Belfield. (Wurts and Skinner.)

25560. Electric lampholders, sockets, and the like. Verity.

25660. Electric arc lamps or lighting apparatus. Smith.

25943. Portable electrical batteries. Mayer.

1897.

996. Accumulator plates. Majert.

13977. Three-phase alternating-current induction meters. The British Thomson-Houston Company, Limited. (Steinmetz.)

16967. Telephones and telephonic systems. Oprendek and Sárkány.

17691. Electrical conduits. Doulton and Morris.

18556. Lightning arresters. The British Thomson-Houston Company, Limited. (Hewlett.)

18628. Portable electric primary batteries. Cole.

19118. Dynamo-electric driving apparatus especially suitable for propelling vehicles. Goldschmidt.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	11-11¼
Brush Company, Ordinary	3	1-1½
—— Non. Cum., 6 per cent. Pref.	2	1½-2½
—— 4½ per cent. Debenture Stock	100	103-107
—— 4½ per cent. 2nd Debenture Stock	100	96-100
Callender's Cable Company, Debentures	100	108-113
—— Ordinary	5	7-8
Central London Railway, Ordinary	10	9¾-10½
——	6	5¾-6
Charing Cross and Strand	5	12-13
Chelsea Electricity Company	5	10½-10¾
—— 4½ per cent. Debentures	100	111-113
City of London, Ordinary	10	25-26
—— 6 per cent. Cumulative Pref.	10	17-18
—— 5 per cent. Debenture Stock	100	131-136
City and South London Railway, Consolidated Ordinary	100	69-71
—— 4 per cent. Debenture Stock	100	138-140
—— 5 per cent. Pref. Shares	10	15½-15¾
County of London and Brush Provincial Co., Ordinary	10	12¾-13¼
—— 6 per cent. Cum. Pref.	10	15½-15¾
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1⅛ 2
—— 5 per cent. Debentures	—	89-94
Edison and Swan United Ordinary	3	2¼-2⅜
—— 5 per cent. Debentures	5	4-5
Electric Construction, Limited	2	2-2½
—— 7 per cent. Cumulative Pref.	2	3½-3⅝
Elmore's Copper Depositing	1	⅝-¾
Elmore's Wire Company	2	1-1¼
W. T. Henley's Telegraph Works, Ordinary	10	19-20
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	9-9½
—— 7 per cent. Preference	5	10¾-11¼
India Rubber and Gutta Percha Works	10	21¾-22½
—— 4½ per cent. Debentures	100	103-107
Kensington and Knightsbridge Ordinary	5	13¾-14½
—— 6 per cent. Pref.	5	8-8½ xd
London Electric Supply	5	1¾-2
Metropolitan Electric Supply	10	17¾-18½
—— 4½ per cent. First Mortgage Debenture Stock	100	119-123
National Telephone, Ordinary	5	6¾-6¾
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	15-17
—— 5 per cent. Non. Cum. Third Pref.	5	6-6½
—— 3½ per cent. Deb. Stock	100	104-109
Notting Hill Company	10	15-16
Oriental, Limited, £1 shares	1	1¼-2
—— £5 Shares	5	8¼-8¾
—— £4½ shares	4½	7¼-7¾
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	103-105
South London Electric Supply, Ordinary	2	1¾-2½
St. James's and Pall Mall, Ordinary	5	15-17
—— 7 per cent. Pref.	5	9½-10½
Telegraph Construction and Maintenance	12	36-39
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	8	12¾-13¾
Westminster Electric Supply, Ordinary	5	14¼-15¼
Yorkshire House-to-House	5	8-8¾

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NOTES.

The Labour Question in Russia.—The Minister of Finance has issued an order regulating the duration and distribution of the hours of work in factories and other industrial undertakings, and has sent corresponding instructions to the factory inspectors.

Electric Light in Rhodesia.—The opening up of the territory of the British Chartered Company of South Africa will lead to the rapid extension of the electric light, and we already hear that electric light will be started at Buluwayo on the opening day of the railway.

An Electric Mail Van.—During the past week an electric motor-van has been on trial at the General Post Office. The van has been making five journeys a-day between St. Martin's-le-Grand and the south-western district office in Victoria-street. So far the experiment seems to have been successful.

Motorcar Accumulators.—A writer on this subject in *L'Industrie Electrique* says that to obtain a speed of 18 kilometres (about 11 miles) it requires 100 watt-hours per ton-kilometre and a specific power of 1,800 watts per ton. With the present accumulators it takes about 5 kilogrammes to store 100 watt-hours, and 300 kilogrammes to draw one ton at the speed indicated.

The Turin Exhibition.—The German-Italian company for the transmission of electrical energy from Bussoleno to Turin are pushing forward the installation works so as to have them ready for the opening of the exhibition in May next. In view of that event they are going to replace animal traction by electric traction on all the tramway lines of the town. The system has not yet been decided upon.

The Nationalisation of Swiss Railways.—It is reported that a movement is on foot in several quarters for the collection of 30,000 signatures from Swiss citizens with the object of submitting to the referendum of the Swiss people the law recently enacted by the Federal Legislature for the purchase of the railways by the State. The signatures required for the purpose must be collected by January 14 next.

Unfounded Rumours.—With reference to the report that a survey was about to be undertaken immediately for a deep-level electric line to connect the London, Brighton, and South Coast Company with the termini at Euston, St. Pancras, and King's Cross, the *Financial Times* is authoritatively informed that no such project is under consideration. The only new work which the Brighton Company has at present in contemplation is the extension of the station premises at Victoria.

Fire-Alarm Calls.—We note that the Corporation of Doncaster have put all the firemen's houses in electric communication with the fire brigade station. This question is one which the smallest town cannot afford to neglect, but how many towns there are—large towns even—at the present day which still keep up the old-fashioned and slow method of summoning the firemen by means of the "fire bell"! There is ample room for a vast deal of improvement in this respect in the provinces, and the system of electric fire-call posts might also be extended with advantage.

The Chemical Society.—At the meeting of the Chemical Society at Burlington House on November 4, Prof. James Dewar, president of the society, will give an account of some of his most recent researches. The professor will deal with the following subjects: "The Properties of Liquid Fluorine," "The Liquefaction of Air and the Detection of Impurities," "The Absorption of Hydrogen by Palladium at High Temperatures and Pressures." It will be remembered that a short time ago Prof. Dewar and M. Moissan succeeded in liquefying fluorine for the first time in the history of science. The liquefaction was carried out in the laboratories of the Royal Institution.

Acetylene.—The following notification appeared in the *London Gazette*, under date October 19, in substitution for that published in the *Gazette* on October 15: "Explosives Act, 1875. Notice is hereby given that, after the expiration of 40 days from the date hereof, it is proposed to submit to her Majesty in Council, in pursuance of the above-mentioned Act, the draft of an Order in Council declaring acetylene, when liquid, or when subject to a certain atmospheric pressure, and when not specially exempted by an order of the Secretary of State, to be an explosive within the meaning of 'the Explosives Act, 1875,' and prohibiting its being manufactured, imported, kept, conveyed, or sold."

The Siemens Engineering Society.—This society has been formed among the employés of Messrs. Siemens Bros. and Co., Limited, for the discussion of technical papers to be read by the members. The inaugural meeting was held at the Charlton Assembly Rooms on the 19th inst., when the president (Mr. Alexander Siemens) delivered an address, in which he gave the history of the formation of the firm, its rise and progress, and the attainment of its present position. The address was followed by a musical programme, and during the course of the evening a presentation was made to Mr. W. L. Phillips, who, as mentioned elsewhere in this issue, is proceeding to Australia in connection with the firm's Sydney branch.

Dundee Institute of Architecture, Science, and Art.—The council of the institute announce that the conversazione will be held, by permission of the College Committee, in the rooms of University College, on the evening of Saturday, 30th inst., when an attractive programme will be presented. Lecturettes by one or two professors will be given, and exhibits of architectural drawings and other objects of interest will be shown. Tea will be served in one of the rooms during the interval for promenade. Ladies and gentlemen nominated for election on or before the 27th inst. will be elected associates or members at this the inaugural meeting of the session. The meetings for this session will be intimated later.

The Society of Engineers.—The next ordinary meeting of this society will be held at the Royal United Service Institution, Whitehall, on Monday, November 1. A paper will be read, entitled "Sea Defences," by Mr. Richard F. Grantham, M.I.C.E., F.G.S., of which the following is a synopsis: Diversities of form of sea defences—Loss of land by erosion of the coast—Importance of littoral drift—Classification of forms of sea defence—Slopes of walls of reclamation areas—Forms of upright walls, groynes, and examples—Best form of profile of wall—Undermining of walls—Function and object of groynes—Best direction of groynes—Groynes as the sole means of defence—Difficulty of adopting a general system of protection round the coast. The chair will be taken at 7.30 p.m. precisely.

The Production of Platinum in Russia.—Statistics have recently been published by the Russian Ministry of Finance which states that Russia supplies more platinum than any other country in the world, the production being forty times more than that of all the other countries put together. This production, which was 6,540lb. in 1880, has risen to 9,930lb. in 1898. The maximum output was obtained in 1894, when 11,900lb.

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were produced, but the falling off in the following year is attributed to the general depression, which considerably affected the works. The whole of the metal comes from the mines in the south of the Oural. The raw metal is not worked in Russia, but abroad, principally in Germany. The price always remains very high, and has even reached £20 per pound of raw metal.

The Engineering Dispute.—During the past week a formal invitation to a conference has been given by the Board of Trade to the secretaries of the Employers' Federation of Engineering Associations and the general secretary of the Amalgamated Society of Engineers. It does not appear very hopeful that the intervention of the Board of Trade will be accepted yet, because of the difficulty of arriving at a basis from which an amicable conference can be commenced. A give-and-take policy would be necessary, and at present neither side seems disposed to modify any of its demands sufficiently to induce reciprocity from the other side. The following are the latest returns of the numbers of men now idle throughout the country: engineers, 29,000; allied workers, 20,000; labourers, 28,000; non-unionists, 6,000—total, 83,000.

Swiss Electricians.—The tenth annual gathering of the Society of Electricians of Switzerland was held on October 3 at Neuchâtel, under the presidency of Mr. Wissling, of Wadensweil. A by-law relative to the creation of an inspectorship of electric installations, similar to that of steam-boilers, was adopted. The inspector will have a maximum salary of £300 a year, and his duties will be to inspect regularly all the installations belonging to members of the society. The inspectorship will be subject to a committee of five members, of whom three will be nominated by the association, one by the Federal Council, and the fifth by the cantons interested. The meeting also voted a grant of £20 for a monument in honour of the Italian electrician, Galileo Ferraris. After the banquet the members of the association visited the electric works of the gorges of the Reuss.

The Economy of Electric Railways. — Prof. George Forbes, in an article in the *Engineering Magazine*, gives some interesting figures in support of his contention that electricity is bound to supplant steam on railways. He compares the City and South London Electric Railway, the Liverpool Overhead Railway, and the Metropolitan District Railway with one another. He divides the miles travelled by passenger trains into the cost of power and the cost of repairs and renewals of carriages so as to arrive at the working cost per train mile. His results are: City and South London Railway, 6·48d.; Liverpool Overhead Railway, 3·84d.; and Metropolitan District Railway, 11·76d. per train mile. The District Railway trains are approximately four times the weight of the two electric lines, and if the train mileage of the latter were increased to that of the former the figures for cost of power would doubtless be reduced.

An Electric Pumping Plant.—An electric pumping installation has been fixed in the floating dry dock at Havana. It consists of two generating plants, one in each wall, but with connecting cables, so that either can serve the whole dock. Each plant is complete with boiler, engine, and direct-coupled dynamo. The power is transmitted by cables to 10 electric motors, five in each wall, having their switches and resistances located in the valve houses. These motors are vertical and drive direct on to the shafts of the horizontal centrifugal pumps placed in the bottom of the walls. The pumping machinery is capable of lifting an ironclad of 15,000 tons in weight in 2½ hours, which means that 15,000 tons of water must pass through the pumps before the process of lifting is complete. The whole of the electrical machinery has been supplied by Messrs. Scott and Mountain, of Newcastle, and it includes a complete system of electric lighting throughout the dock.

Thermo-Electric Properties of some Liquid Metals.—An abstract of an interesting paper on this subject by Mr. William Beckit Burnie is published by the Chemical Society in their *Journal*. The author thermo-electrically compared tin, lead, bismuth, and mercury with copper, the tested metal being contained in a hard glass tube, so that the observations could be pushed to temperatures considerably above those of the melting metals, and the changes in the thermo-electric properties during the process of melting observed. About the melting point, a small variation of temperature produces a considerable change in the direction of the thermo-electric curve. The effect is smallest with lead, with tin it is larger, and with bismuth it is very remarkable, that metal changing during melting from an exceedingly active thermo-electric metal to one very similar to lead in its thermo-electric properties. With mercury, also, a great change takes place at the melting point.

The Lighting of Portsmouth Dockyard.—Great advances have been made of recent years in the application of electricity at our docks, and in consequence complaints are continually being raised in reference to yards lighted by other means. We hear now that the Admiralty, on their visit to Portsmouth Dockyard last week, expressed a favourable opinion of a scheme designed to provide electric lighting on a large scale. It is proposed that a station, 150ft. long and 50ft. wide, shall be erected between the new electric shop and the wing of the old convict prison, which has been converted into an electric store, and that not merely shall a system of electric lighting be applied throughout the dockyard in place of the very inefficient lighting by means of gas, but that motors shall be provided for furnishing driving power. The present cost of the gas lighting is about £3,000 a year, and it is estimated that the new scheme would mean a present expenditure of £30,000, and an ultimate expenditure of £100,000.

A Warning Note.—Some of the members of the Manchester City Council have been visiting the German and Austrian technical schools, and their report contains statements of which English manufacturers would do well to take heed. Alderman Higginbottom, whose name is so closely associated with the municipal electricity undertaking of Manchester, says that it is a mistaken notion to suppose that Manchester was the home of engineering. In all the electrical installations he had seen on the Continent the engines and apparatus were of foreign manufacture, and he had never seen finer engines anywhere than he had seen abroad. Councillor Phythian says that prior to his visit to the Continent he maintained that English firms could make the best engines and the best dynamos. He has come back, however, with an altered opinion, and feels bound to admit that he has seen work which would put to shame a great deal of the work done in this country. Remarks of a similar nature have been made by other prominent members of the Council.

Electric Wagon Haulage.—Excavation work has always been laborious because of the limited means at the disposal of contractors for hauling the earth to the road-level. A huge site is being excavated in Chicago for the foundations of the new Government building to a depth of 27ft., and in consequence of the steepness of the gradient of the temporary roadways electricity is employed to assist the horses in drawing up the heavy wagon-loads of earth. A 20-h.p. series-wound Edison motor is installed in a shed on the street-level. It is operated at 220 volts, and is directly geared to a 14in. hoisting drum, which is equipped

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with a hand-brake. About 125ft. of ¾in. rope is wound round the drum and hooked on to the wagon, which is by this means drawn up with ease. A total of about 6,500lb. is pulled up a grade having a rise of 27ft. in 100, and an average of 15 h.p. is required. The motor weighs 2,100lb., and works at 1,000 revolutions per minute at full load. It is found to be more economical than steam hoisting.

The Motive Force of the Rhone.—The company which was formed for the purpose of utilising the motive power of the Rhone has published an account of the actual state of the works of the Jonage Canal. This company obtained the concession in 1892, and the works, which were commenced three years ago, will be completed before the end of the current year. The canal itself, 9½ miles long and 180ft. broad, is finished, and the works at the dam, designed to receive 16 turbines and 16 dynamos of 1,250 h.p. each, are built and roofed in, while over 45 miles of electric conduits are laid in the town of Lyons. Pending the opening of the works, a temporary steam plant of 400 h.p. has been laid down to supply power to the Lyons industries, and the whole of the electricity available has been taken by over 80 subscribers. The price for 1 h.p. for 100 kilowatt-hours is in round figures 23s. 4d., and for 100 horse-power hours 16s. 8d. The prices for 5 h.p are 19s. 2d. and 14s., and they diminish in inverse ratio to the amount of horse-power used per 100 hours till they reach 7s. 6d. and 5s. 10d. for 50 h.p.

Alloys.—Prof. Chandler Roberts-Austin has commenced a series of Cantor lectures before the Society of Arts, the first of which is devoted to theoretical questions. The author recalls the fact that much of the evidence as to the analogies of alloys to saline solutions (in regard to which great progress has been made during the past four years) has been derived from the use of either of the resistance pyrometer, or that in which a thermo couple affords a basis for measuring high temperature, and he states that it has become more and more evident that alloys may be divided into two main classes: (1) those which are merely solutions of the constituent metals, and (2) those which contain true chemical compounds; for while few alloys are true chemical compounds, most series of alloys contain compounds in solution. The first class is in some respects the more interesting. Solutions are defined by Ostwald as being "homogeneous mixtures which cannot be separated into their constituent parts by mechanical means." This definition will apply to alloys, and it is now well known that solids may truly dissolve solids, and therefore that solid solutions exist.

Electric Lighting of Trains.—The retirement of Sir Allen Sarle from his position as secretary and general manager of the London, Brighton, and South Coast Railway, recalls the fact that this was the first railway company to attempt to light its trains by electricity. The first experiments were made in 1881, when Mr. Laing was general manager, and they resulted in a Pullman car being fitted with accumulators and run regularly from October of that year. There were of course some failures resulting from inexperience, but they were soon remedied, and the system has gradually spread since 1885, when Sir Allen Sarle succeeded Mr. Laing, until at the present time it is almost universal on this line. It will be remembered that in 1895 (Vol. 15) we published in this paper a series of articles by Mr. R. W. Weekes, giving a history of the subject and describing the machinery employed. We glean from this source that the initial cost of equipping each train was at that date about £400, and the working cost for maintenance and renewals worked out at about £54 per train per annum. It was estimated that the company got about 15 per cent. more work out of trains lighted by electricity than by gas, and as the cost of upkeep decreases considerably with the number of trains fitted, we expect that percentage has increased correspondingly.

The Brussels Exhibition.—The ceremony of the official closing of the Brussels Exhibition took place last week in the Salle des Fêtes of the main building in the presence of the King of the Belgians, Princess Clémentine, the Count of Flanders, and Prince Albert. All the Ministers, members of both Chambers, and leading representatives of the diplomatic world were present. In delivering the closing address, M. Nyssens, Minister of Commerce and Industry, expressed the warm thanks of the Belgian nation to all foreign countries which had assisted to crown the enterprise with such marked success. The ceremony was brought to a conclusion by the distribution of awards by his Majesty among the representatives of the various sections. The honours conferred in connection with the exhibition have been officially announced. Mr. Dredge and Mr. Gore, the British and United States Commissioners respectively, are appointed commanders of the Leopold Order. M. Oostendorp, the Paraguayan Consul-General, is made an officer, while M. Gihoul, the Liberian Consul, M. Goldzieher, the Persian Consul-General, and M. Stinglhamber, the Turkish Vice-Consul, are created knights of the same order. Grand prizes have been awarded in the British section to Sir W. G. Armstrong, the Eastern Telegraph Company, Messrs. Elliott Bros. (two), and Messrs. C. H. Parsons and Co., among others.

Anticipated Inventions.—It is curious to reflect that many of our so-called modern inventions have been invented long before and forgotten, but that this is so many authorities can vouch for. We are so constantly hearing of them that they pass almost unnoticed, and our revelry in the newness of them remains undisturbed. An author writing on this subject in an evening contemporary a short time ago referred to an early discovery of the electric telegraph, which may have escaped the notice of many of our readers. Arthur Young was on a visit to Mr. Lomond, at Paris, in October, 1787, when he saw what he describes as something very remarkable. He says: "You write two or three words—Mr. Lomond takes them with him to his room and turns a machine which is enclosed in a cylindrical case. A wire connects it with a similar cylinder and electrometer in a distant apartment. His wife stationed there, by remarking the corresponding motions of a ball, writes down the words they indicate. Length of wire makes no difference in the effect." Mr. Young does not go into details, probably for the very reason that they were beyond him, but it is somewhat remarkable that considering how much we know of Mr. Lomond as a savant of his time, we have no other record of his discovery. The Revolution was responsible for a good many things, and perhaps the forgetfulness of this invention must be attributed to the same disturbing element.

A New Lamp and New Filament.—Mr. Hiram S. Maxim has done many things, and attempted a good many more, and according to an anonymous correspondent of one of the financial newspapers he is going to bring out a new invention in the way of filament and lamps which is to "create some noise in the electric lighting world." We commend the business instincts which prompted the sending of this information to a financial paper first, and we take the liberty of reproducing it from motives of curiosity to see how much "noise" will follow: "Mr. Hiram S. Maxim, the inventor of the Maxim gun and of cordite, and one of the earliest pioneers of electric lighting in the States, has recently perfected some improvements in electrical illumination, for which he claims advan-

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tages over every other known system, and which, he says, will reduce the item of cost of such illumination to the level of, if not below, that of common gas. The ordinary lamps now used have 16 c.p. This new lamp has 40 c.p., taking the watt unit of electrical energy. The American lamps require four and eight-tenths to five to the candle-power. The best English lamps take four and two-tenths to the candle-power. The new Maxim lamp takes only two and eight-tenths to the candle-power. That expresses mathematically the economy of the new lamp in electrical energy. It is believed that this invention, which includes a new filament and lamp, will create some noise in the electric lighting world. It can be applied to every existing system, and may, perhaps, be welcomed alike by the various companies that produce and the public who use electricity for illuminating purposes."

The Institution of Junior Engineers.—The inaugural meeting of the seventeenth session will be held on Friday, November 5, at 8 p.m. at the Westminster Palace Hotel. The presidential address will be delivered by Mr. John A. F. Aspinall, M.I.C.E. The annual general meeting was held on the 22nd inst., Mr. H. B. Vorley, chairman of the council, presiding. The council's report contained a very satisfactory record of the proceedings of the society during the past year; 68 new members had been elected, and after allowing for removals of names from the register the total membership was 480. Seven meetings had been held for the reading and discussion of papers, 11 visits had been made to engineering works in the London district, and numerous other works had been seen during the summer meeting in the North of Ireland. The institution premium had been awarded to Mr. W. R. Beckton for his paper on "The Protection of Buildings, etc., from Fire." The congratulatory address to the Queen, the conversazione, anniversary dinner, office fund, financial position, and Sanitary Congress were other matters referred to in the report, and an appreciative allusion was made to the services rendered by Mr. H. Kempster, now retiring from the post of hon. librarian which he had ably filled for the past two years. It was announced that Sir A. R. Binnie, the retiring president, would be succeeded by Mr. John A. F. Aspinall, chief mechanical engineer to the Lancashire and Yorkshire Railway, and that the election of officers had resulted as follows: chairman, Mr. H. B. Vorley; vice-chairman, Mr. Basil H. Joy; hon. librarian, Mr. J. N. Boot; hon. auditors, Messrs. W. H. De Ritter and P. Marshall; members of council, Messrs. Walter J. Munter, A. Marshall, R. Marshall, and L. H. Rugg.

Rapid Electric Travel.—The proprietors of the *Engineering Magazine* have just inaugurated a European edition, which is edited and published in London, and the October issue possesses great interest from the cosmopolitan scope of its articles, no less than from the reputation of the authors, and the minor details of good paper, good illustrations, and good printing. Mr. Charles Henry Davis and Mr. F. Stuart Williamson contribute the first of two papers, on "The Enormous Possibilities of Rapid Electric Travel," showing the possibility of producing, by the use of electric motors, a speed supposed to be thought of only by visionary people. This paper discusses the engineering problems involved, and the authors say they have good reason to think that a speed of 170 miles per hour or more can be attained and maintained without any danger to or inconvenience to the passengers. They discuss in detail the various resistances, and come to the conclusion that many existing formulæ are far from the truth, and that the resistance of the proposed train, on a line built as suggested, would be much less than engineers now believe. They confess, however, that what the resistance actually would be is somewhat problematical. Allowing 90 per cent. of the weight to be applied for braking purposes, and an efficiency of one-sixth with 2lb. rolling resistance, a car running at 170 miles per hour could be brought to a stop on a level track in about 9,910ft. with present-day brakes. Assuming uniform retardation, this would be 3·139ft. per second. With a double system of brakes and track brakes, the proposed car could no doubt, say the authors, be brought to a stop in a much shorter distance without danger to the passengers, although perhaps with some inconvenience.

The Electro-Harmonic Society.—A smoking concert will be held at the St. James's Hall Restaurant (Banquet-room), Regent-street, W., this (Friday) evening, October 29, at 8 o'clock. The following artistes will attend: Mr. Trefelyn David, Mr. Bantock Pierpont; solo violinist, Mr. T. E. Gatehouse; solo pianist, Mr. Alfred E. Izard; vocal comedian, Mr. Wallis Arthur; musical sketches, Mr. George Robins; ventriloquist, etc., Mr. Sidney Gandy; small string orchestra—first violins, Messrs. T. E. Gatehouse, E. Cryer, and Harold Pywell; second violins, Messrs. J. Greebe, W. Thornton, and W. A. Hewlett; viola, Mr. Sidney Venables; violoncello, Mr. George Pywell; contrabass, Mr. C. Skinner; musical directors, Mr. T. E. Gatehouse and Mr. Alfred E. Izard. The following is the programme: March, from "Suite" (Lachner), orchestra; song, "There's a Land" (F. Allitsen), Mr. Bantock Pierpoint; song, "Flashes" (MS.), Mr. Wallis Arthur; pianoforte solo, "Valse Chromatique" (B. Godard), Mr. Alfred E Izard; song, "River of Dart" (Cooke), Mr. Trefelyn David; ventriloquial exposition (introducing the well-known figure "Ebenezer Twiddlepump"), Mr. Sidney Gandy; selection, "Benedictus" (A. C. Mackenzie), orchestra; musical sketch, "Imitations of Popular Performers," Mr. George Robins; vocal duet, "The Two Beggars" (H. L. Wilson), Messrs. David and Pierpoint; selection, "Czardas" (Michiels), orchestra; old song, "Simon the Cellarer" (Hatton), Mr. Bantock Pierpoint; violin solo. "Scénes de la Czarda" (Hubay), Mr. T. E. Gatehouse; song, "It Pleased the Children so" (Roberts), Mr. Wallis Arthur; musical sketch, "Imitations" (Gandy), Mr. Sidney Gandy; song, "At Rest" (E. St. Quentin), Mr. Trefelyn David; musical sketch, Mr. George Robins.

Patent Law.—The following is a syllabus of a course of six lectures which will be delivered during the Michaelmas term of the Council of Legal Education, commencing on November 2, by Mr. J. Fletcher Moulton, Q.C., on "Patent Law," in the Middle Temple Hall: Lecture I.—Nature of grant by letters patent—Their legal status prior to Act of Monopolies—Effect of that Act—Practice and procedure in the sixteenth and seventeenth centuries—Modern developments—Legal status of letters patent under existing law. Lecture II.: The invention—Difficulty of definition of the word "invention"—Essential characteristics of a patentable invention—Negative canons derivable from judicial decisions—Delimitation of the invention in the specification—Origin and function of claims—Their interpretation—Colourable imitation. Lecture III.: Conditions of validity: (1) Novelty—Prior user—Secret user—Experimental user—Prior publication—Its sufficiency—Conflicting decisions—Distinction between public knowledge and common knowledge—Publication by the inventor himself. Lecture IV.: Conditions of validity (continued): (2) Sufficiency of specification—Double duty of the patentee—Difficulties arising therefrom—Examples; (3) Utility—Origin and nature of the condition—Meaning of the term in patent law—Commercial utility; (4) Conformity—Origin and nature of the condition—Fair development. Lecture V.: Procedure—Mode of obtaining the grant—Amendment of

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grant—Revocation of grant—Rights and remedies of patentee—Rights and remedies of public—Action for threats—Compulsory licenses. Lecture VI.: Defects of English patent law—Foreign systems—Relative advantages—Possible improvements—International rights. The lectures will be open to all members of the Inns of Court free, and to gentlemen non-members on payment of a fee of £1. 1s. for the course.

Photographic Exhibition.—The Eastman Photographic Exhibition, which opened on the 27th inst., in the New Gallery, Regent-street, contains many fine specimens of film photography not only from professionals but also from amateurs, including 30 photographs by H.R.H. the Princess of Wales and other members of the Royal family. The technical exhibits are especially interesting. Amongst other topics, this section points out the use of the kodak and film photography in illustrated journalism. Exhibit No. 3 shows four developed solio prints, two of which have been exposed an hour and a half to light from an incandescent electric lamp of 16 c.p. These are contrasted with a print made by daylight and one printed by magnesium light. Amongst the X-ray photographs some novelties are shown. They are printed on X-ray paper, and not on plates. The use of this paper, which has the support of no less an authority than Dr. Barrie-Blacker, is very evident. A physician, summoned in case of an accident, may carry a sheet of it in his pocket, wrap it and tie it around the patient's body, thus avoiding all necessity of the latter's keeping still—which is often difficult—and have a print in a few minutes. A rather curious incident occurred with regard to this material. The *Daily Chronicle* expedition to the Greek War was fitted out with an enormous quantity of it, but no photographs were returned; not even one wounded soldier could be procured as a subject for treatment. Twelve photographs of a hand are shown which have all been taken at one exposure, and the print taken on the twelfth sheet of paper varies but little in distinctness from that taken on the first. Full-size radiographs of a cat, a rabbit, and a fowl are also on view, besides miles and miles of cinematograph films. A vast number of exhibits competing for the £600 worth of prizes make a good show. The exhibition closes on November 16.

A Telescriptor.—Another idea which was foreshadowed by Percy Gregg 17 years ago in his "Across the Zodiac" (one of the pleasantest three-volume romances written during the last quarter of the century) appears to have materialised. Arguing from the point that the planet Mars has cooled—*i.e.*, become habitable about 10,000 years previous to the period at which the earth has arrived at that stage—he comes to the conclusion that civilisation must be correspondingly advanced upon the former planet. He describes an imaginary visit to that place, and there every house has its electric light, electric sociable tricycle, and electric communication. The latter is composed of a desk with a diaphragm. When a letter is to be written, the instrument is switched on automatically to a similar arrangement in the correspondent's house. A thin metal plate is placed upon the diaphragm, and the message is written with a stylo, which is attached to a wire carrying current. The writing appears simultaneously upon the similar plate at the other desk. When the message is finished, a bell rings, and the metal sheet can be detached. It is only remarkable that a serviceable apparatus of this kind has not been perfected before to-day. However, experiments have been made at Berlin with an instrument called the telescriptor which appears to fill the bill, if its practical application for long distances can be proved. It takes the form of a typewriter, and costs about £25. It can be electrically connected by means of a call-bell with any other similar apparatus, and the message, which is typed off through the keyboard at one end, will be reproduced in plain letters and numerals on a plate at the other end. The Berlin correspondent of the *Daily Telegraph* says that Messrs. Siemens and Halske have obtained the sole rights of manufacture for Germany, and are represented on a syndicate for extension of the patent. The German Postmaster-General is said to take a lively interest in the invention, which is the result of eight years' labour on the part of an Austrian engineer named Hoffmann.

The Weak Points of Engine Dynamos.—An interesting article has been written by Mr. Charles E. Emery descriptive of engines for electric railway power stations. The article appears in the *Street Railway Journal*. The author deals pretty fully with the difficulties connected with large engine dynamos, of which the principal features affected are the main shaft and its bearings and supports. He points out that if the armature varies from its central position between the pole-pieces when electric current is being generated, the magnetic attraction on the side towards which the armature approaches becomes at once very much greater than that on the other, and if there is the slightest yielding of the parts the armature will be drawn still further out of centre. If a permanent eccentricity has been developed the strain and wear on the bearings is enormously increased, and if the action is due to weakness of any kind an alternating straining action takes place, tending to bend the field yokes or displace the engine bearings. The author remarks that any irregularities due to slack in the bearings are small compared to those resulting if the shaft be relatively weak and springs so as to cause the armature to be shifted out of centre, whereby the air-gap between it and the pole-pieces is lessened in one place and increased on the opposite side, so that the magnetic attraction augments the eccentricity. For loads corresponding to the strengths of the shafts the deflections would be substantially the same for the same lengths, because the torsional resistance of a shaft, which enables it to transmit power, varies as the cube of the diameter, and the transverse resistance at the same rate. The larger shaft would, however, have greater speed between bearings, and the deflection would, therefore, be increased in that proportion. The weakness of the main shaft constitutes one of the most prominent difficulties early encountered with large engine dynamos. The author gives publicity to what he admits is a rumour in connection with the competition for the engines of the Central London Railway, which, he says, was decided by this very question of shafts. He says: "It is reported that the bid of an English firm was the lowest, and that of an American firm but little higher, and that the engineer of the American firm simply called attention to the fact that the main bearings provided for in the English engine were only 14in. in diameter and 24in. long, whereas his were 20in. in diameter and 36in. long, and he added in a joking way that 'he knew by experience his were not large enough.'" The engines ordered are authoritatively reported to be of only 1,300 h.p. each. The author goes on to talk about the massiveness of appearance of electric railway engines, and inclines to the opinion that the extra weight of material, particularly of cast iron, has been put in some of them rather to make an impression than to serve any useful purpose. He declaims against the practice of constantly putting in more metal to secure operation without the decided tremors which appear to show weakness, and says that the increase of weight could have been largely avoided if one had stopped following the practice of another and simply gone back to first principles, which admit of no dispute.

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THE KOPPEL ELECTRIC LOCOMOTIVES.

The question of the design of small locomotives for use on pioneer lines has been always a difficult matter. The needs of the railway contractor have called for such locomotives, for which several systems of power have been tried. In many ways the electric locomotive has distinct advantages over its rivals, steam and compressed air, for these narrow-gauge lines. Reviewing these advantages briefly, we see that the electrical equipment is more economical to work, as one good stationary engine develops power much more cheaply than several small locomotives. Again, the electric locomotive can be more readily designed for narrow gauges than steam or compressed-air locomotives.

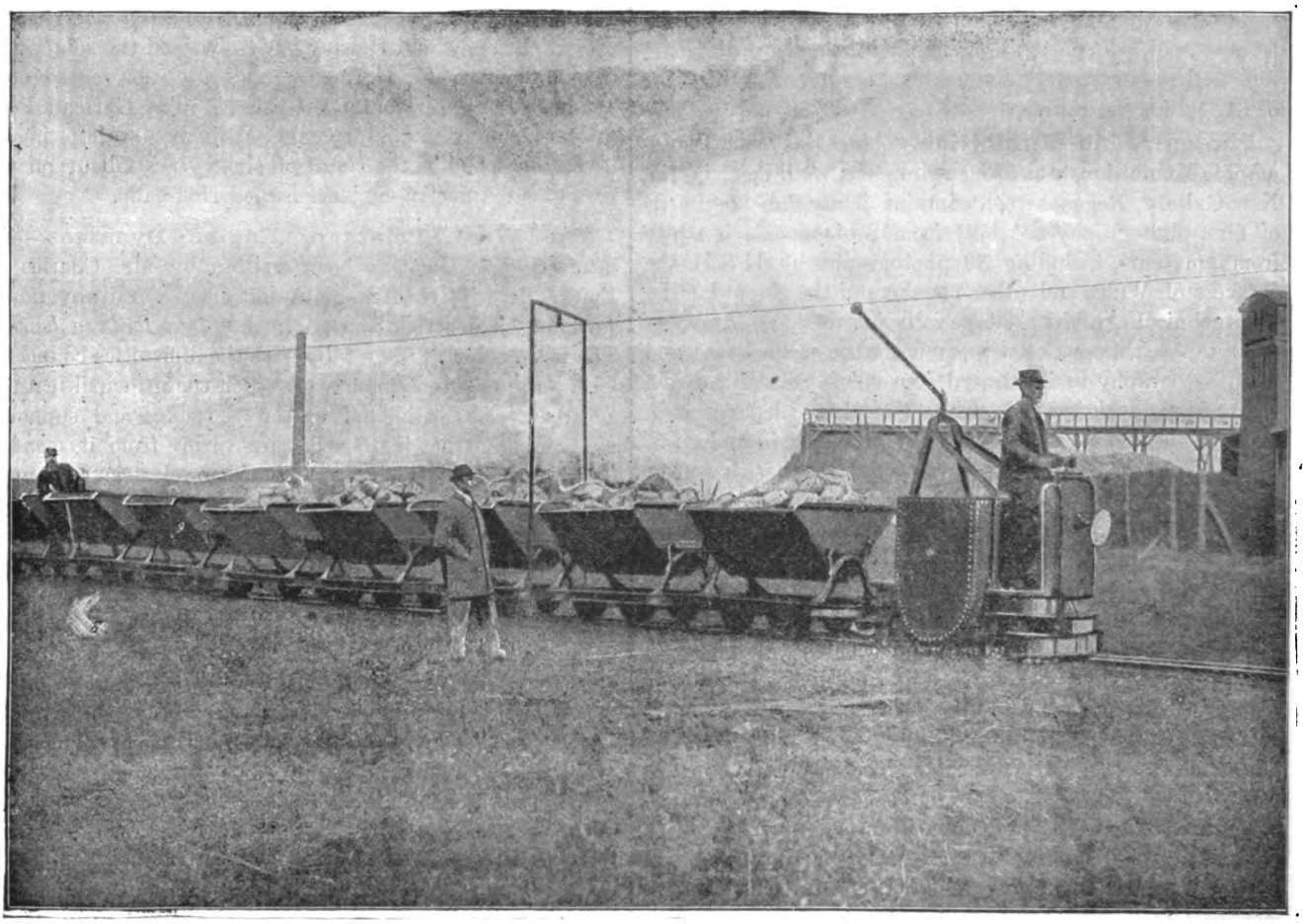

FIG. 1.—An Electric Line Equipped on the Koppel System.

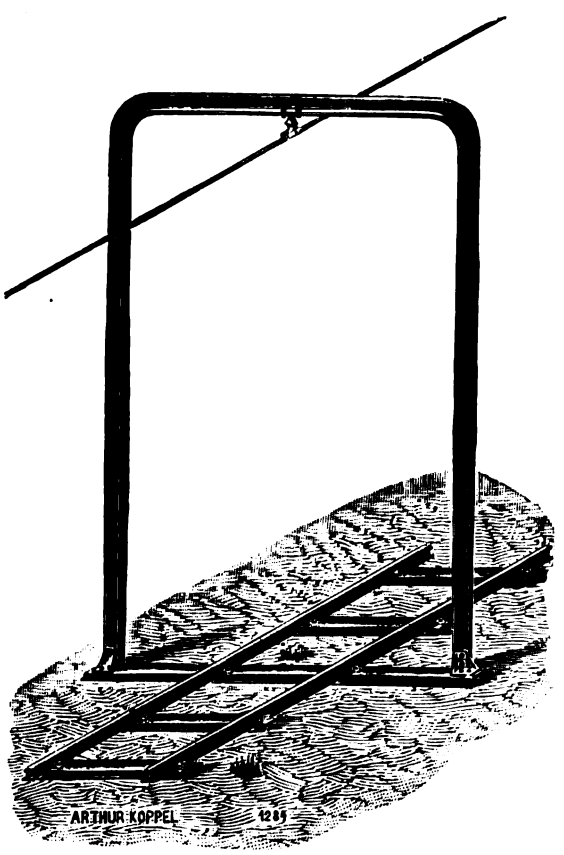

FIG. 2.—The Section with the Support for the Overhead Line.

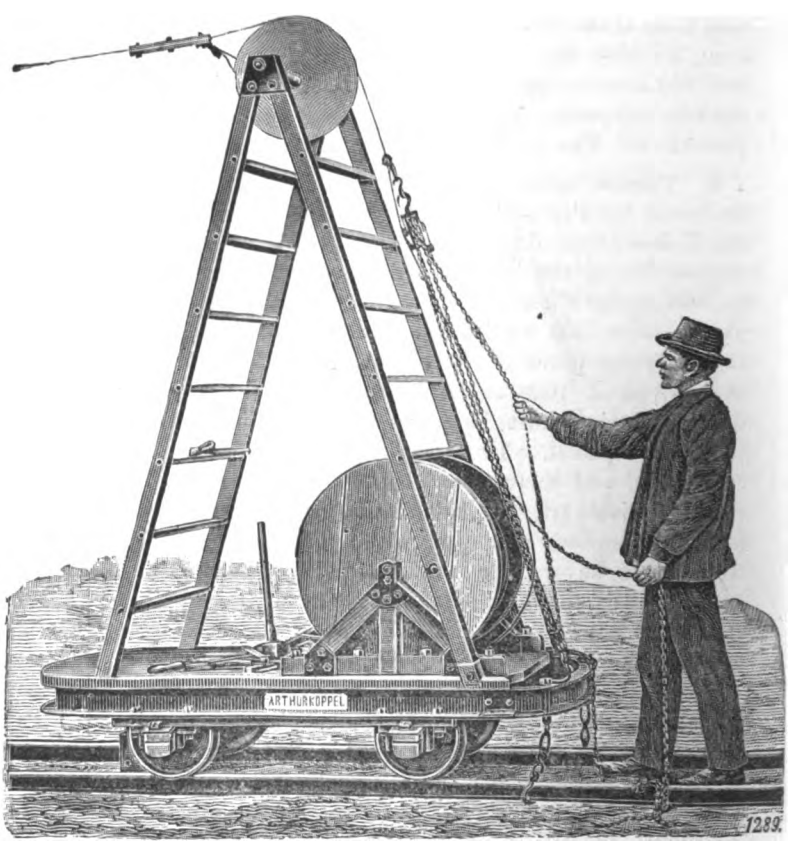

FIG. 3.—The Straining Gear and Terminal Anchor.

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A new system of equipment of such lines is now being introduced into this country by Mr. Arthur Koppel, of 96,

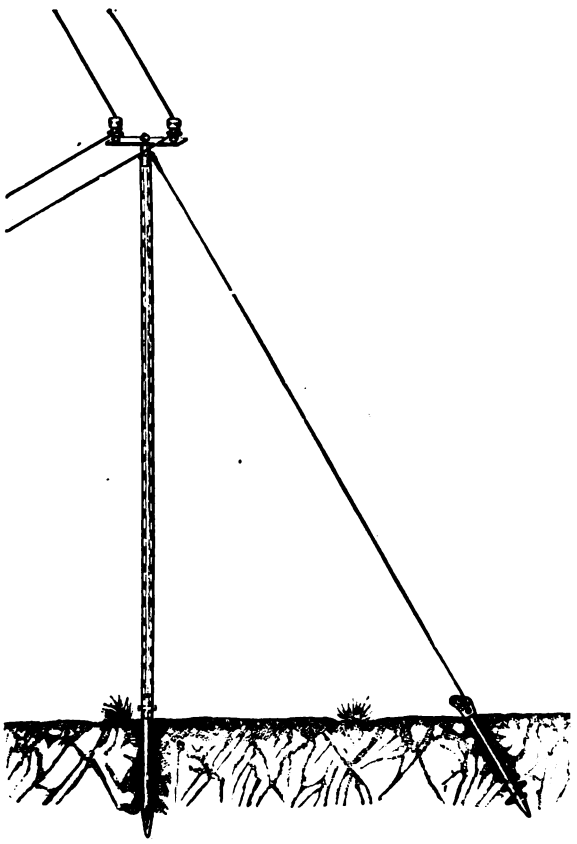

FIG. 4.—Light Pole for Carrying the Feeders.

Leadenhall-street, E.C. The keynote of this system is flexibility, the arrangements being such that extensions

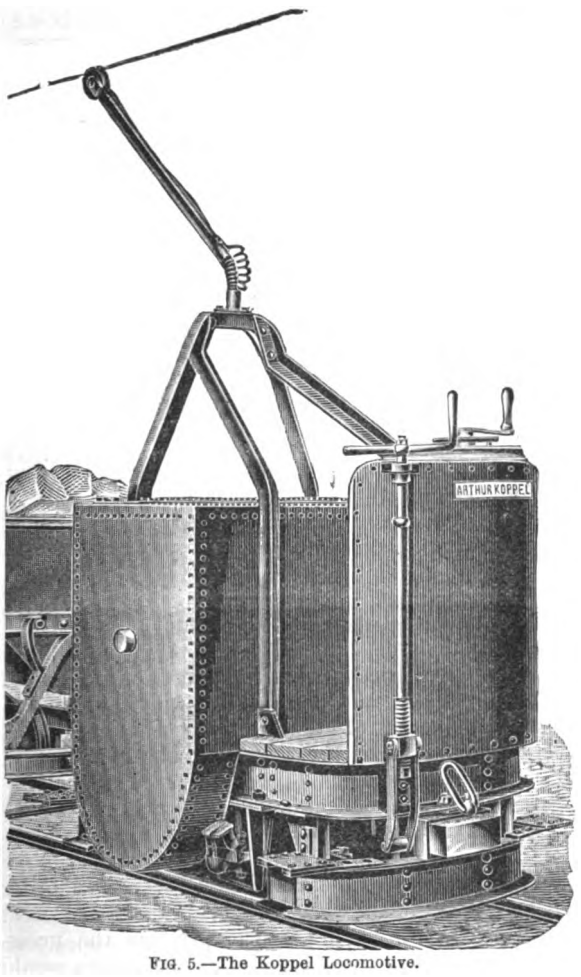

FIG. 5.—The Koppel Locomotive.

or alterations can be readily effected. In fact, the line is portable, and it is claimed also to be cheaper than the ordinary construction. The overhead conductor is employed, as can be seen from Fig. 1, which gives a general view of a locomotive and train of skips on a line actually at work abroad. The supports for the wire are not provided by separate posts and brackets in the usual way, but by arched carriers attached to the sections of railway line, thereby forming a portable section of the electric railway, as illustrated by Fig. 2. The steel carrier or "arch" is fixed to one of the sleepers, which is made of sufficient length for that purpose. On the straight line these line supports are placed about 25 yards apart. In curves of a small radius each section of tramway is provided with an arch, to keep the line of the wire as nearly as possible parallel to the curve of the line. Apart from these

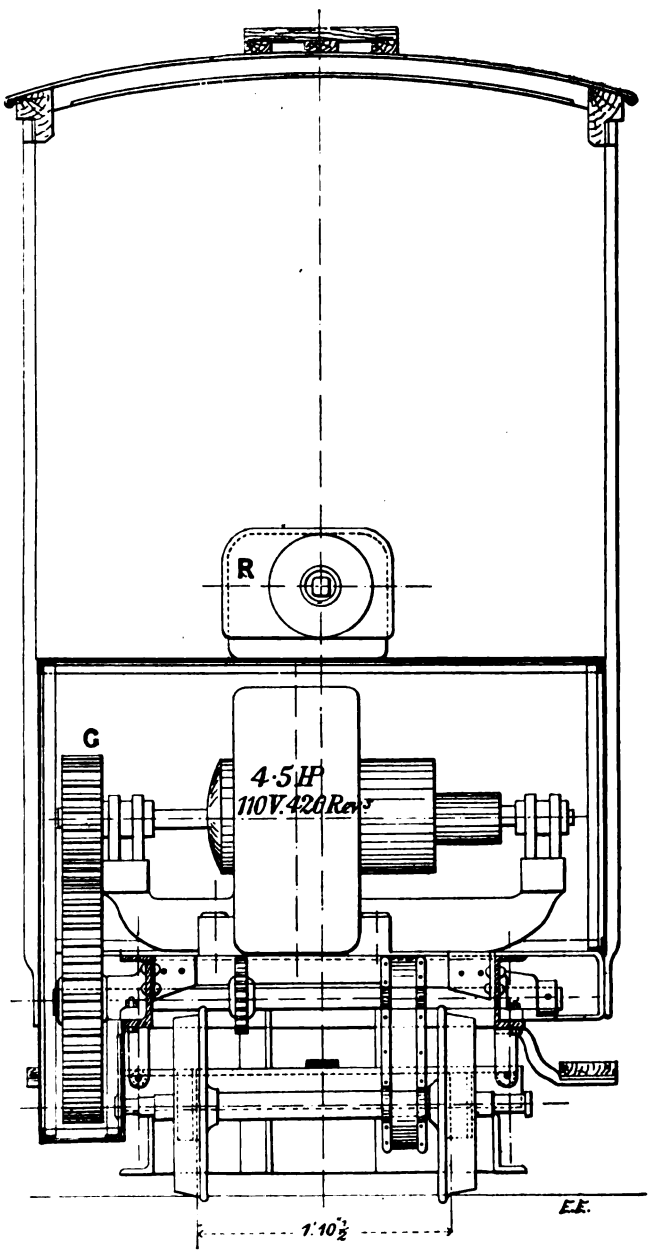

FIG. 6.—End Elevation of Locomotive.

special extended sleepers with wire carriers attached, the line is constructed in the ordinary manner with rails 14lb. per yard and upwards. As the electric locomotives are lighter than steam locomotives, the weight of rail required is somewhat less. The special trolley for erecting the wires along the railway line is shown in Fig. 3. This consists of an ordinary four-wheeled platform wagon with ladder, and wire drum with tightening gear and clamps or grips for anchoring the trolley to the line. The wire is led over a sheave on top of the ladder and fixed to the picket post at the beginning of the line. When erecting the wire the trolley is pushed beyond the first carrier arch, clamped on to the rails, and the wire is then tightened by means of the tightening gear. It is then firmly fixed to the insulator on the carrier arch. The tension in the

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copper wire is taken up by a second portable ladder, which is also provided with a tightening gear and can be clamped to the rails in the same manner as the trolley, so that the trolley can then be pushed behind the second carrier arch and the process previously described repeated. By the tension in the wire the carrier arches acquire the necessary stability, while without the procedure previously described it would be impossible to use such light arches attached to the sleepers. On permanent lines, the extreme ends of the wire are attached to properly anchored picket posts. On portable lines, on the other hand, the trolley with the wire drum is fixed to the rails at the end of the line, as shown in Fig. 3, so as to enable the line to be lengthened or shortened as may be required with ease.

tion, but it is securely boxed in a watertight iron cover. The controlling gear is then placed vertically in front. Figs. 6 and 7 show the details of the electrical and mechanical parts of this locomotive when fitted with a platform at either end, and with a hood. The motor, M, is of the internal pole type, and is supported on the underframe of the wagon. A double gear is used. The first is a spur gearing, connecting the motor to a countershaft placed under the motor. This gear reduces the speed of rotation to about 200 revolutions. The countershaft is then connected to the two axles of the trolley by chain gearing. This gives the necessary flexibility between the car body and the wheel required, as the springs give to any inequality of the rails. In this gearing

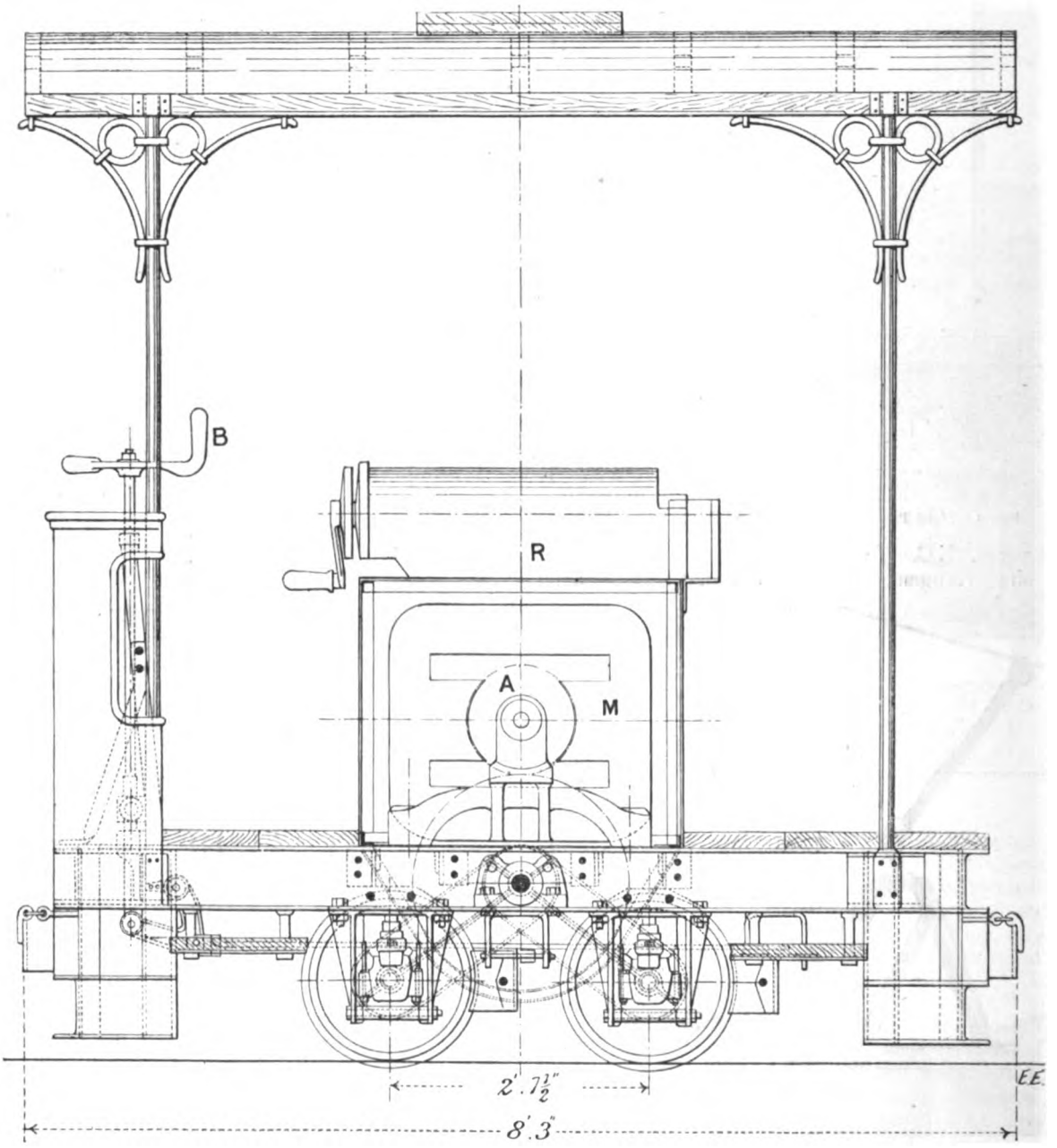

FIG. 7.—Detailed Elevation of a Koppel Locomotive with Double Platform and Hood.

Care is taken in insulating the drum and ladders so as to prevent leakage from this erecting trolley to earth. The feeders from the power-house to the overhead wire and to the rails respectively are erected on light iron posts, which have also been standardised by Mr. Koppel. A specimen of these posts with an anchored stay is shown in Fig. 4. All these details are arranged for convenience of the contractor required to rapidly equip a line of railway, which can also removed as soon as the work has been done.

The locomotive used is varied in form with the gauge of the line, but we are particularly concerned with those for gauges under 24in. One form of such locomotive without a hood to protect the driver is shown in Fig. 5. In this locomotive the gear is the same as that of the next illustra-

there is no change of speed. The underframe is provided with spring axle boxes, and also with spring buffers and draw-bars. The speed of the motor can be regulated within very wide limits by the regulator, R. An effective hand-brake is also provided.

For gauges of 20in. and upwards the motors can be mounted on springs and attached to the running axles inside of the wagon underframe. This construction is particularly recommended by Mr. Koppel where, in order to mount heavy gradients, the dead load of the motorcar must be assisted by the paying load to produce the necessary adhesion. In such cases several motor-wagons would be used in the same train. As regards the working voltage, this can be varied to suit special requirements, but the

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locomotive we illustrate was designed for 110 volts. At this pressure its possible working speed was at least eight miles per hour. The supply of power is also a matter not referred to particularly, as in many cases a lighting plant is used by the contractors, which could also be employed to provide the necessary energy for the electric railway. The good work done by small electric locomotives in the excavation work for the Waterloo and City Railway* will convince our large contractors of the valuable service which electricity can render both above and below ground.

THE MECHANICAL CONSTRUCTION OF ELECTRICAL MACHINERY.

BY F. M. WEYMOUTH.

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The Dynamo.

(Continued from page 525.)

Armatures (continued).—In Figs. 305 to 307 are depicted further examples of spider-built armatures. These represent designs by Messrs. Ernest Scott and Mountain, Newcastle-on-Tyne, and we have to thank that firm very much for the drawings from which our diagrams are reproduced. Fig. 305 shows a longitudinal section through a bar-wound

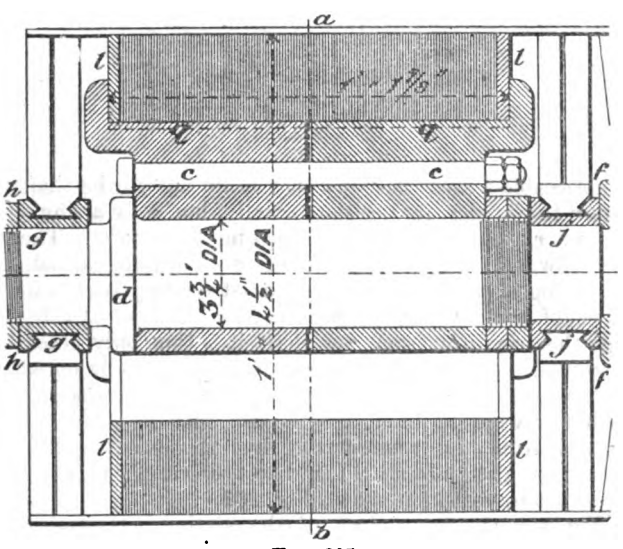

Fig. 305.

drum armature from one out of a set of 24 dynamos built and supplied by this firm for the War Office, the output being 200 amperes, 80 volts, with a speed of 340 revolutions per minute. Fig. 306 is a part longitudinal section, and an end view, of a Gramme armature, showing the core only. The cores for the drum and Gramme armatures are thus practically similar; and the end view in Fig 306 will answer for both.

It will hence be observed that the spider, which is of gunmetal, has three arms, and is made in two similar parts divided on the centre line, *a b*. These are drawn together by three steel bolts, *c c*, of which one penetrates the length of each arm. The iron discs forming the core proper are enclosed between plain end-plates, *l l*, which take the immediate pressure of the fingers of the spider, and which in the drum core are made of wrought iron, but in the Gramme core (Fig. 306) are of gunmetal or brass. These plates and the discs are slotted on the interior circumference, so that they fit over and are driven by the arms on which they ride, as may be noted by the dotted line, *q q*, indicating the normal bore of the core. It will thus be perceived that the whole core, when once bolted up, can be put bodily on or off the shaft without taking to pieces, this feature forming one of the reasons given by this firm for their preference for the use of a spider. The structure is held on the shaft by a nut and lock-nut at one end acting against a collar, *d*, at the other end; and the security is still further made good by the sleeve, *j*, of the end-winding, with the commutator beyond, the end of which latter is visible at *f f*.

It may be noted, however, that this construction, involving the centering of the end-winding on separate sleeves, such as *j* and *g*, does not permit of the winding being drawn off the shaft with the core, at least as regards

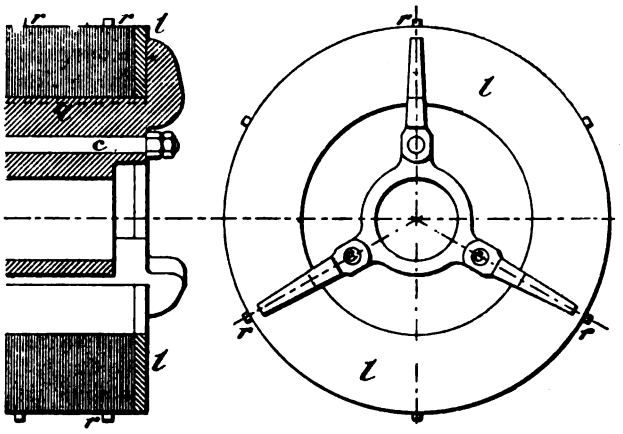

Fig. 306.

the end, *g g*. This armature being direct driven, the shaft has a cast iron coupling (not shown in the diagram), which comes beyond the end, *g*; and thus, in order that the sleeve, *g*, may be removed, this coupling is made detachable by being simply screwed on to the shaft. A nut, *h h*, intervenes between the coupling and the sleeve, *g g*, which it retains. Some dimensions are added from which other proportions may also be ascertained.

A great advantage claimed by the makers for this method of constructing the drum armature, wherein it is similar to the Gramme type, is that, owing to the large cavity within the bore, its temperature is the more easily kept low. We are informed, however, by this firm that it is sometimes their practice to further assist the ventilation by putting packing pieces between the discs, about every 2in. in the length of the core, so as to cause additional passages for exit of air from within, much in fact in the manner already illustrated at *z z* and *y y* in Fig. 294.

Fig. 306 also shows the horns for driving the conductors. These, lettered *r r*, are of gunmetal, and are knocked into holes drilled in the core. Between them and the conductor bars, fibre, ebonite, or paper packing is used so as to spread the pressure and prevent injury to the insulation on the bars: and the horns are, of course, arranged in annular rows, so as to come under the binding wires.

Fig. 307 shows a type of spider used by this firm for small one-unit machines. It will be observed that there

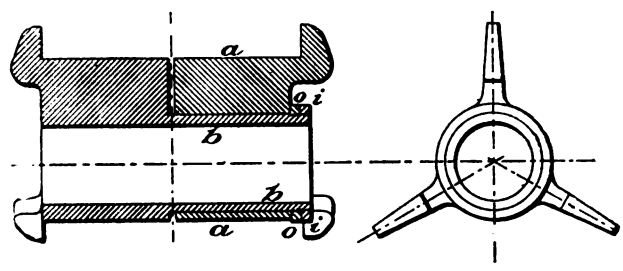

Fig. 307.

are no bolts; but one-half of the spider, *a a*, fits over a reduced prolongation, *b b*, of the other half, and is secured thereon by a nut and lock-nut, *o o* and *i i*; and the outer diameter of the cylindrical portion, *a a*, is the same as that of *b b*. This method of construction thus has the advantage in the case of Gramme winding, that owing to the absence of bolt-heads and nuts it allows the more room for the internal portion of the winding, liable otherwise to be cramped by the fastenings used for keeping the parts of the spider together. It has to be noted further that not only is the core self-contained, but if Gramme wound, the whole armature complete is also self-contained, and as such can be put on or off the shaft, which remark will apply, of course, equally to Fig. 306. Reverting once more to Fig. 305 we are informed that the

* *Electrical Engineer*, vol. xvi., p. 499.

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machines fitted with these armatures have given, and are giving, great satisfaction both as regards heating and efficiency.

We now approach another type of drum armature which has some features of special interest. We borrow this design from one of the plates in the fifth edition of Prof. S. P. Thompson's "Dynamo-Electric Machinery"; though it should be stated that in so doing we have removed the commutator otherwise shown in both views. The design is by Mr. C. E. L. Brown, of Oerlikon. A feature for which we perhaps the more especially introduce this armature here is that its construction is adapted for carrying what is termed "cylinder winding," so called from the fact that the whole of the winding, including the end connections, assumes a cylindrical form of one diameter; and the end-winding is not carried inwards toward the shaft as in other methods. This type of winding does not appear to be much used in England, if we except the case of the armatures of the Parsons steam-turbine driven dynamo, which latter is described in the present writer's book "Drum Armatures and Commutators" (pp. 80 to 82). A further example, however, in recent English practice was to be noticed in the *Electrical Engineer* for September 3, 1897, p. 300, where was illustrated an armature thus wound, constructed by Messrs. Easton, Anderson, and Goolden.

But this armature affords further interest from the fact that it has a "slotted core," as depicted at *x*, Fig. 309.

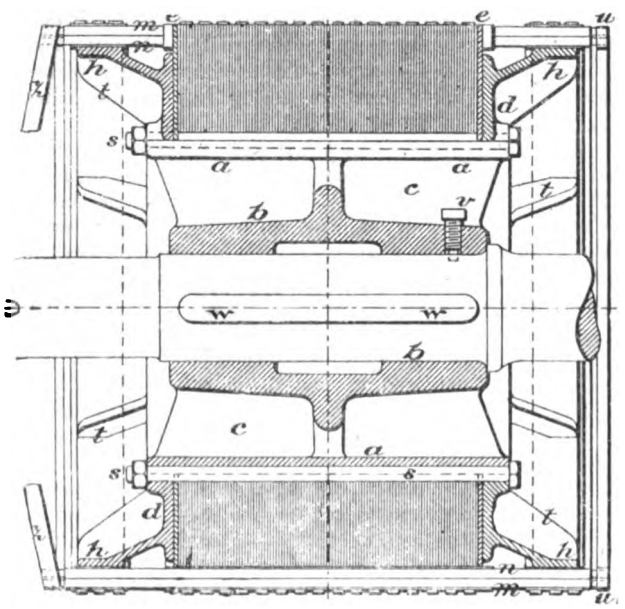

FIG. 308.

These slots are to be understood as being carried all round the core, with two conductor bars in each, laid one over the other. It is thus to be further observed how that this form of end-winding lends itself particularly to the use in conjunction therewith of slotted cores, though more especially perhaps, as we shall see, in the case of four-pole, or multipolar machines. Having regard to further general detail we note that, similar to the last illustrated, the core is carried on a spider, *a b c*, in this case with six arms, *c c*, so as to form a large central cavity; and the thickness of the core on one side is less than half the total radius. The core is enclosed between two end-plates, *d d*, between which and the thin discs are interposed other plates, *e e*. These latter are slotted on the outer periphery similarly to the thin discs, by which means the pressure of the end-plates, *d d*, is brought to bear on the core end in between the conductor bars, and protection is afforded to the teeth of the thin discs adjacent to the ends. It is now to be noted that, cast on the end of each end-plate, *d d*, is a cylindrical bracket, *h h*, the attachment of which to *d d* is strengthened by six ribs or webs, *t t*; and it is on this bracket, *h h*, that the end winding is carried, with a circular covering of insulation between it and the bracket as shown.

The end-plates at *d d* are bored to a fit on the spider similarly to the plates, *e e*. It is to be noted further that the bolts, *s s*, carried the length of the spider, lie half in long half bosses, *a a*, on the spider arms, and half in the soft-iron core, as indicated clearly at *r*, Fig. 309, and in Fig. 308, and that consequently their "pitch circle" coincides with the outer diameter of the spider arms, or inner diameter of the iron core. These bolts, *s s*, are thus used not only for tightening up the core until it is reduced to the same length as the spider at *a a*, but they also act as keys for driving the core: and a feather, *w w*, in the shaft drives the spider.

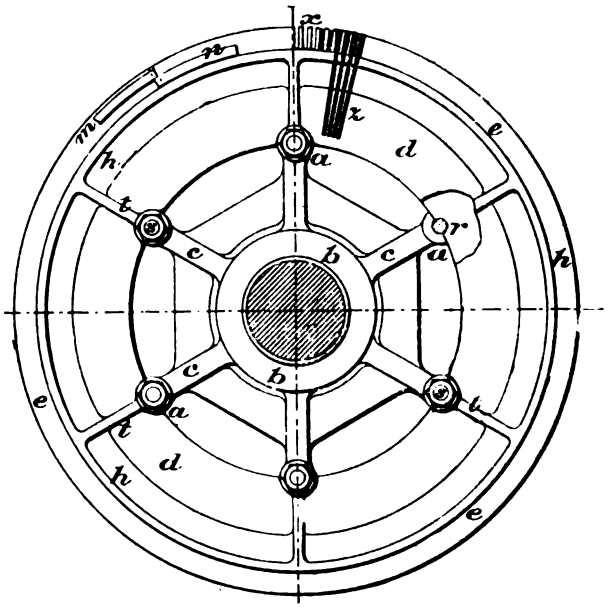

FIG. 309.

A noticeable feature is that there is no nut on the shaft to retain the spider in position axially, but only a single set screw, *v*, with its point penetrating the shaft. The writer, however, has been informed of this simple attachment having been adopted with most satisfactory results in the case of some armatures for tramcar motors. To disengage the armature from the shaft it is thus only necessary to slacken out this set-screw. It is, then, to be noted in Fig. 308, that withdrawing the shaft does not necessarily disturb the winding, though, of course, this may be disconnected from the commutator first if desired. This armature is also intended for direct driving, the shaft being identical with that shown Fig. 288.

In Fig. 308 the upper half of the section is through a tooth in the core between two slots (*x*, Fig. 309): while the lower half section is through a slot showing a pair of bars, *m* and *n*, in full view. The latter section also is through a bolt hole leaving a bolt, *s s*, in full view, the dotted line along the centre of which indicates the joint between the iron core and the spider, and the bolt thus half in each. In the upper half the spider arm is shown in full view, projecting in advance of the section, and thus only half of the bolt is exposed.

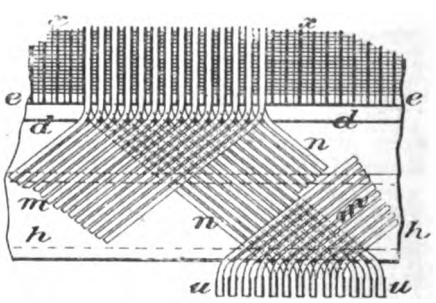

FIG. 310.

Fig. 310 is a part-developed plan or outside view, somewhat diagrammatic also, showing more definitely the arrangement of the end connections of the winding. The lettering indicates the same parts as in the foregoing views. It will be noted that the outer layer of bars, *m m*, turns aside at the ends in one direction, and the inner layer, *n n*, in the opposite direction, round the circumference, as also indicated in end view at *m n*, Fig. 309; and they are coupled

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at *u u*, or at the commutator lugs *z z* as shown in Figs. 308 and 309.

In this instance, illustrating presumably a four-pole machine, a straight conductor, *m*, will be coupled to a straight conductor, *n*, about 90deg. only apart, and not to one on the opposite side of the armature as would be the case with a two-pole machine. Consideration will show, therefore, that this point affects the dimension from *e* to *u*: for a bar, *m*, required to be connected to a bar, *n*, opposite, having to pass round the circumference twice the number of degrees, and necessarily maintaining the same angle with the end-plate, *d d*, would project at *u* twice as far as from *d d* as in the case illustrated. With a two-pole machine thus this form of winding would make a much longer armature than, say, the Hefner-Alteneck winding usually employed—as, for instance, in Figs. 300 and 306—and would lead to much waste of space at the armature ends. But in a four-pole machine, as is evident in our present illustrations, this objection has less force. The convenience with a slotted core will also be clear, especially with two bars in the slot as shown: for a bar, suitably shaped, is carried intact from *u* to *z*, at which latter positions also will thus come all the joints, where they are most accessibly situated. Lying in two cylindrical layers, no bar in any part of its length leaves the cylinder it helps to form; and there are no special cross connectors to make as in the case of other types of end-winding.

(To be continued.)

ACCUMULATOR TRACTION IN COLOGNE.

BY C. H. BIGGS, JUN.

It is pretty generally known that Germany during the last few years has made rapid progress in matters concerning traction. In most of her principal towns, not to mention numerous comparatively small ones, the tendency has been to adopt electricity as the motive power for street-car working. Taking the country as a whole, the mileage increase of lines worked electrically has been remarkable for its rapidity in comparison with progress made in the same direction over the rest of Europe—notably in England. Even in Germany, however, exceptions are found to the general rate of progress. Perhaps the most prominent of these is Cologne, where steam and horse traction still practically monopolise the field. Now it would seem that Cologne is at last waking out of her lethargy, for not only are the municipal authorities proposing to construct electrically-equipped lines of their own, but also one of the several private companies owning lines in and around the town is actually embarking upon a practical experiment with a view to eventually converting all of its passenger cars for accumulator traction. The experiment promises to be an interesting one, for the particular line over which it is to be conducted is for its length the best paying line in Germany, I understand. Having regard to this circumstance, it may be taken for granted that the directors will be chary of making any change from the present method of working—which is by steam—unless success looms ahead in no undecided guise. It will therefore be as well to watch developments.

In so far as the track itself is concerned, it is favourable for this mode of traction, being practically level throughout its extent. The course lays between Cologne and Frechen, and three journeys will be made over it daily by the car. The distance from the one point to the other is about 10 kilometres, so that only 60 kilometres will be covered per day. Outside of Cologne the track is composed of ordinary railway metals laid above the level of the road, which, of course, offer much less resistance (about half actually) than the slotted rails which constitute the town portion of the line. These preliminary conditions, it will be seen, are, as above stated, favourable; but turning to the car fitted out for the experiment we find that it was not specially constructed for the purpose, but is, on the contrary, of a heavy type intended originally for steam haulage. Its weight without accumulators or passengers, but inclusive of motors, etc., was 12,000 kilogrammes, and as originally constructed it provided accommodation for 70 passengers. Now, however, the rearrangement of the interior, necessitated by the introduction of accumulators, has considerably reduced this carrying capacity. In fact, room for only 51 persons can now be found. Thus it will be seen that difficulties of no mean order have had to be surmounted by Herr Arthur Scharfe—the engineer who has designed and superintended the conversion—in order to give the experiment a fair chance of success. The car is mounted upon two bogie trucks, one being provided with a couple of motors. These are of ordinary American type, and will run usually in series. Either is powerful enough to drive the car with its full complement of passengers, the idea of having two being simply to make the experiment more complete by providing better facilities for observing wear and tear of commutators, etc. They take from 45 to 70 amperes starting current at full load. The controllers are of the well-known Thomson-Houston pattern. An electrical and also a mechanical emergency brake are provided.

But, of course, one's interest culminates in the accumulators themselves, their capabilities and arrangement. These are of a type manufactured by the Electricitäts-Gesellschaft, Gelnhausen, by Frankfurt-on-Main, and are claimed to be specially suitable for traction work. As a full complement the car carries 46 accumulators, arranged, as in usual practice, under the seats. Their total weight amounts to 5,500 kilogrammes. Each accumulator contains 16 positive plates, or 32 plates in all. These are contained in four separate vulcanite cells (each cell containing eight plates), which are in turn packed together into a wooden box, the whole constituting one complete accumulator. Connections, of course, are as usual, all being free of access, and the familiar glass tubing is, moreover, used in the cells to prevent opposite plates from getting into contact. Gas is prevented from leaking into the car by rubber-lined pneumatic lids, with which every box is provided. These lids are placed in position and the pneumatic rims inflated in the same manner as a bicycle tyre, the rubber then making close contact with the outer containing box on all sides. Flexible tubing passing through the lids conducts superfluous gases from the cells to the exterior of the car.

With regard to the plates constituting this particular make of accumulator, the exact constitutents of the active material employed is naturally known only to the manufacturers. But it is an open secret that granulated pumice stone is used to secure maximum porosity, and, therefore, great active surface of lead in the paste. This active material is supported by leaden frames.

Under working conditions the battery will never be called upon for more than about 70 amperes starting current, though capable of yielding fully 100 amperes, while the normal rate of discharge will be between 30 and 40 amperes. The capacity of the battery will suffice for two journeys between Cologne and Frechen. An interesting feature with regard to the arrangement of the accumulators is that they cannot be removed from the outside of the car. Charging will be done without disturbing them at all. This latter, indeed, is very simply arranged, for the tramlines pass in close proximity to the Frechen electricity supply station, directly opposite to which a siding has been constructed for the reception of the car. To this siding overhead leads are conducted from the station, which are connected with the accumulators through contacts provided outside the car when charging—a very simple operation. In practice the two rows of accumulators (one ranged on either side of the car) forming the battery will be charged in parallel, each with either 25 amperes for three hours or 75 amperes for one hour, as may be convenient. The generating station, which had only an alternating-current plant, has been of necessity provided with a special dynamo for the charging purposes. This was supplied by Ernst Heinrich Geist, of Cologne, and has a generating capacity of 250 amperes at 240 volts, with 700 revolutions per minute. The charge for the charging current is at the rate of 15pfg. (1⅝d.) per unit. It may be added that the cost of converting and equipping the car for accumulator traction has been, in round figures, £1,000.

On Saturday, October 23, a party of gentlemen—members of the Elektrotechnische-Gesellschaft at Cologne—attended a trial run of the car in response to an invitation issued by

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Messrs. Hiedermann and Co., the constructors and proprietors of the line. Notwithstanding that considerably above the full complement of passengers was carried, the car ran quickly and very smoothly throughout. Much interest was evinced by the members of the party in the arrangements at Frechen for charging the accumulators, etc. A thorough inspection of these having been made, an instructive visit was then paid to a neighbouring brown-coal mine, after which an equally successful return run to Cologne in the accumulator car was negotiated.

WATER POWER, WITH REFERENCE TO ITS APPLICATION TO ELECTRICAL MACHINERY.

BY J. HERMANN FIELD.

III.

The employment of mixed-flow turbines is much more usual in the British Isles for moderate falls—and England is eminently the land of low falls—than of other systems, though in several instances Jonval turbines, manufactured by Continental firms, are at work. Such a turbine station at Brantham Mills was described by Mr. Steiger before the Institution of Electrical Engineers in May of 1896. The illustration in Fig. 11 represents a mixed-flow turbine made by Messrs. Carrick and Ritchie, of Edinburgh, for a working fall of 6ft. It is 6ft. in diameter, and develops 70 h p at full gate, with the above-mentioned head, passing 8,000 cubic feet of water per minute. This shows an efficiency of 77½ per cent., which is a good working figure seldom exceeded in practice, though test efficiencies in favourable circumstances will reach 85 per cent., notably where smaller bodies of water and higher heads are in question. The gate here shown is of the cylindrical type, rising and falling between the guide blades and the wheel buckets. Being steadied during motion at four points of its periphery, and counterbalanced by weights, this form of gate lends itself readily to sensitive governor control, a point often unattained in machines of large diameter. It will be noted from the figure that the discharge of water in this low-fall turbine takes place partly below and partly in the middle of the wheel, while the discharge from some other mixed-flow machines, such as the "Little Giant," is entirely below, the whole of the water being turned in an axial direction by the guide blades before ceasing to be subject to their action. The turbine pit suitable for this "Waverley" machine would have an area of about 225 square feet, with a consequent full-gate mean velocity of water approach equal to ·6ft. per second, the mean velocity to be allowed in the head and tail races to be about 2·5ft. per second.

Turbines of this class in common use have footstep bearings of *lignum vitæ*, or guaja wood, completely immersed, and usually bearing the whole weight of the wheel, shaft, and bevel wheel at the top. These materials for bearing surfaces are found to be very suitable for use under water, as this latter forms their best lubricant, its access to the surface being often specially provided for by inlet holes in the crown. They are also well adapted to carry very heavy weights without undue wear. Fig. 12 shows an ordinary form of this footstep. The shaft is swelled to take a brass step which works on the *lignum vitæ* block, arranged with its grain vertical. Wear is taken up by screw, lever, or wedge adjustment, and a groove is cut round the wood block, or holes are bored slantwise through the step from above to effect the necessary lubrication. Other forms of subaqueous steps are enclosed and water-tight, and, having steel bearing surfaces in place of brass and wood, they are supplied with oil. Circulation is kept up either by the natural weight of the column of oil in the supply tube, which reaches to a point above water, or by the action of a small pump.

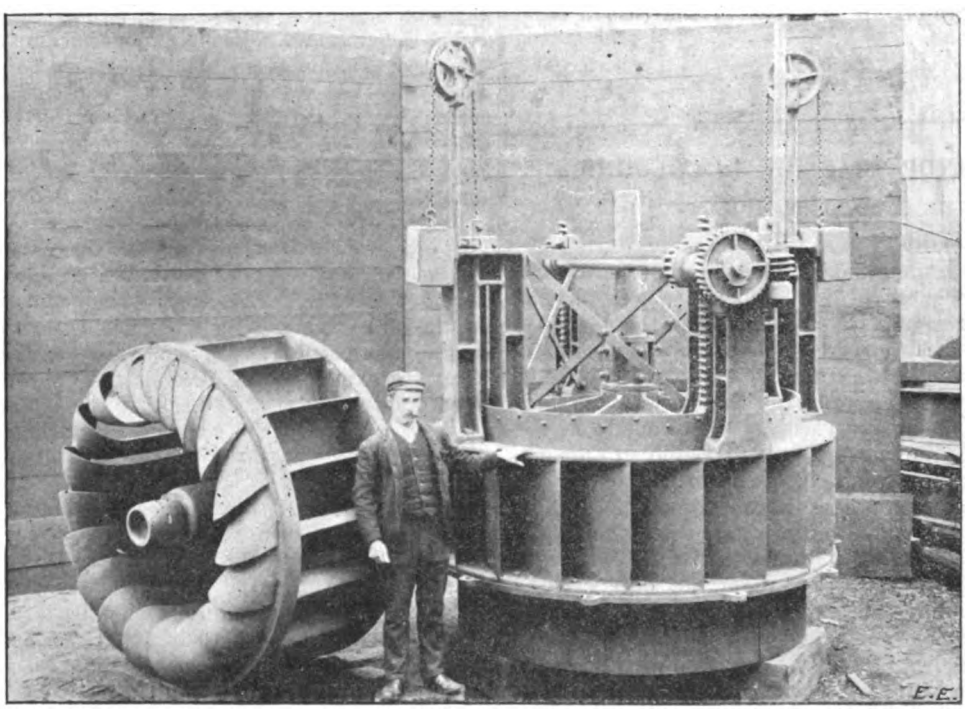

Fig. 11.—Mixed Flow "Waverley" Turbine.

Step bearings above water, running in a chamber of oil, are much used for the heavy wheels at work on the Continent; the turbine and its hollow driving shaft enveloping and practically hanging from the solid footstep shaft at a height convenient for ready access. Fig. 13 shows such a footstep bearing in common use. The central lower shaft, of wrought iron, is stationary, and acting the part of a strut is kept as short as possible. It rises from a footstep pedestal, solidly bedded below the turbine, to some distance above the water, where it carries an oil-bath, A, and ends in the bearing surface of brass or steel; a similar steel-ended shaft works on it either directly or through three steel lenses in the oil-bath. The lenses when used serve to distribute the pressures equally, and to prevent undue wear by minimising the chances of defective lubrication. The upper shaft carries the hollow cast-iron driving shaft shown in the figure, which envelopes the lower stationary shaft, B, and carries the turbine wheel. This hollow shaft is steadied internally by a bearing working on the centre wrought-iron shaft at the level of the wheel, and by a similar bearing just below the oil-bath.

Forms of immersed steps have been designed by various makers for use with pressure water, that of M. Girard having been used in practice. The lower end of the shaft was supported by the pressure of water admitted to a

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cylinder, hydraulically packed, so that no end lubrication was needed, and no wear took place. The difficulty of continued working with these devices lay in their tendency to leak pressure water, or else to eventually burn out the packing. The bevel gear referred to above for transmitting the power to a horizontal shaft is always in use for large

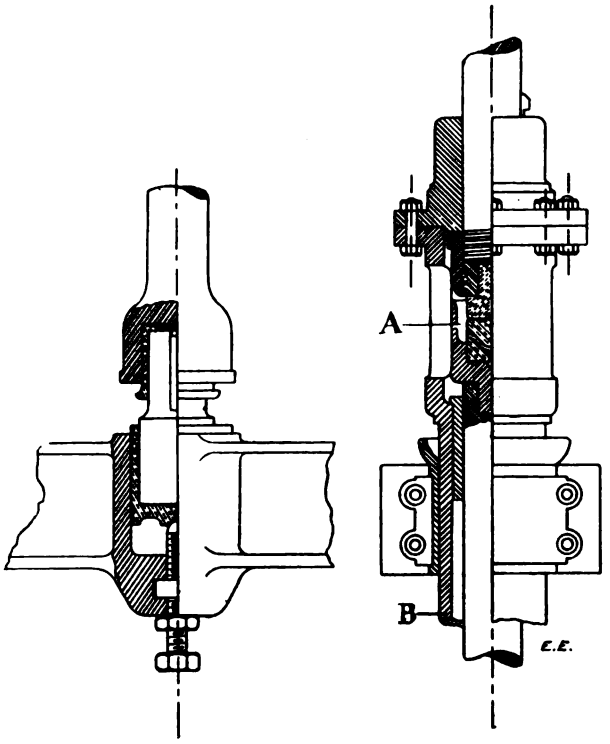

FIG. 12.—Lignum Vitæ Footstep. FIG. 13.—Continental Above-water Step-bearing

powers on low falls with vertical shaft turbines, since the speed of the wheel of large diameter and with great quantities of water passed must necessarily be too small to allow of advantageously coupling electrical machinery directly to it. The countershaft running from the bevel gearing at a higher speed may best be belted or roped to the dynamos, direct coupling after-bevel gearing being inadvisable in most cases.

Vortex turbines, the embodiment of the results of Prof. J. Thomson's experiments, and as manufactured by Messrs. Gilbert Gilkes and Co., of Kendal, are in use on falls from 3ft. upward; with vertical shafts for very low falls and with the more convenient horizontal shafts on heads of 10ft. to 200ft. or more. Fig. 14 shows a horizontal shaft vortex wheel of 300 h.p. for a 300ft. fall, fitted with

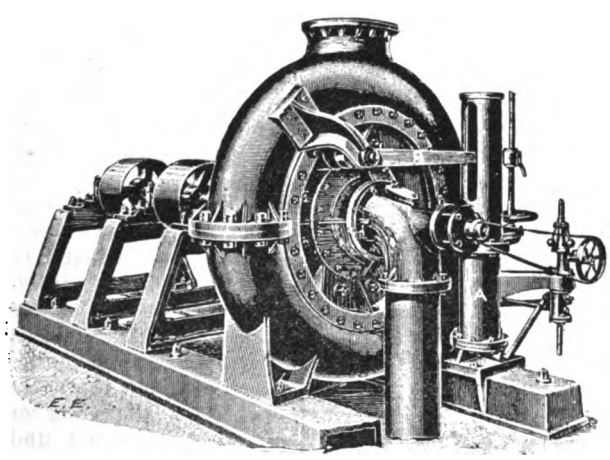

FIG. 14.—Vortex Wheel, 300 h p.

hydraulic piston governing arrangement and draft tube. The regulation of water supply is, as before explained, effected by guide-blade levers connected together within the chamber and actuated from the lever, B, simultaneously by whatever form of governor is in use with the machine.

Passing from the consideration of the class of turbines already defined as that of "pressure or reaction" working, impulse turbines and jet-wheels occupy an important place in the production of power for electrical purposes under high heads, and for *very* high falls they are indispensable. Turbines of this second class differ from those already dealt with, in that (1) they rely for their action on the momentum only of the moving water; (2) since they are open to the atmosphere, there is no pressure in the clearance spaces between guide blades and wheel buckets, and they are consequently not subject to any influence due to water pressure, other than that contingent on the acceleration of the water as it strikes the wheel and is reversed in direction; (3) the passages are not completely filled with water (see Fig. 15); (4) they discharge above tail water.

Now although the term "turbine" is often applied to machines of "partial admission," where the water is not supplied to all the wheel buckets simultaneously—*e.g.*, Girard radial outward flow—it is perhaps better restricted to those wheels which work by reaction, or, at any rate, to those which have a full supply to all parts of their perimeters. The extension of the meaning of the term to embrace impulse wheels of partial admission must

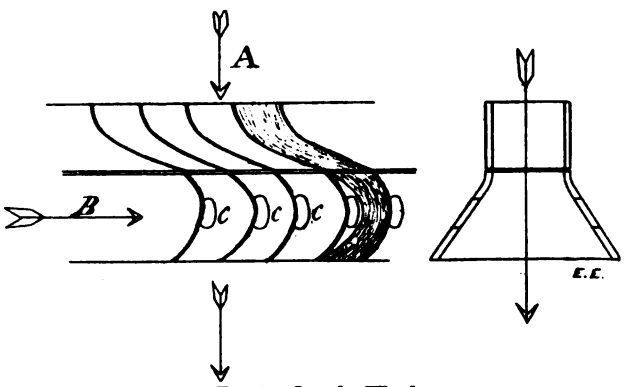

FIG. 15.—Impulse Wheel.

necessarily involve also the inclusion of single-jet machines, such as the Pelton, which are certainly very far removed in action from a "turbine" as generally understood, and, indeed, much more closely resemble the undershot waterwheel.

Turbines of the "impulse" persuasion have been recommended for use even on small falls by experienced turbine builders and engineers, but whatever their merits may be, and they are of course undisputed, for the development of power in mountainous countries with heads varying from 200ft. to 1,000ft., it is certain that their employment in place of the low-fall reaction wheels has met with but poor support from British engineers.

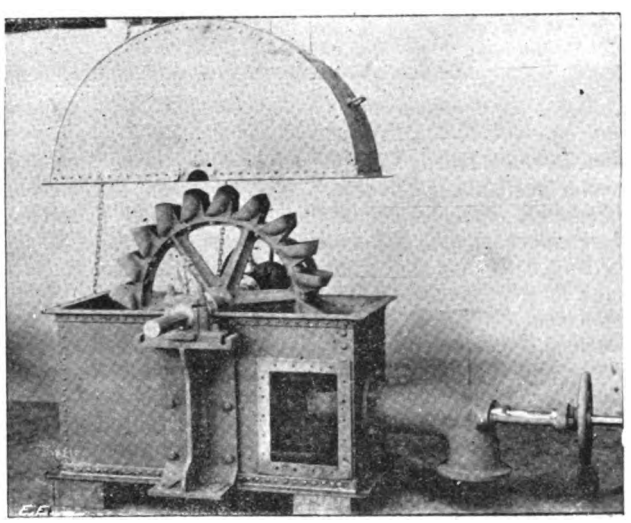

FIG. 16.—3ft. Pelton Wheel.

On the Continent the axial-flow "Girard"—practically a ventilated Jonval—is to be seen working with a good efficiency, the turbine being kept clear of tail water as with the Fourneyron type. The shape of the guide blades and buckets and the direction of water flow in this machine may be seen by reference to Fig. 15, in which the holes, C, are for the purpose of ventilating the buckets. Its working thus relies only on impulse or "action," and the buckets

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have to be so shaped that the whole of the kinetic energy of the water is absorbed. The modifications necessary for satisfying this condition will be seen on comparing the figure with Fig. 8 of the Jonval turbine, in which pressure action has also to be taken into account. Indeed, the widening of the buckets of the wheel towards the point of discharge, the modification also of their curved shape, and the ventilation of their sides form the main points, in regard to which the Girard axial flow differs from the standard pressure Jonval.

It may be said of impulse wheels generally that inasmuch as that their passages do not require to be *filled* with water, no such stringent restrictions apply to them in the matter of diameter, speed, or size of buckets, as is the case with reaction turbines, whose efficiency directly depends on the proper proportioning of all its parts in reference to velocity and head of water. Further, the impulse machine, whether it be a Pelton type jet wheel, or a turbine of axial flow, may, without injuriously affecting its efficiency, be made to vary largely in its diameter to suit speed required, in its dimensions to suit varying quantities of water, and in the number of its passages or buckets simultaneously in action to suit variations in the requirements of power. An early form of impulse wheel, with water passing through a jet, was introduced in 1865 in California, and was there known as the "Hurdy Gurdy." According to the quantity of water available, it had jets of ⅜in. upwards. Its simple construction, exactly resembling a small size primitive undershot wheel with flat radial buckets, enabled it to be rigged up with ease, and transported at small expense, and, though its efficiency was only 40 per cent., it was used to a large extent.

Natural developments soon led to the adoption of curved buckets, and the later form of divided cup introduced in the well-known Pelton wheel brought the efficiency up to 80 or 85 per cent. A neat 3ft. enclosed Pelton wheel and delivery tube is shown in Fig. 16, taken from a photograph of a machine ready for delivery in the shops of Messrs. Carrick and Ritchie. The buckets are secured to the rim of the wheel by bolts, and, being interchangeable, are readily replaced when occasion arises. A wheel of this size will give from 10 h.p. at 230 revolutions per minute to 160 h.p at 570 revolutions on falls of 80ft. and 500ft. respectively. The design and shaping of the buckets and their mode of attachment to the rim of the wheel have long occupied the attention of engineers, and many modifications in use in their own day have now been superseded.

It is manifestly the function of a perfect wheel to so deal with the water, to whose action it is subjected, as to remove from it all its kinetic energy (on which it solely depends, since the supply is open to the atmosphere), leaving it with no velocity relatively to the nozzle from which it emerged. This can only be done by completely reversing the direction of water flow while still in contact with the bucket, and since the discharged water must not interfere with the issuing jet, it becomes necessary to displace it laterally and so remove it. The jet of water strikes midway on the centre division of the bucket, and its two parts are then freely deviated laterally. It is evident that for the water to have no velocity relatively to the nozzle, it will be necessary that the linear velocity of the buckets be half the velocity of the issuing stream, which velocity is, of course, that due to the head indicated by a pressure gauge at the supply pipe close behind the nozzle. The shape of the interior of the bucket, and the diameter of the wheel, must therefore be adapted to completely reverse the direction of the water and throw it back with a velocity relatively to itself equal to the difference of the velocities of the issuing jet and of the wheel. The Pelton wheel, so well known and extensively used in America, has a good working efficiency of 80 per cent., and a test efficiency with favourable conditions of 85 to 88 per cent.

The methods of regulation employed with jet wheels are of three kinds: (1) the shutting down of some of a number of nozzles; (2) the diversion of a portion of the pressure water from one swivelled nozzle so as to allow a varying proportion of the jet to escape the wheel: (3) the throttling of the water just before the nozzle, the valve being worked by hand or by governor.

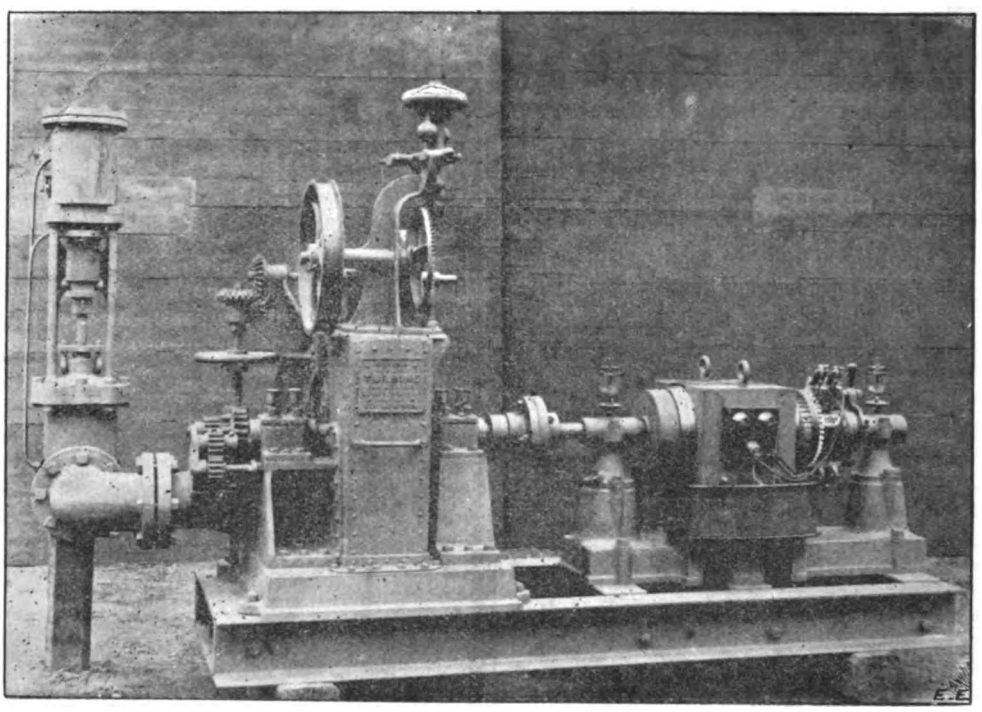

FIG. 17.—Girard Turbine and Governor.

Pelton wheels work exceedingly well under governor control, and owing to their great adaptability to differences of head and quantity of water, they may conveniently be made to suit the speed of any dynamo coupled direct, on practically any fall for which they are suitable and for greatly varying bodies of water. It is not an uncommon thing to use one Pelton wheel to give out at maximum efficiency from full power to 25 per cent. of the same merely by the temporary changing of its nozzles, one or more, according to the variations of water supply with the changing seasons of the year.

A few details of the cost of water-power plants and works in connection therewith will probably be of interest, though it is not possible to state any typical cases either for low, medium, or high falls, as local conditions will always greatly influence the expenditure necessary to develop a given power. The construction of low-fall turbine works is usually of an expensive nature, as in most cases a dam will be necessary across the stream just below the point of intake of water by the headworks for the purpose of increasing the head, and of using a larger proportion of the total flow in the stream. The large size

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also of the head and tail races requisite to pass the given quantity of water causes a great expenditure per yard run, and if these have to be of considerable length in order to obtain the working fall the value of the water power may be so much reduced as to render its improvement unremunerative. The following are some approximate costs applicable to such a case as that of the mixed-flow turbine illustrated in Fig. 11 when used on a 6ft. fall, and compared with this are one or two other cases arranged below of turbines working under greater heads:

Cost of turbine, bevel gearing, horizontal shaft, sluices, screens, and all ironwork necessary for erection	£600
Cost of excavation and formation of walls of flume and outlet, end of headrace, and work for sluices	400
Cost of excavation and formation of head and tail races for a lade of, say, 500 yards	500
Cost of weir across stream with contingent works, assuming the stream to supply a mean quantity of 8,000 cubic feet per minute, as required by the turbine	350
	£1,850

or £26. 8s. per brake horse-power inclusive of such building work as has direct connection with the water power.

A second case of British work on a small plant, in which a 12-h.p. turbine is used on a 27ft. fall for lighting a private mansion in Scotland, shows costs as follows:

Rough weir across stream to raise level of water a foot, formed of boulders anchored to bed of stream, the spaces being filled with concrete, also forming intake	£20
600 yards of 18in. fireclay pipe, slope 1 in 500, laid complete for head and tail races	360
Inlet sluice and screen, tank, by-pass sluice and gear, etc., fixed	32
Steel riveted pipe, laid and jointed, 27 yards, 14in. diameter	50
12-h.p. turbine, governor, and gear fitted in place	125
Foundation for turbine, and small machine house	50
	£637

or £53 per horse-power, inclusive of building.

On a fall of 300ft. in Stirlingshire, the Girard turbine shown in Fig. 17 was installed for the supply of electric light for private purposes. It works with a net head of 280ft., is regulated by a hydraulic governor, and coupled direct to its dynamo. The inlet of the governor is separately controlled electrically from the house, so that the machine is readily shut down when desired from there. Costs arranged on a similar basis to the foregoing:

Earthen dam to store 50,000 cubic feet of water, with puddle clay interior, pitched with stones on the inner surface, 70ft. long, 14ft. high at middle	£200
Sluices and screens, ironwork, etc.	20
700 yards cast-iron pipe, laid and jointed, partly 8in., partly 9in.	365
Girard turbine, governor, gear, sluice valve, etc.	150
	£735

or £36. 15s. per horse-power.

Another case, where the abundance of water in the stream gave a plentiful supply without recourse to a dam, gives costs at £20 per brake horse-power:

Intake and timber lade, sluices and screens	£65
9-h.p. turbine fixed, foundations for same	90
Supply pipe and draft tube	25
	£180

The capital expended in erecting the large power station at Olten Aarburg, in Switzerland, is here shown to amount to £35·68 per horse-power. The figures have been kindly put together for the writer by Herr Allemann, the director of the works:

Dam across river 112 metres wide, and sluice gear to headrace	£36,640
Head-race 760 metres long, 45 metres broad at bottom	18,400
Machinery for power production only	17,000
Buildings	17,160
	£89,200

which is for a total of 2,500 h.p.

This figure includes both the buildings in which the turbines are set, and also the dynamo-house and switch-room and offices, but no electrical generating or distributing plant.

Now the above given particulars of the expenditure found necessary per brake horse-power on different sites, exactly representing such works as correspond in any station with steam engines and boilers, steam-ring, and all setting, are useful in this comparison, since the rest of the buildings and offices will be the same whichever source of power be used. The question of the cost of roadmaking to the turbine-house seldom has to be considered, as no such traffic is to be expected, as would be the case with manufacturing works.

(To be continued.)

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

PLYMOUTH REFUSE DESTRUCTOR.

As we inserted Mr. G. Watson's letter on the above subject, we feel bound to give the following reply from Mr. A. R. Debnam:

SIR,—Kindly allow me a small portion of your space to reply to the managing director of the Horsfall Furnace Syndicate. The figures I used on Monday were obtained from the same source that he quotes, or rather that portion of it that appears in the *Minutes of Proceedings* of the Institution of Civil Engineers, issued August, 1897. It says there: "The total cost of destruction amounted per 1,000 kilogrammes of refuse to 1·762 marks," and there being 1,015 kilos to the ton, a mark being equal to about 11¾d., it was no inaccuracy to say it cost 1s. 9d. per ton to destroy. True, if you take the value of clinker in Hamburg, it would reduce the cost, but we are discussing the value to us of a destructor here, and as the clinker is valueless in Plymouth, it cannot be taken into account for the reduction of cost. With respect to the value of steam that can be obtained from a destructor, this is a very debatable point, and one of the reasons for deferring the question is for the committee to glean further evidence upon this, not simply what it may be, but its actual value to some public body who are taking their power wholly from a destructor.

By referring to the same authority, the cost of the 36 cells was £24,000, equal to £666 per cell. The basis I took on Monday was £500 per cell. This, at any rate, was on the safe side.

Mr. Watson further states that the saving to the town as against the old system is 1s. per ton, but that certainly will not apply to Plymouth, for whatever system we adopt will cost more than the old method; and we are prepared for that.

Now, as to Oldham, Mr. Watson says: "Mr. Debnam's strictures on the Oldham plant were well dealt with by Mr. S. J. Page, who defended us both justly and ably." Therefore I will take Mr. Page's remarks as the answer of the Horsfall Furnace Syndicate. My words were: "At Oldham they found that the Horsfall destructor had to be rebuilt after four years' use." Mr. Page's reply: "It had not been rebuilt at all, as stated by Mr. Debnam, but a steam draught had been adapted to the old furnace." The information with respect to Oldham was in the first instance gleaned from the report signed by Mr. Page, wherein the following passage occurs: "The six cells erected in 1891 were reconstructed, and have been working 12 months." Well, if reconstruction is not rebuilding, what is it? The fact is that all destructors wear out rapidly, and one is safe in saying that the cause of this wear and tear is clinker and the operation of clinkering.

So far this discussion is mainly on the cost of destroying the town's refuse, and where I differed from the committee was in respect to the costs put down in their report, and here I will use the Horsfall Company for the purpose of explaining what I mean. This company issues a pamphlet dated February, 1897, giving a table of costs for destroying refuse, and it says the relative cost per ton burnt, in stoker's wages, for the Horsfall was 9¾d., and Beaman and Deas 13¾d.

But these are the precise figures used by the committee as being the cost of destroying the refuse, ignoring the fact that other expenses in addition to stoking are incurred. In conclusion, allow me to say that my opposition is not to the Horsfall or any other furnace in particular, but to the whole scheme, until further and fuller information is obtained.—Yours, etc.,

A. R. DEBNAM.

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MUNICIPAL TRAMWAYS.

We may not agree with the policy of municipalising tramways, but that policy seems to be extending and must now be treated as a concrete fact rather than an abstract question. It is easy to see why municipal bodies are anxious to have the tramways under control. The main and, in fact, the all-important question with them is to have no divided control of the carriageways under their control. The task of a borough engineer to keep in due repair and sanitarily perfect the streets of a busy town is an exceedingly difficult one. He cannot know the times and the seasons when the tramway companies, the waterworks, the gas, the telephone, and the electric companies will want to interfere with the street traffic, yet it comes within the scope of his duties to in a measure play second fiddle to these various authorities while he is playing first fiddle to the citizens of the town, and has to obtain and preserve for them free and uninterrupted carriageways. Obviously, then, if the water, gas, electric light, and tramway works are under the control of the local authority, it is far easier for the engineer of the authority to minimise the troubles arising from street work in these various directions. We are willing to grant the immense advantages arising from absolute control, though we think, so far as tramways are concerned, there are disadvantages which outweigh the advantages. However, as that does not seem to be the opinion of the various authorities which have examined the matter, our task in considering tramway work is simplified, and is merely to examine the schemes variously proposed to and by the authorities. Fortunately, the trend of modern opinion is to use electrical energy as the motive power. The most recent report on the subject before us is that of Manchester, which falls into line in this direction with the reports of Sheffield, Douglas, Liverpool, Bradford, and other towns. It is evident that the influence of the Continent and America is being felt here. The Manchester report says: "One result of the investigation is to show that electric traction is fast superseding all other means of hauling trams. Wherever electric traction has been introduced on a small scale, the system is being largely extended, and the use of horses is being entirely abandoned." That is true, and this extension, as we have before pointed out, and as various reports have also recorded, improves the sanitary condition of the streets, and relieves the ratepayers' pockets. Upon another point the Manchester report agrees with previous investigations. It says: "To sum up, it would appear that the overhead trolley system with span wires attached to posts fixed along the sides of the streets is the most suitable for Manchester." When we come to consider the development of electric tramway work and the part that our own manufacturers have taken in that development, the conclusions from such consideration are not particularly gratifying. Volk, at Brighton, was the pioneer, then followed short lines in Ireland and the conduit line at Blackpool. These, with the City

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and South London and Liverpool Overhead Railways, the Southend Pier, and the Ryde Pier tramlines, were designed and equipped by English firms, as were the Staffordshire and Birmingham lines. There is no doubt, however, that a good deal of the material for the equipment of some even of these lines came from America. If, however, credit is to be given for energy in pushing electrical tramway work, it must be given to our Transatlantic cousins and their agents over here. We are compelled to acknowledge the immense educational value of their work. They have canvassed the towns, educated the authorities, found capital, and again and again have proved the value of electric over other forms of traction. Our manufacturers must wake up if they are going to obtain a look in at this class of work. They deserve to see orders going elsewhere, when buyers cannot find suitable apparatus described in their lists. This really is the only text we desire to preach upon; the other sentences are merely prefatory, and to show there has been, is, and will be a demand in this direction.

HONOUR TO PROF. HUGHES.

We are glad to record that H.M. the King of the Belgians has conferred upon Prof. D. E. Hughes the decoration of "Officier de l'ordre Leopold," in recognition of the great benefit civilised mankind has obtained from the use of Prof. Hughes's printing telegraph instrument. This instrument is largely used in Belgium—a fact we can easily vouch for, in that for many years we were more familiar with the central telegraph department in the Belgian capital than with our own telegraph department in London. The King of the Belgians also deserves congratulation in that he shows his appreciation of the men who by their works are benefactors to their race, by honouring them while alive rather than eulogising them with grandiloquent phrases after death. Not only through his labours in telegraphic apparatus, but also by his investigations in electrical and magnetic science is Prof. Hughes a maker of history, and we heartily wish him long life to enjoy the knowledge that his labours have been appreciated by princes and governments, as well as by the minor items which collectively make up civilised humanity.

REVIEWS.

Applied Mechanics: A Treatise for the Use of Students who have time to work Experimental, Numerical, and Graphical Exercises Illustrating the Subject. By Prof. JOHN PERRY, M.E., D.Sc., F.R.S., etc. With 371 illustrations. Cassell and Co. Price 9s.

Usually the author in his preface tells the scope and plan of his book. Prof. Perry does this, but we prefer to take his views as expressed on p. 118. He there says, "The method I have adopted in this book is to illustrate each principle by means of a machine in which that principle happens to appear most important." Prof. Perry fully understands the defect of this method—indeed, he explains it, and shows how it is to be avoided. It would be a huge task to adequately describe this work, which consists of 30 chapters with an appendix, filling nearly 700 closely-printed pages. There is just one point, which, however, is not so much a matter for the consideration of authors as of publishers, relating to the size of type used. It seems to us that the majority of text-books err in using too much small type, and thus, when closely studied, have a straining effect on the eyes of students, increasing the number of people who have to use spectacles rather early in life. In this book the matter which the younger student may postpone is put into smaller type than the body of the book. Was it De Morgan or Babbage who paid so much attention to type and paper in order to ease the strain on the eyes of readers? and ought not more attention to be paid to these things than is customary at the end of the nineteenth century? But all this is beside the question of the merits or demerits of an author's production. Prof. Perry seems to have ransacked every branch of mechanical construction in order to find examples wherein the principles he deals with are clearly shown. But besides his own descriptions and explanations the author wants in his readers "the instinct of comprehending easily." Given this faculty, the student should be in clover, for in almost every case, not only is the abstract explanation given, but also a concrete example with actual practical figures. Then each chapter concludes with a number of numerical examples, which, if carefully worked, must drive home in the best possible manner the subject-matter of the chapter. We find a difficulty in clearly indicating what the contents of this book are, because the method of the author is neither synthetic nor analytic, but may be said to be after the fashion of men of genius *sui generis*. If we look a little closely into the construction of one or two chapters, a little comprehension may be gained of the whole, for the chapters all seem fashioned on the same plan. Thus, Chapter XII. deals with "materials used in construction," and the author reiterates that "mere reading will give to no student a knowledge of the properties of materials." This truism may be carried too far. Life is not long enough for the student to do alone the work cut out for him in this book. We should say, in regard to this chapter, if he carries out a little practical testing on one or two samples of stone, wood, or iron, he may very well take the results obtained by other people, without getting them himself. The student must make a patient exhaustive investigation in a few directions, but it would be an absolute waste of time to do more. Reading is quite enough after that. Now in this chapter Prof. Perry gives a mass of general and a few special facts about stone, bricks, limestone, timber, firwood, other woods, glass, cast iron, with remarks on patterns, cooling of castings, wrought iron, steel, alloys, copper, brass, sterro and delta metal, manganese, silicon, and aluminium bronze. We say the information here is general—that is not said for the sake of objection, because the information required is necessarily general in character. The chapter following—viz., Chapter XIII.—deals with tension and compression, and the materials used in construction are sometimes subjected to tension, sometimes to compression; hence, it is of advantage to the student to know which materials possess properties most suitable to resist the one or the other. The author tells his readers what preliminary knowledge they ought to possess before investigating the behaviour of materials when subjected to tension and to compression; then discusses strain and the machines used to determine strain and stress, pointing out the experiments will show "that the strain is proportional to the stress." Progressing gradually, we come to the consideration of strength, elastic strength, and factors of safety. A very good example of the way in which Prof. Perry treats these matters may be given by quoting his paragraph, p. 307:

Live Loads.—When a weight is suddenly applied to stretch a wire, it produces greater effects than when slowly and quietly applied. We know the reason. A weight which, slowly applied, would produce an extension of 1in., will, when put on and let go, produce an extension of 2in. The wire now shortens to its original length, then extends 2in., and continues to get shorter and longer, the weight vibrating. As there is friction of some kind among the particles of the wire, and there is also external friction, the lengthenings and shortenings gradually lessen till, in a short time, the wire settles down into the same state as it would have been if the load had been slowly applied.

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Now, if we suppose this wire, when stretched 2in., to be strained just beyond its elastic strength, it is evident that the *suddenly applied load* does harm; whereas the same load slowly applied would do no harm. The harm is greater if the weight, besides being applied suddenly, is moving before it begins to act on the wire. Take the case of a stone which is being removed by means of a crane. If the stone, happening to fall a little, be brought up by the chain, the increase in the stress on the chain is proportional to the height from which the stone has fallen, and is greater the less the chain is extended. When a wire is lengthened ·1ft. by a weight of 1,000lb., which has been increased gradually, we know that the pull on the wire began with 0, and as the wire gradually extended the pull became greater, till it is now 1,000lb. The average pull was 500lb., and 500 × ·1, or 50 foot-pounds, is the total *strain energy stored up* in the wire. If we wish to give more energy to the wire, we must strain it more, and this is just what we do when we let the weight fall suddenly. The extra strains due to loads being live depend upon the mass which we set in motion in applying the load. In some railway bridges it has been found that the increased deflection is 14 per cent. greater, and it is usual to add 50 per cent. to such live loads and treat them as dead.

There is another quotation we should like to give. It tells somewhat against the author's method of treatment, yet is quite true. He says, p. 361:

The *engineer* recognises from the beginning that his problems are too complicated for any exact mathematical investigation. He therefore leaves out his apparently insignificant terms rather at the beginning than the end; but, indeed, he leaves them out in any part of his investigation if they are likely to give trouble, for he recognises from the beginning that his theory is only to guide him, and that the final appeal must be to experiment. The engineer looks upon the phenomena involved in the loading of the tie-bar as simple because experiment is easy; whereas the mathematician, seeing that a lateral contraction accompanies an axial elongation, regards it as complicated.

The whole book is written with an evident desire to put aside useless information and give that which can at once be put to practical use. If the author has failed in some instances to duly consider the extent of an ordinary man's information, and expects too much, it is erring on the right side. The student or reader who does not understand may skip. He won't lose much, for the mass of information is so great that a slight loss will not detract from its usefulness. As we have said, the whole realm of mechanical construction has been examined in order to obtain suitable examples for investigation and discussion, and we rise from an examination of the work with our previously high opinion of Prof. Perry's abilities greatly enhanced. The book itself should be invaluable to the earnest student.

NOTES ON ACCUMULATOR CONSTRUCTION.

BY DESMOND G. FITZ-GERALD.

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X.

Before considering the Planté process of formation, it may be useful to note the behaviour of lead electrodes under conditions other than those which obtain in that process.

(*a*) When the electrolyte contains an acid radical (NO_3, Cl, $C_2H_3O_2$) forming with lead a soluble salt, or a free base (K_2O, CaO) combining with lead oxide to form a plumbite ($K_2O + PbO = K_2PbO_2$) lead is dissolved at the anode and deposited at the cathode. In these cases, however, the tendency to form peroxide of lead at the anode is often exhibited. Thus, in electrolysing a solution of oxide of lead in ammonic acetate, or in sodic acetate (Keith's lead-refining process) some lead peroxide may be formed on the anode, and this oxidant reacts to some extent on the acetic radical. And when a plumbite has been formed in the electrolysis of an alkaline solution, or, generally, when a soluble plumbite is subjected to electrolysis, peroxide of lead or a lower oxide may be deposited at the anode, whilst metallic lead is liberated at the cathode.

(*b*) With water as the electrolyte, and a high E.M.F. to overcome its resistance, no peroxide of lead, as Gladstone and Tribe have pointed out,* is produced, but only the hydrated protoxide ($2PbO, H_2O$).

* "The Chemistry of the Secondary Batteries of Planté and Faure," p. 11.

(*c*) When dilute sulphuric acid is electrolysed with lead anodes under a potential difference of less than two volts, peroxide of lead is not formed at the anode, but only sulphate of lead, the resistance of which soon arrests the current. If now the effective E.M.F. be somewhat augmented, the sulphate disappears and peroxide of lead is produced. Here we have the first stage of the Planté process.

XI.

The first stage has generally been explained or represented by an equation which, reduced to its simplest expression, is the following:

$$Pb + H_2SO_4 + 2H_2O = PbO_2 + H_2SO_4 + 2H_2.$$

That is, according to the Frankland view, *hexabasic sulphuric acid* yields two atoms of oxygen to the lead, evolving two molecules of hydrogen:

$$Pb + SH_6O_6 = PbO_2 + SH_2O_4 + 2H_2;$$

the hexabasic acid being afterwards reconstituted by accession of water:

$$SH_2O_4 + 2H_2O = SH_6O_6.$$

These equations indicate that the net result is the decomposition of water, the evolution of its hydrogen and the combination of its oxygen with lead to form PbO_2. And this indication is *primâ facie* in accord with observed results. Like "the lie that is half a truth," the explanation put forward may be the more dangerous on that account; it may cause us to ignore, or to neglect, facts of great importance with which the explanation would not harmonise. And there is some reason to believe that electrical science and practice have suffered from a too ready acceptance of plausible explanations in equation form. I may here, therefore, make note of some facts and observations which may bring into question the accepted explanation of the phenomena observed in lead reversible batteries. My object is not so much to insist upon any particular theory as to bring about improvements in the construction and working of secondary batteries, the importance of which is not appreciated, probably because it is not understood.

XII.

It has been pointed out above (*c*) that sulphate of lead formed at the anode under a low E.M.F. is converted into peroxide when the potential difference between the electrodes is augmented. Now to convert lead sulphate into lead peroxide, with evolution of sulphuric acid (H_2SO_4) or sulphuric anhydride (SO_3), requires a very strong oxidant indeed. "Normal oxygen" is incapable of producing this reaction; otherwise sulphate of lead, more especially as a natural product, would not be permanent. Another form of oxygen—"electro-positive oxygen"—is not only ineffective in this direction, but instantly reduces the peroxide of lead to protoxide, with production of normal oxygen. It is only oxygen in another allotropic form, "electro-negative oxygen," free or in endothermic (loose) combination, that is competent to convert a sulphate into a peroxide. It may here be useful to explain that what I call "electro-negative oxygen" (ozone) is oxygen that will not only convert an electro-positive—such as an oxidisable metal—into an oxide, but will also convert a substance electro-chemically neutral—such as an oxide—into a higher oxide or a peroxide. What I term "electro-positive oxygen" (electro-positive to normal oxygen or to ozone), or antozone, is oxygen that will convert a readily oxidisable metal into oxide (it is electro-negative to the metal), but which will reduce peroxide of lead to the condition of normal oxidisation, or will combine with ozone, with production of normal oxygen.

XIII.

In the Planté process of peroxidising a lead plate, oxygen is evolved as well as absorbed. In fact, the weight of oxygen liberated is usually far greater than that entering into combination at the surface of the lead anode. At the commencement of the peroxidation, however, when the current is of low density, little or no oxygen may be evolved, though the peroxidation is taking place with comparatively great rapidity. As the plate becomes coated with peroxide the ratio of the evolved to the absorbed oxygen increases, its value, even with low current densities, readily becoming

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7 or even 10. The condition of the surface of the plate may or may not wholly explain this phenomenon. It is possible with a very low current density to obtain some peroxidation without any visible evolution of oxygen from the anode, but in this case, as in others, it can be shown that oxygen has been absorbed by the electrolyte.

XIV.

The presence of a powerful oxidant in the electrolyte which has served to transmit a charging current can usually be indicated by the "iodised starch test."* A weak, clear solution of starch being mixed with a weak solution of iodide of potassium (KI), the addition of a drop of the mixture to a solution containing an oxidant results in the liberation of iodine ($2KI + O = K_2O + 2I$), which forms with the starch a compound usually of a blue colour, but often rendered brown or brownish red by the action of the solution to be tested. The reaction occurs with acid taken—with a pipette—from the vicinity of the anode. If two portions of the electrolyte, containing respectively the anode and the cathode, be separated by a porous diaphragm, or by being placed in separate glass vessels connected by a bent glass tube filled with the electrolyte, the fluid containing the anode will usually, after the passage of the current, strongly affect the starch reagent. When in charging the current is reversed, according to the Planté system, it is in the vicinity of the *new anode*, where spongy lead is becoming peroxidised, that the oxidant appears to be most strongly developed, and it is then that the characteristic odour of ozone becomes most appreciable. The oxidant in this case is not hydroxyl—*i.e.*, peroxide of hydrogen (H_2O_2)—since it does not give the blue colouration with chromic acid (H_2CrO_4) which is characteristic of that body. The production of gaseous ozone, but not that of a non-gaseous oxidant in the electrolyte, was observed by Planté.†

XV.

It was also observed by Planté‡ that after the cessation of the charging current, and before or after the completion of the secondary circuit, gas continues "for some instants" to be evolved from the peroxide surface of the anode. His observation applied to the case of a lead voltameter; in the case of a charged element (lithanode) of comparatively large dimensions, I have noticed the copious evolution of gas for quite 10 minutes after the charging circuit was broken. Moreover, when a platinum wire was immersed in the fluid, torrents of gas were evolved from it whenever it was brought into contact with the peroxide. The gas evolved in each case appeared to be normal oxygen. The explanation given by Planté is obviously fallacious. He says: "This fact is explained by the affinity of peroxide of lead for hydrogen, which causes the production of a local couple between the oxidised surface and the underlying metal, and, in consequence, the decomposition of water." But "the affinity of peroxide of lead for hydrogen would effectually obviate any evolution of hydrogen; and, if water were decomposed by the action of the local couple, its oxygen would be appropriated by the underlying lead, or by the hypothetical hydrogen on its surface, whilst its hydrogen would pass electrolytically to the conductive peroxide and be absorbed by it. The gas evolved cannot be hydrogen, since it is evolved from the surface of the peroxide. But supposing hydroxyl (H_2O_2) to be present in the electrolyte, then we know this would react upon peroxide of lead, reducing it with evolution of normal oxygen gas.

Under exceptional circumstances this reaction may take place with startling violence. Some cases of this kind were mentioned by the late Mr. W. W. Griscom in a paper on "Some Storage Battery Phenomena," read before the American Institute of Electrical Engineers in 1894. It may be instructive to quote the following from the paper in question: "The automatic discharge of the positive plate," says Mr. Griscom, "is a comparatively rare phenomenon. In my experience I have secured accurate data in only three instances. . . . On one occasion a cell was reversed experimentally, and the reversing charge continued until 470 ampere-hours, or three times the normal capacity of the cell, had been passed through it. The potential attained 2·41 volts on a low charging rate. The positive had the healthy dark colour of electrolytic peroxide of lead, and was freely gassing, showing that it was as fully charged as possible. The charging current was interrupted, and the E.M.F. fell gradually to 2·12 volts in a perfectly normal way. In 35 minutes a curious seething sound attracted my attention to the battery, and I found it in a state of violent, almost explosive, ebullition. The gas given off was pure oxygen in immense quantities."

XVI.

It has been observed, and the observation has been sufficiently confirmed, that when a lead secondary cell is rapidly discharged peroxide of lead may be formed on the *spongy-lead* plate—whilst peroxide is being reduced and sulphated on the peroxide plate. This effect, at first sight almost incredible, since it would appear to contradict the principle of the conservation of energy, has been referred to by Messrs. Gladstone and Tribe,* who shrewdly comment upon it as follows: "It is difficult to conceive how the reduction of the peroxide of lead on the one plate to oxide or sulphate should be attended by a direct oxidation of lead on the other plate up to peroxide itself, as that would involve a reversal of the E.M.F. It is more easy to imagine that the peroxide results from the oxidation of sulphate of lead already formed, through the agency of electrolytic oxygen." Very true; and if the energy of the charging source has been partly expended in the production of an endothermic ozonide, such as that presently to be mentioned, it becomes quite possible to conceive that, in virtue of the law of polarisation, the ozonide, together with oxygen, may pass towards the spongy-lead element, whilst the hydrogen molecules are moving towards the peroxide plate.

XVII.

The following facts were brought into prominence by my friend and old pupil, Mr. G. H. Robertson, F.C.S., in his paper read before the Society of Arts in December, 1891. Persulphuric acid ($H_2S_2O_8$) was discovered by Berthelot in 1878, and he brought forward evidence to prove that it is the primary product of the electrolysis of sulphuric acid solutions, and that peroxide of hydrogen (H_2O_2)—which, since the time of Faraday, had been known to be present in sulphuric acid after electrolysis—is really due to the following reaction:

$$H_2S_2O_8 + 2H_2O = H_2O_2 + 2H_2SO_4.$$

The quantity of persulphuric acid generated by the electrolysis of dilute sulphuric acid varies with the density of the latter, being practically nil (?) when the density is 1,300, whilst acid above and below that density will contain it in varying proportions. Persulphuric acid is an unstable body, which begins to decompose as soon as the current which has given rise to it ceases. The hydrogen peroxide to which it gives rise is also unstable when concentrated, but a weak sulphuric acid solution of it is comparatively stable, and the stability increases as the percentage of hydrogen peroxide diminishes. This accounts for the fact that this substance is found in sulphuric acid electrolytes long after the persulphuric acid which gave rise to it has disappeared. Persulphuric acid, unlike hydroxyl, exercises no decomposing action upon permanganate of potash or peroxide of lead.

In some experiments carried out at the General Post Office, the secondary cells tested were always found to contain active oxygen, due to the presence of persulphuric acid and peroxide of hydrogen in varying proportions. During charge, persulphuric acid is the main constituent of this active oxygen; during discharge the quantity of hydrogen peroxide gradually increases; whilst in a cell which has remained at rest for some time the active oxygen is almost wholly composed of the latter substance.

XVIII.

Let us suppose that we can take two molecules of sulphuric acid and abstract from them one molecule of hydrogen—evolved into the atmosphere. Or let us suppose that we can take two molecules of sulphuric acid and add

* With acid of density 1 300 (40 per cent. of H_2SO_4), it is said that little or no persulphuric acid is generated.

† "Recherches sur l'Electricité," par Gaston Planté (1879), p. 61.

‡ *Ibid.*, p. 19.

* "The Chemistry of the Secondary Batteries, etc.," p. 27.

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to them one atom of oxygen. In the first case we shall produce one molecule of persulphuric acid, and in the second case one molecule of persulphuric acid plus one molecule of water. Thus,

$$2H_2SO_4 - H_2 = H_2S_2O_8.$$

or

$$2H_2SO_4 + O = H_2S_2O_8 + H_2O.$$

And either of these operations resolves itself merely into the abstraction of a molecule of hydrogen from a sulphuric acid electrolyte — the corresponding atom of oxygen remaining in combination with the latter. Thus, to evolve hydrogen, whilst forcing to corresponding oxygen into combination necessitates a high E.M.F., because the compound produced ($H_2S_2O_8$) is endothermic, or absorbs energy in its formation. Now, reverting to (XII.), we have an oxidant capable of decomposing sulphate of lead, according to the equation—

$$H_2S_2O_8 + PbSO_4 + 2H_2O = PbO_2 + 3H_2SO_4.$$

THUNDERBOLT'S ELECTRIC GOVERNOR.

We were privileged some few days ago in being allowed to see a new governor that has been patented by Mr. Edward Thunderbolt.

Mr. Thunderbolt, who is a native of Melbourne, came over to this country some 12 months ago to bring out and perfect his invention. Soon after his arrival he was fortunate in having his governor brought under the notice of Lord Kelvin, who took such great interest in it that Messrs. James White, who are so well known as the manufacturers of all Lord Kelvin's inventions, took it up, and are at present having most extensive trials made with it at their premises by Mr. Thunderbolt.

We might here say that there are two types of electric governors that Mr. Thunderbolt has designed, and they both act perfectly in controlling any desired uniform speed for any kind of stationary or electric engines or turbines notwithstanding the most violent variations of load, and they further have the power of entirely stopping the motors should any accident occur.

The first type which being actuated by the electric power of the circuit, is arranged to act directly on the throttle of the engine or turbine, and is suitable for engines up to 15 h.p. or 20 h.p. In the second type of governor a small air-pump is required, which exerts a pressure on a piston which is arranged to control the throttle or valve gear, the air pressure being regulated in a most ingenious manner by mechanism controlled by the electric circuit. This type of governor is suitable for engines up to any size.

We met the inventor at Messrs. White's works, and he just took us downstairs to their main engine-room, where they have a pair of very fine horizontal engines of about 80 h.p. On the stop-valve of these engines was fitted one of the small type of governors, which although not intended for engines of this size, controlled it perfectly and allowed of the load being altered at will without any perceptible variation in the speed of the engine.

This governor is shown at Fig. 1. The apparatus is connected at the inlet pipe, E, with the steam-boiler in the case of a steam-engine, or the water supply in the case of a turbine, and the outlet, F, is connected to the engine or turbine. If the apparatus be at work, and an additional number of lights be switched on the circuit, the E.M.F. will be slightly decreased, and therefore a decreased current will pass through the solenoid, H, consequently a less attractive force will be exerted on the core, G, thus allowing the spring, K, to draw the core partially out of the solenoid. This action will raise one end of the lever, A, which is fulcrumed at A^1, and with it the piston rod, C^1, and piston, C, thus opening the ports, D^1, in the cylinder, D, and allowing an inrush of steam or water, as the case may be, into the engine cylinder through the pipe F. The speed of the engine will thus be increased to cope with the additional amount of work put upon it by the extra number of lights.

On shutting off a number of lights a reverse action takes place—that is to say the core, G, will be drawn down, and with it the lever, A, so lowering the piston, C, and partly closing the ports, D^1.

It will be noticed that the position of the fulcrum, A^1, can be altered with regard to the rod C by sliding the supporting pillar along the fixed lower rod, thus enabling the sensitiveness of the governor to be varied.

If the current be suddenly cut off from the circuit, as, for instance, a belt breaking or a main fuse blowing, the safety appliance will come into operation, so as to entirely prevent any racing away of the engine. The action will then be as follows: the pull on the core, G, being suddenly released, the spring, K, will cause same to jump up, and with it the rod, N, secured to lever, A, so causing the said rod A to strike the pin, L, and to turn it on its fulcrum at L_2, thereby releasing its opposite end from engaging with the slotted frame, K^1, which now being released drops down, and with it the end of the lever, A, so causing the rod, C^1, and the piston, C, connected to the lever to close ports, D, and thus stop the further supply of steam or water to the motor. An ordinary sliding stop-valve is shown at S for shutting off the steam or water by turning the hand-wheel, W.

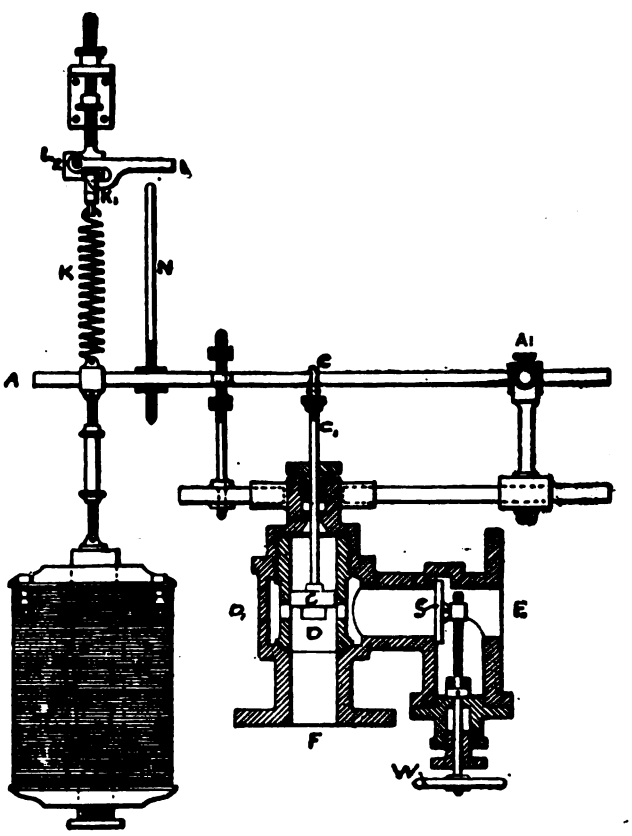

FIG. 1.

It will be noticed from the figure that various adjustments are arranged for—*i.e.*, the length of the safety-rod, N; the position of the core, G, in the solenoid, H; there is also arranged a steadying arm, with adjustable thumb-screws, for limiting the play of the lever, A, and therefore of the rod, C_1, and piston, C; there are also adjusting screws arranged for altering the tension of the spring, K.

After having thoroughly explained the governor and shown how immediately it controlled any variation of load, Mr. Thunderbolt took us upstairs, where he had one of his compressed-air governors fitted up. The fault with the smaller governor that we have just described is that the power exerted by the solenoid is not always sufficiently powerful to actuate a heavy or stiff rod quickly enough to give the required control of the engine. While for a small engine this type of governor was found to do its work perfectly satisfactorily, the inventor saw that if he wished to adopt the governor for any sized engines, etc., he would require to introduce some other agency to assist the electrical action. While debating this point he told us a very simple fact suggested the method he finally adopted—namely, the quick shutting of a door causing the window to rattle. He noticed that immediately the door was closed sharply, the

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compression of the air in the room instantly showed itself on the window. Working on these lines, Mr. Thunderbolt arranged a small air-pump driven off the engine shaft to charge a cylinder with compressed air; in this cylinder works a piston, which in its turn is connected on to the throttle or slide valve to be governed.

Referring to the duplex air-pumps which receives the motion from the engine, the speed of which is to be regulated, will take in a supply of air and discharge it into the pipe or passage, K, thence to the governing cylinder, which is placed on the top of this pipe, K, in which is the piston controlling the valve of the engine; it will be seen, therefore, that as the pressure in the governing cylinder varies so proportionately will the position of the piston vary, and hence the amount of steam admitted to the engine. The pressure in the cylinder can be varied (1) by the speed of the air-pump, (2) by allowing a certain amount of the air in the cylinder to escape.

Fig. 2 is this second method upon which the chief action of the governor depends, and it is arranged in the following manner: The amount of escape of air through the port, O^1, and consequently the pressure of air upon the governing piston, is controlled directly by the increase or decrease of the load or the number of lamps on the system; for instance, if a number of lights on the circuit were suddenly switched on a decrease of current will pass through the solinoid, S^4, and consequently a less attractive force will be exerted upon the core, S, thus allowing the spring, T, to act, and to raise one end of the lever, R, which is fulcrumed at R_4, and so lower the valve, Q, and open the port, O^1; an immediate escape of air thus takes place through port, O^1, and consequently a reduced pressure is exerted upon the governing piston, which will then move forward, owing to the force of a spring which encircles the piston rod, thus actuating the rod to open the throttle of the engine or motor, and cause an increase of speed of the engine which will be communicated to the dynamo. When any load or a number of lights are switched off the dynamo, a reverse action takes plate—namely, the current through the solenoid will be increased, and the core will be drawn down and so close the valve.

If the current be suddenly cut off from the circuit by a broken belt, broken circuit, or any other cause, the safety apparatus will then come into operation so as to prevent the racing away of the engine or motor. In such a case the pull of the core, S, is released, and the spring, T, causes one end of the lever, R, to jump up, and with it the rod, T^4, which then strikes arm, T^3, and releases the hook, T^2, from frame, T^1, thus causing that end of lever, R, to drop by the force of gravity, and so close the port, O^1. The air pressure on the piston is therefore increased, and forces the piston and rod back, completely shutting the throttle valve, and so stopping the engine.

Fig. 3 shows the general appearance of the compressed air governor when connected up with small air compressor and governing cylinder.

It will readily be understood how the action of the governor just described is dependent partly upon the variation in the supply of air by the pumps driven at a speed depending upon that of the engine to be governed, and partly upon the variation of area of the outlet for the air from the compression or governing cylinder, which is effected directly by the action of the electric current.

It will be noticed that in this air-compression governor, as in the direct-acting governor, the position of the fulcrum of the moving rod can be varied as regards the spring and the solenoid so as to make the governing more or less sensitive as circumstances may require.

We might mention that one of these governors has been running for some time on the electric light engines at the General Post Office, Melbourne, and one has also been recently fitted with very marked success on the large engines driving the electrical machinery for generating the power for the Liverpool Overhead Railway.

In conclusion, we must say that the governor possesses very marked advantages over any other electric governor that we have seen, both from the point of efficiency and also as regards simplicity and ease of work. It possesses two very sensitive elements acting in unison—namely, electricity and compressed air. They act simultaneously and act automatically, when the load is increased or decreased, by turning on or off exactly the desired amount of steam or water required for working the engine or turbine at the correct speed, thus effecting a very great saving in wear and tear more particularly as regards lamps and fuel.

We might also mention that Mr. Thunderbolt has arranged a form of his air-compression governor for use on steamships at sea to prevent the racing of the propeller, and it seems to answer very satisfactorily from all accounts. It will, however, be the electrical governor that will mostly interest our readers.

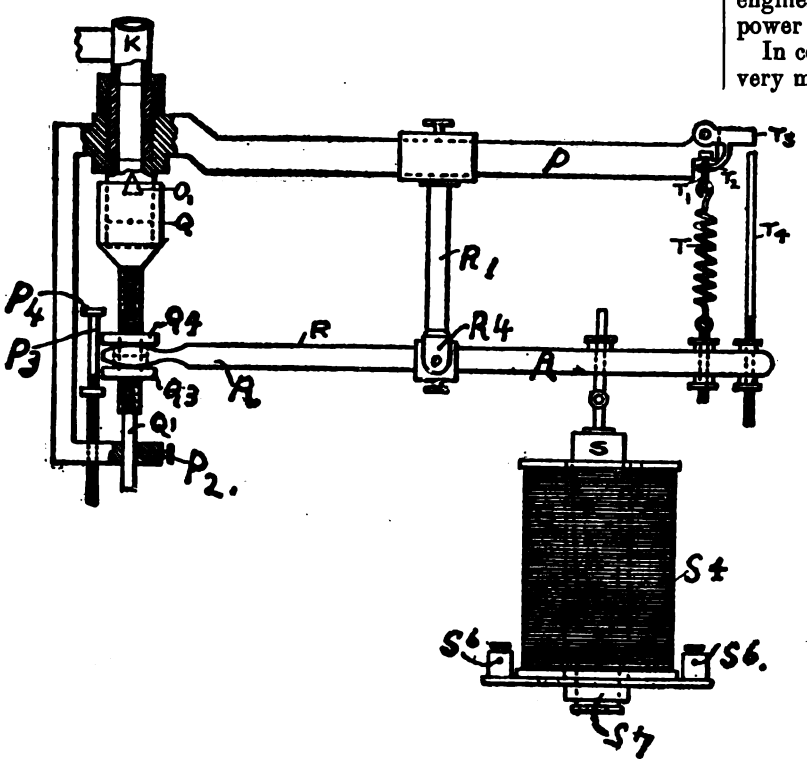
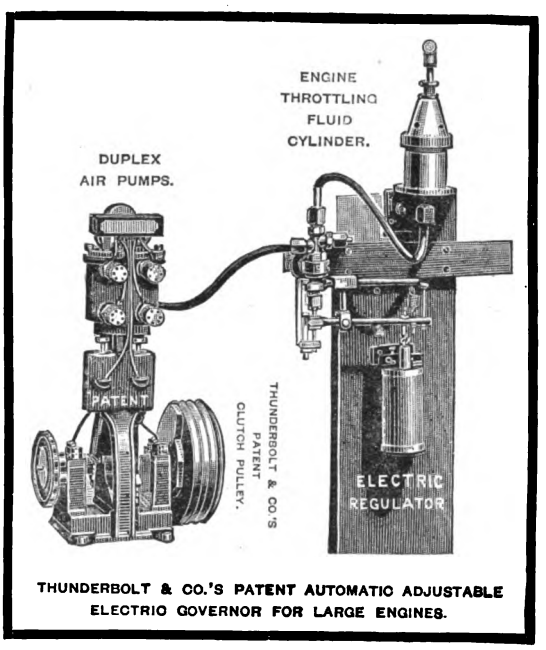


FIG. 2.



THUNDERBOLT & CO.'S PATENT AUTOMATIC ADJUSTABLE ELECTRIC GOVERNOR FOR LARGE ENGINES.

FIG. 3.

HIGHFIELD'S ACCUMULATOR CONNECTORS.

Messrs. J. Carter and Sons, of Stalybridge, are introducing a new type of connecting bolts for accumulators, an illustration of which we give herewith. Mr. J. S. Highfield is the designer of these bolts, which are manufactured under his patent. The idea of the inventor is to prevent the heating of connections

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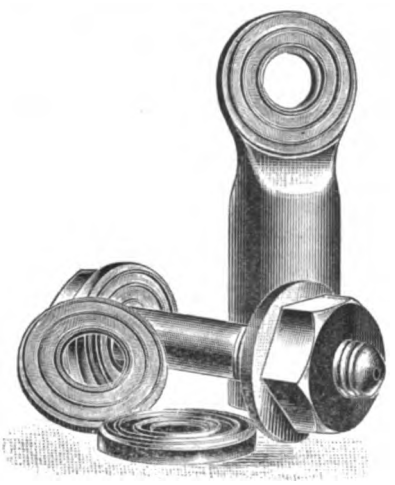
so often noticed due to faulty contact caused by the acid vapour corroding the surfaces.

The bolts and sockets shown in the illustration are made with flanges on which are turned several concentric ridges, the ridged flange taking the place of an ordinary washer. When the nut is screwed home on to the lead lug, these ridges not only clean the face in cutting their way in, but also make a close airtight joint, which entirely prevents acid vapour or damp getting in and corroding the surfaces, the result being that the lugs do not heat, and all trouble on the score of dirty connections is saved. The sockets are preferably clamped between two lugs, the ridges acting in the same way. For large currents, double-ridged washers may be clamped between the lugs, thereby preserving the inner surface joint as well as the outer. For the attachment of flat bars or rods, single-ridged



washers are used; they are sweated on to the bar, and then the whole is bolted home on to the lead lug as before.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. The answers to any question should, as far as possible, be sent within 10 days after the question has appeared. Questions may be sent at any time. Question 5 given below relates more to an American than to an English system, and information upon it will hardly be obtainable from an home source. Still, we trust someone may be found ready with the information required.

QUESTIONS.

5. Where can the monocyclic system of alternating-current distribution be seen at work, and what advantages or disadvantages does it possess when compared with the triphase system?—H. B. S. (Altrincham).
6. What are the relative advantages and disadvantages between the two high-pressure systems using alternating and direct currents respectively for ordinary town supply?—W. A. S. (Belfast).
7. Seeing that local authorities repay the capital by periodic instalments over a number of years, yet have to keep their plant in a state of efficiency, is it necessary or desirable to depreciate the value of the plant as appearing on the books annually? Give reasons.—H. L. (London).

ANSWERS.

Question No. 1.—How could the output of an alternator be increased without altering the speed?—F. B. (Bolton).

Answer No. 1.—You can do this either from the engine or from the exciter. In the first case, open out the stop-valve fully; this does not necessarily mean an increase in speed, but an increase in brake horse-power. It is well, however, to keep an eye on the tachometer or speed indicator while doing this. In the second case, which is the more preferable of the two, cut the resistance gradually and carefully out of the field circuit of the alternator so as to allow a stronger current to flow round the alternator's field magnets, thereby increasing the number of magnetic lines per square unit (inch or centimetre) of polar face. This has the effect of making the armature coils cut a larger number of magnetic lines per revolution, and is equally applicable to alternators with revolving armature or magnets. If your alternator is driven by a motor—*i.e.*, a motor-alternator—you will have to regulate the field circuits of both motor and alternator, but do not move the position of the motor brushes, as it would cause an increase in speed. Your best and safest method of increasing the output of a steam-driven plant is to first open the engine stop-valve and then regulate the excitation current. Do not overload your machine by more than 25 per cent. for one hour.—H. B. S.

Answer No. 1.—Assuming that the speed of the alternator is kept constant, its output in watts would be increased by decreasing the resistance of the external circuit and increasing the strength of the current in its field to counteract the small increased drop of E.M.F. in the armature. Or, if the resistance of the external circuit as well as the speed is constant, the output could be increased by augmenting the field and consequently the E.M.F. of the machine. The output would then increase according to Ohm's law. Thus

$$\frac{\text{E.M.F.}}{\text{ohms resistance of armature and external circuit}}$$

= amperes, and amperes × E.M.F. = watts.—J. PILLING.

Answer No. 1.—The output of any alternator is limited only by two things: (1) the power of the engine driving it; and (2) the heating of the armature coils. The output at any moment is controlled simply by the resistance of the external circuit, or, in other words, by how many lamps are connected. With an engine properly governed the output can be taken over the whole range from no load to full load merely by adding lamps and with the speed practically unchanged. To still increase the output, all we have to do is to add still more lamps, the limit being either (1) or (2), as stated above —T. A. LOCKE.

[We have awarded the 10s. prize to the first of the above three answers, but do not consider that either of them fully meets the case. This is perhaps due to the question itself, which is not so explicit as it might be. The fact is that the governor of an engine should look after the steam supply, and that the regulation of the field current does not, *per se*, increase the output.—ED. *E. E.*]

Question No. 2.—Two alternators running in parallel, the load being 100 amperes, it is required that they should do 80 and 20 amperes respectively. How could this be done?—F. B. (Bolton).

Answer No. 2.—The distribution of the load on two alternators running in parallel is effected by the adjustment of the governors of the engines. The weight or spring of the governor of the alternator set which is required to give 80 amperes is adjusted for greater admission of steam, which tends to make it run faster than its partner. The two machines, however, being in parallel, one really cannot run before the other, but the alternator which is tending to turn fastest takes up load from the one that is lagging, until equilibrium is restored between the two. Also the current in the fields should be so regulated that, if the alternators were run separately with similar loads on them and at the same speed, they would require exactly the same current in the fields. This regulation of the fields is rather important, for if not attended to a large current may pass between the two alternators without doing any useful work.—JOHN PILLING.

Answer No. 2.—The speed of the two alternators must be kept in the same relation the one to the other, in order that they may keep in step. An increase in the speed of one will cause it to lead in phase, and it will do more work, relieving the other of a portion of its load. This extra work on the one machine will check its speed, and the other one, being relieved, will be accelerated, and thus the balance restored. To give each alternator a certain percentage of the total load, it is only necessary to adjust the governors to suit that percentage, as is done when paralleling the machines. The current given out by paralleled alternators depends entirely upon the amount of steam admitted to their engines. By giving more steam to one engine its speed *tends* to increase, but is checked by the excess of work. Thus the speed being kept constant, the output must increase. Alternators when in parallel

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should have their loads adjusted, so as to be in an equal ratio to their maximum outputs.—T. A. LOCKE.

[Both these answers are good. The importance of regulating the field strengths to keep the synchronising current down decides us in favour of the first.—ED. *E. E.*]

DOUGLAS.

REPORT OF THE COMMITTEE ON ELECTRIC TRACTION.

(Continued from page 536.)

It may be stated at this point, as affecting the method of construction, that in open-conduit systems, many professional experts prefer the system that has both negative and positive conductors put in one conduit, as at Budapest. This view is entertained by Mr. Arnot, electrical engineer, Glasgow. Several of the systems previously referred to have got one cable in the conduit, the current going by the rails. The "Simplex" system is a case in point. In support of the contention against the adoption of this method, it is pointed out that any leakage from the main conductor must find its way to the rail by the passage that gives it the least electrical resistance, which, should there be an iron pipe in the vicinity, will be by that pipe. This will cause electrolysis; but where two conductors are in one conduit which is formed of some metallic material, the failure of insulation on the return conductor would immediately be detected as a fault and remedied, and where a general leakage occurred over the entire system, it would be limited to the case of the conduit, and would not stray to pipes in the ground. The Board of Trade regulation defining the amount of leakage allowed does not apply when both conductors are put in one conduit. Of all underground systems the Budapest system is usually considered to be the best, but it remains to be proved by actual experience whether that system could be satisfactorily carried out under the very stringent regulations made by the Board of Trade, and which, it may be assumed, would be adopted by the Insular Legislature in connection with any local system of electric traction.

The conduit system has not as yet had an extensive trial in England, and, unfortunately, the limited experience already acquired has not been very happy or assuring, either to corporations or companies, as to its ultimate success. Mr. W. George Lawes, city engineer of Newcastle-on-Tyne, in reporting to the Corporation, states that at Blackpool, where the conduit system was laid, and promised well for a time, when taken over by the Corporation it gave so much trouble owing to excessive leakage, and consequent deterioration of the apparatus generally, that for some it had to be worked by horses. A moist climate is unfavourable to the rather delicate apparatus, and promotes leakage of energy by keeping the conductors damp, and would presumably require even closer attention to keep the tube clean. Mr. Lawes states that a piece of damp paper would, if blown or dropped through the slot, and falling on the conductors, be sufficient to "short-circuit" them, and stop all traffic on that particular section until its actual whereabouts was discovered and it was removed. It is usually believed that the electric conduit, which appears to be specially susceptible to the deteriorating influence of dirt, even in a favourable dry climate, would be more so in wet and muggy weather, when the amount of mud that must of necessity pass through the slot would cause instant trouble and inconvenience, and interruption from that cause would be even more frequent. At one stage in its existence, as already referred to, this appears to have actually been the case at Blackpool, and to have practically made the conduit system unworkable as first laid down, so much so that its use had to be discontinued for a time and horse traction again resorted to pending extensions and alterations of a costly nature. Indeed, so strong are the periodical storms in Blackpool that, although the road level is well above high-water mark, the road bed is frequently flooded, and the difficulties experienced in applying electricity underground in such a situation are, of course, unusually great, and would to some extent be felt in Douglas. It is stated that the conduit system would be much preferred in Blackpool to the overhead if it was not for the sea-water and the sand, the former getting into the conduit in the times of storm and affecting insulation. As it is, the tramways may have to be relaid, and in that case it is stated as being probable that the overhead system will be substituted, and the electric lamp standards utilised for the suspension of the wires. Now it is well known how great the difficulty would be to secure proper insulation under the existing climatic conditions, and when it is considered that apart from the cost of providing numerous drains to convey the water getting into the conduit to the sewer, any moistness or dampness in the conduit affects the insulation, it will be readily understood that on a route like that of the Douglas promenades, which is liable at certain seasons of the year to storms of exceptional severity, as well as probable heavy deposits and accumulations of mud, road detritus, sand, gravel, and shingle, and overflow of salt water, with an open slot through which water or dirt can freely make their way, the work of keeping the conduit clean and maintaining efficient insulation must be exceptionally difficult.

Overhead Conductors.—The open-conduit system of electric traction being, from what has previously been stated, out of the question, there now only remains the overhead conductor system for consideration, and knowing the strong objections and great antipathy which exist in many quarters and in many minds with regard to the adoption of this system, the deputation feel that the most careful consideration of the advantages and disadvantages claimed for and alleged against the system are most important. In the first place, the advantages of a special character appurtenant to the overhead electric system as compared with all other forms and descriptions of electric traction may be briefly enumerated as follows: (1) the overhead system is the cheapest to construct; (2) the overhead system is the cheapest to maintain; (3) the simplicity of the overhead system; (4) the rapidity with which the lines can be constructed or converted from the horse system of traction; (5) the comparatively small interference with the surface of the streets and street traffic; (6) the adaptability of the standards or poles for the electric lighting of streets and thoroughfares; (7) the overhead system is less liable to leakage than the underground system; (8) the overhead system is the most efficient, taken as a whole, of mechanical traction which has hitherto been demonstrated by practical working.

The question of the cost involved in construction in relation to any method of future locomotion is certainly one of paramount importance, though not the only question which is involved and which has to be considered. This matter, however, has been so fully dealt with in considering the conduit system that there is no necessity to recapitulate in detail the arguments already used. Suffice it to say here that the deputation is fully satisfied that the most reliable information and the best and most experienced advice, professional and otherwise, clearly show that the overhead system is undoubtedly the cheapest to construct. In the recent debate upon the question at a meeting of the City Council of Liverpool, Mr. William Oulton stated that out of one hundred experts there was a consensus of opinion that with regard to the cost of electric traction there was no comparison between the overhead trolley system and any other. At the same time, under the conditions existing in Douglas, the deputation do not hesitate to acknowledge that while the question of cost is of much importance, in the light of compensating advantages accruing from any other system, and all other things being equal, the question of cost would under such circumstances be a secondary consideration, and cost would not then dominate or influence the issue. But in the opinion of the deputation such circumstances do not exist. And yet it must be borne in mind that the initial expenditure of capital is an important factor in every enterprise.

The equally important question of maintenance has also been fully considered elsewhere, and under this head it is merely necessary to submit the abstract proposition that the overhead system is the cheapest to maintain.

The simplicity which characterises the overhead system must be self-evident to anyone impartially studying the question. It is essentially clean, safe, and comfortable in its application, as well as being under perfect control. The overhead system, according to the oft-repeated testimony from time to time furnished to the deputation, has distinctly passed the experimental stage in every particular and in every detail, and the apparatus appurtenant to the system has practically reached a culminating point—a point where interchangeability of parts, and ease and simplicity of repairs, can scarcely be carried further. Every accessory now is most highly developed and perfected, and no difficulties present themselves to-day, however greatly they may have impeded the pioneers in the development and use of overhead electric traction. The very simplicity of the system enables any necessary repairs to be effected with a minimum of trouble, inconvenience, delay, or expense, being under all circumstances the most accessible for purposes of maintenance and repairs. From the operator's standpoint it may indeed be considered certain that no sub-surface system will ever equal the elevated conductor as regards efficiency and utility. The rapidity with which the lines can be constructed or converted from the horse system of traction ought in itself to be a strong recommendation in favour of the system. The comparatively small interference with the surface of the streets and general street traffic, vehicular and pedestrian, is another argument which strongly demonstrates the superiority and efficiency of the system over the conduit system, and indeed this fact has contributed very largely to the wide acceptance and adoption of the system in other places. Again, where standards of artistic design, with ornamental arms or brackets on either side of the centre pole, are placed in the centre of the roadway, arc lamps can be attached, and the poles used with much advantage for the electric lighting of the streets from the same station as would supply the power for the working and lighting of the tramcars, thus removing the necessity for another set of poles on the causeways or in the roadways. This

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combination of enterprises—the combination of the electric lighting with the electricity for the propulsion of the tramcars—would certainly be advantageous in more senses than one. With regard to the important matter of leakage the main conductors being so far removed from the roadway, the insulators can be kept perfectly clean, and the possibility of leakage of current in the conductor carried overhead where insulation can be complete and reliable is thereby practically reduced to a minimum, and is very much less than with the underground system. It is no doubt a strong statement to make that the overhead system is the most efficient system, taken as a whole, of mechanical traction which has hitherto been demonstrated by practical working, but the statement is perfectly warranted and is amply justified both by facts and actual experience in working, as a careful perusal of the descriptive report will show. The manifold difficulties in insulation, points, and crossings, and connection between conductors and motors characteristic of the conduit system are distinguished by their absence in the overhead conductor system. Again, additional and important advantages of the overhead system when compared with the conduit system are perceptible from the fact that no trouble or inconvenience is likely to be occasioned in connection with drainage requirements, or interference with gas or water mains or drain connections. The overhead system, too, is very little affected by either rain or snow, except that the rails must be kept clean, as they must be in any system of tramways. Whilst electricians have long been expecting the advent of a conduit system far removed beyond the pale of a mere speculative theory, a system approximately as cheap to construct as the overhead wire method, equally certain in its action at all times, and as free as possible from liability to get out of order, it will have been observed from a perusal of the descriptive report the overhead system has long ago passed beyond the range of theory in relation to its desiderata in both the New and the Old Worlds.

There is undoubtedly an overwhelming and growing opinion in favour of the system as being the most efficient system, 18 out of every 20 miles of electrical traction being operated by means of overhead conductors. Important city and town councils like Bristol, Leeds, Sheffield, Glasgow, Liverpool, Dublin, Coventry, and Hartlepool have adopted the overhead system as being the most suitable, and experimental lines are either constructed or are in course of construction, or shortly to be laid, with a view to disabuse local æsthetic prejudices and serve useful object lessons. Manchester has but recently decided to municipalise its tramways, and the feeling on the City Council is strongly in favour of the substitution of overhead traction. These corporations are of opinion that if constructed on the most improved principles, with ornamental poles of neat and chaste design, the overhead lines are not seriously offensive to the eye, and they believe that a short acquaintance with them will very soon remove preconceived or first-sight objection to them. They are quite content to have the sky-line slightly interrupted with an electrical wire in return for cheap, clean, comfortable, convenient, and rapid travelling, and when it is clearly demonstrated that the conduit system, apart from the question of cost, cannot be satisfactorily worked on the Douglas promenades, which are so liable to frequent heavy incursions of salt water, the deputation do not think it likely that the burgesses of Douglas will prove less regardful of the substance and the reality in preference to what may not be inaptly described as the artistic shadow. On the other hand, it is but right to state that the Birmingham Corporation is decidedly opposed to the introduction of the overhead wire system in any part of the city. They believe that less objectionable and equally efficient methods of applying electricity to the working of the tramways are available, and at a reasonable cost. In this view the Corporation is supported by Dr. J. Hopkinson, who states that in such a city as Birmingham an electric tramway in which the conductors are entirely underground is much to be preferred to any other system, and that the greater cost of the former system, though by no means negligible, is very small compared with the advantage gained in so populous and wealthy a city as Birmingham. Special local circumstances must of necessity be a predominant feature in determining the needs and requirements of a locality.

To be continued.)

MANCHESTER ELECTRIC LIGHTING.

A deputation from the Manchester Corporation recently visited a large number of Continental towns to inspect electric lighting and traction plants. This was in view of the large extensions of electric lighting in the near future, and the probable adoption of electric traction. The deputation consisted of Alderman Lloyd Higginbottom, the chairman of the Electric Lighting Committee; Councillor John Phythian, deputy chairman; and Mr. C. H. Wordingham, the city electrical engineer; and was accompanied by Councillor Mainwaring. They visited the following towns: Brussels, Cologne, Barmen, Elberfield, Hanover, Hamburg, Berlin, Dresden, Nuremburg, Munich, Vienna, Budapest, Venice, Florence, Rome, Tivoli, Milan, Zurich, and Paris. The deputation carried many letters of introduction, and recorded their appreciation of the courtesy shown to them. The following is their report as presented to the Corporation of Manchester:

General Report on the Results of Inspection of Continental Stations.

The object of the inspection was to ascertain the latest Continental practice in electric lighting, and to learn the extent to which electric traction was used, and the various methods by which it was applied, and especially, if possible, to ascertain how the problem of how the current for both lighting and traction was dealt with.

The first point which stood out prominently was the employment of slow-speed dynamos, coupled directly to slow-speed engines. This practice is almost universal on the Continent, there being very few instances of belt or rope driving. Secondly, it was clear that the tendency was to have few machines of very large power rather than a number of small machines. In this connection, it is satisfactory to note that the new generator of 2,500 h.p., now on order for the Electricity Committee, is on these lines, and, indeed, is an advance on anything seen on the Continent, since the number of bearing surfaces is considerably reduced by placing the dynamo between the high and low pressure engines, while in point of size it is two and a half times as large as any seen.

As regards boilers. Tubular boilers were almost universally employed, but, on the other hand, it was in nearly all cases stated that the reason for this was economy of space, and that boilers of Lancashire type would be preferred on other grounds. This also is a satisfactory confirmation of the soundness of the work already done at the electric light station in Manchester.

One result of the investigation is to show that electric traction is fast superseding all other means of hauling trams. Wherever electric traction has been introduced on a small scale the system is being largely extended, and the use of horses is being entirely abandoned. Electric traction is not only preferred to horse traction, but to all other forms of mechanical propulsion; even the Serpollet steam system in use in Paris, and which appeared so promising, is being abandoned in favour of the electric system.

The essential elements common to every system of electric traction are an electric generator driven either by steam or water power, and an electric motor fixed upon the tramcar geared to the axles of the wheels and causing them to revolve. The difference between the various systems of electric traction is comprised in the various ways of establishing the connection between the generator and the motor. The most direct and simplest method consists in connecting one pole of the generator to the tramlines and the other to a wire suspended over the middle of each track and carried on insulated supports. This system is known as the overhead trolley system.

Next in order of simplicity and directness comes the underground conduit system. In this each pole of the generator is connected to an insulated conductor carried in a concrete culvert beneath the roadway. Connection with both conductors is established by means of a contact-making device known as a "plough," which enters the culvert through a slot running longitudinally in the same direction as the tramlines.

The third system is as simple as either of the two preceding ones, but it is less direct. It consists in charging secondary batteries or accumulators from the generators, which accumulators are fixed on the car, and afterwards give out current to the motor on the car. The electrical energy is thus stored in the accumulators, and no direct connection is necessary between the generator and the motor.

The fourth system is that known as the closed-conduit system. In this, one pole of the dynamo machine is connected to the rails, and the other is connected in succession to a series of metal plates between the tramlines, the connection being established automatically by the car as it moves onward. This system is as direct as the trolley or slot system, but it is much more complicated, and is very liable to become deranged.

All systems of electrical traction fall broadly under the four heads named above, but there are endless differences in detail. Thus, with the trolley system the overhead wire may be supported on posts fixed either in the middle of the roadway or at the sides, arms projecting from the posts over the tracks; or it may be carried on wires known as span wires, stretched across the track and attached either to the buildings or to two posts without arms. The wire may be fixed over the centre of the track, or near one side, the latter being known as the side trolley system. Contact may be made with the wire either by means of a wheel, known as the trolley wheel, carried at the end of a long arm fixed on the roof of a car, or by means of a metal bow, also carried on the top of the car.

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Again, in the underground slot system, the slot may either be at the side—one rail forming one side of the slot—or it may be midway between the two rails of each track, a third line of metal being thus necessary for each track.

In the accumulator system the batteries may be removed from the cars for charging, or they may be left in the cars. In certain cases, the accumulator system is combined with the trolley system, and the accumulators are charged from the overhead wires in those portions of the city where it is fixed, while the electrical energy so stored in the accumulators is used to run the cars over the lines in that portion of the city where overhead wires are not allowed.

Comparing the advantages of the various systems, there can be no question that the overhead trolley system is by far the cheapest to construct, costs less for maintenance than any other system, is the simplest to operate, and the most easily repaired. It is much less liable to interruption than either the underground slot system or the closed-conduit system.

The accumulator system is extremely reliable, but the expense attendant on its introduction throughout the whole of the system of tramways is prohibitive, while if it be adopted for certain portions of the city, the working expenses are largely augmented on account of the great weight of the batteries having to be hauled over the whole of the lines whether the accumulators are furnishing current or not.

The underground slot system, though as simple to work as the overhead trolley, is very much more expensive, and possesses the serious disadvantage that it entails an entire cessation of traffic over the portion of line being converted for at least three weeks during its construction. The closed-conduit system, though very attractive in theory, is not at present sufficiently developed to admit of its adoption being recommended, as it is not capable of dealing with heavy traffic, is liable to fail, and may give rise to shocks fatal to animals and unpleasant to human beings.

Enquiry and observation show conclusively that on the Continent, wherever possible, the overhead system with either trolley or bow is employed. Other systems are only resorted to when the overhead is forbidden from æsthetic considerations. These considerations doubtless have weight when streets such as the principal streets of towns like Paris or Berlin are in question, but in the case of a great commercial city like Manchester, where cheap transit is a paramount consideration, and where an interruption of the heavy traffic would be fraught with disastrous consequences, there appears no necessity to insist upon the streets being kept absolutely free from overhead wires. Again, the overhead construction has been brought to such a state of perfection that the objection on æsthetic grounds is extremely small; indeed, there are probably not half a dozen streets in the finest cities, architecturally speaking, in the world in which it could be held to be a disfigurement. Certainly, in our opinion, it would be none in the busy commercial streets of Manchester, in which the trams at present run.

A further advantage of the overhead system is that it lends itself very readily to the combination of street-lighting and electric traction, since the same posts which carry the overhead wires may be used to support the lamps without appreciable extra expense.

Traction by means of accumulators has received very considerable development on the Continent, and there can be no doubt that it has been proved to be commercially successful as well as practicable from an engineering point of view. At the same time, it is unquestionably more expensive than the trolley system, both as regards capital cost and cost of maintenance, the latter being very heavy indeed.

Passing on now to the question of the supply of current for both lighting and traction purposes, there can be no question as to the economy of combining the two. In the first place, the traction load is one extending over long hours, and the machinery used for the production of current for this purpose can be looked after by the same men, who must of necessity be in attendance ready to run the lighting plant if required. Further than this, by combining the two stations, there need not be so many machines held in reserve, since the reserve machines can be common to the two systems, it being extremely improbable that there would be a breakdown on the lighting and traction machines at the same time. The same remark applies also to the boilers, and another very large source of economy arises from the fact that the loss from radiation from the steam-pipes can be very greatly reduced by supplying both sets of engines from the same steam-range. This economy may not at first sight appear important, but as a matter of fact the loss from radiation from steam-pipes is extremely large, and this alone would warrant the combination of the two stations. Other sources of economy are management and saving of land by the concentration of the plant.

The plant already put down at the generating station in Manchester is exactly suited to the production of current for electric traction, and by far the greater proportion of the tramlines could be worked from the existing site. Some of the longer lines, however, could not be worked directly from the present station, but the provision of current for lighting purposes over so large an area as that of Manchester, together with those outlying districts which have already agreed to take a supply from the city, necessitates a high-pressure generating station, and this would enable the question of electric traction to be dealt with with perfect ease over the whole of the tramway system. The scheme by which the engineer proposes to deal with the problem has already been set forth in his preliminary report of August 18, 1897, and it is interesting to note that this system is that most largely used on the Continent—viz., high-pressure generation with rotary transformers delivering continuous current for lighting and traction. This system is working with apparently great success at Rome, Budapest, and Milan, while it is just on the point of being put into operation at Hanover, and a similar scheme has been adopted for Munich.

To sum up, it would appear that the overhead trolley system with span wires attached to posts fixed along the sides of the streets is the most suitable for Manchester, and these posts could be conveniently used to carry electric arc lamps for lighting the principal thoroughfares. The greater part of the current for working the tramways would be supplied from machinery erected on the land already purchased in Bloom-street adjoining the existing station, and also from the present plant, while those lines which are situated at too great a distance from the generating station would be supplied from the new high-pressure generating station, which is necessary for the lighting of the whole city area.

Electric Lighting.—The deputation were much impressed with the large amount of street-lighting to be found in the Continental cities. Not only in the cities which were visited, but it was noticed that most of the small towns passed through *en route* were lit with arc lamps, showing that electric street-lighting was being almost universally adopted. Railway stations of moderate size were nearly all lit with arc lamps.

The systems of arc lighting in the street depend entirely on the width and character of the streets or squares to be lit, and no rule can be strictly laid down. It was evident, however, that, where possible, the various cities were adopting arc lamps in the centre of the streets, suspended by cross span wires fixed by rosettes to the buildings on each side, or from span wires fixed from vertical posts on each side of the street, the arc lamps being drawn to the side of the street and lowered down to the footpath for cleaning and retrimming.

Where tramlines were laid, the general rule was for posts to be fixed with arc lamps fixed vertical on posts or overhanging from the curved head of posts. In several of the cities visited these side posts have simply taken the place of the gas lamps which have been removed. In cities where rosettes are fixed to the buildings, and span wires and centre lamps, the footpaths are left free from any obstruction whatever. This was specially noticeable in Milan and Cologne.

The deputation strongly recommend that street-lighting by electric arc lamps be extended in Manchester for the winter of 1898-9. They recommend that Downing-street, London-road, Piccadilly, Market-street, Victoria-street, and Great Ducie-street as far as the Assize Courts, Deansgate as far as Peter-street, Peter-street and Oxford-street to All Saints, Portland-street, Whitworth-street, Princess-street from Whitworth-street to Albert-square, John Dalton-street, and King-street be equipped with arc lamps. That in view of the introduction at an early date of electric traction for tramway purposes, the system of arc lighting should be as follows: Where the tramlines are laid, steel posts should be erected on each side of the street with arc lamps fixed on same. That the steel posts should be prepared to receive cross span wires to carry the overhead trolley wires if the overhead system is adopted in Manchester. In the streets where there are no tramlines the arc lamps to be suspended in the centre of the streets and carried by span wires. These span wires to be fixed by rosettes to the sides of the buildings if permission can be obtained from the tenants and landlords, and if the permission cannot be obtained, steel side posts be erected and the span wires be carried from them.

Generating Stations and Installations.—The deputation were much impressed with the manner in which the electric installations in the various cities had been carried out. The workmanship and design of the engines and electric appliances were extremely good, and silent working and steady running seemed to be the order of the day. It was evident that cleanliness of machinery and buildings were made a special object of the management.

Future Extension of Plant.—That as the whole city of Manchester and some of the outlying districts have to be lit by electric light under the Act of Parliament, and that the information gained by the deputation during their recent visit to the Continent has shown them clearly that the current can be transmitted long distances without much loss of current by several systems, steps should be at once taken for the acquiring of a site for a new generating station where land is cheap and water convenient for condensing purposes. This generating station to be utilised both for lighting and traction purposes.

(Signed) LLOYD HIGGINBOTTOM.
JOHN PHYTHIAN.
C. H. WORDINGHAM.

October 11, 1897.

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COMPANIES' MEETINGS AND REPORTS.

EASTERN EXTENSION TELEGRAPH COMPANY.

The half-yearly general meeting of the Eastern Extension, Australasia, and China Telegraph Company, Limited, was held at Winchester House on Wednesday, the Marquis of Tweeddale presiding.

The **Chairman**, in proposing the adoption of the report, stated that the gross revenue for the half-year ended June 30 last had been £290,749, showing a decrease of £23,165 as compared with that for the corresponding period of 1896. The result was, however, much more favourable than was anticipated when they decided to make the extensive reductions of tariff that were brought into force last year and at the beginning of the current year. The loss estimated then from these reductions was, in round figures, £31,000 for the half-year, and the actual loss had been £29,745. In addition to this there had been a falling off in the Australasian and other traffics amounting to £9,304, increasing the total loss for the half-year to over £39,000. On the other hand the Manila traffic, owing to the recent disturbances in the Philippine Islands, had been abnormally heavy during the half-year, and there had also been substantial increases in the Japan and China traffics. There would consequently have been but a comparatively slight decrease to report had there not been a further heavy fall in the value of silver, which had caused them a loss of nearly £17,000 through short collections at the currency stations. The working expenses had amounted to £99,425, showing an increase of £12,169 over those of the corresponding period of 1896. This was mainly accounted for by the fact that the expenses attending the maintenance of the cables—always a fluctuating item—had been considerably higher during the past half-year than they were in the corresponding period of 1896, in addition to which the accounts under review showed several items of exceptional expenditure in connection with donations, negotiations, etc., that were absent from the accounts for the corresponding half of last year. The usual interim dividends at the rate of 5 per cent had been paid for the past half year, amounting to £62,500, and after transferring £75,000 to the general reserve fund, £34,812 would be carried forward. The report was adopted.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY, LIMITED.

The forty-eighth ordinary meeting of this Company was held on Wednesday at Winchester House, Sir A. J. Leppoc Cappel presiding.

The **Chairman** moved the adoption of the report, which recommended a final dividend of 3s per share, making, with the interim dividends, a total distribution of 6 per cent. for the year, and also a bonus of 2s. per share, leaving £7,221 to be carried forward. The receipts for the half-year were £79,133, against £88,973 for the previous half-year, or a decrease of £9,840. The receipts for messages showed a decrease of £10,050, and those from interest, rents, transfer fees, and dividends a decrease of £210. Turning to the expenditure, he said the total expenses were £20,505, which, compared with those of the previous year of £21,090, showed a decrease of £585. After providing £3,200 for debenture interest and sinking fund, and £1,481 for income tax, there was a balance of £53,946 To that was added the balance brought forward, making £69,221, and after paying the interim dividend for the March quarter there remained £39,721. He was glad to say that from July 1 the loss falling upon the telegraph companies in realising their charges collected in the Brazilian currency would be greatly diminished, and in time practically cease, owing to the arrangements made at the International Convention at Budapest.

Mr. F. Youle seconded the motion, which was agreed to without discussion.

MONTE VIDEO TELEPHONE COMPANY.

The annual general meeting of this Company was held on the 25th inst. at Winchester House, E.C. The report showed an increase of £300 from 46 additional subscribers and a decrease of £1,040 on working expenses. Exceptional expenditure had been rendered necessary for repairing the damage done by a cyclone of unusual severity, and for the installation of a new microphone. The Company's securities showed an increase of £700. After ample amounts written off and adding £500 to the reserve fund, they were able to distribute a dividend of 4 per cent. to the preference shareholders, being the same as last year, and to carry forward £976.

NORWICH AND COVENTRY ELECTRIC TRAMWAYS COMPANIES.

The statutory meetings of these Companies, which were called for October 5 but had to be postponed owing to no quorum being present, were held on the 25th inst. in Bank-buildings, Lothbury, Baron E. B. D'Erlanger presiding.

The **Chairman** said the first step towards the construction of these tramways had been taken—that was to say, the whole of the share capital had been subscribed, and half of it was ready to be paid up, and the other half would be paid up as the works proceeded. No good purpose would be served by having the money paid up before it was actually wanted, for that would involve a needless loss of interest; but the shares had been subscribed by respectable people, and would be paid up as called for by the Company. The money being ready, construction would be pressed forward without any more delay than was absolutely necessary. In regard to Coventry, he thought the proposed extensions would be a great boon to the inhabitants of the city.

The following gentlemen were elected directors to both undertakings: Captain Francis Pavy, Baron E. B. D'Erlanger, Mr. E. A. Hopkins, the Hon. Arthur G. Brand, Baron A. von Cramm, and Mr. T. M. Thackwaite. The auditors appointed were Messrs. Deloitte, Dever, Griffiths, and Co., London, and Messrs. Pearson and Sons, Coventry.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Ayr.—Tenders are invited from firms willing to undertake the free wiring of premises in the streets of the burgh, full particulars of which appear in another column.

Blackpool.—The Corporation are prepared to receive tenders for the works required in the conversion of their present system of electric traction, full particulars of which appear in another column.

Azuaga (Spain).—Tenders are required by November 3 for the lighting of the town; the system to consist of 250 lamps of 10 c.p. The estimate amounts to £264 per annum. Address the Syndico of the above town, Spain.

Russia.—The Municipal Authorities of Novorossiak, South Russia, are inviting tenders for the concession for the construction and working of an electric tramway, and for the electric lighting of the town. Tenders by November 1.

Ploesti (Roumania).—Tenders are invited for lease of lighting the town by electricity for a period of 40 years, also for power transmission purposes. Particulars may be obtained on application to the Municipal Authorities at Ploesti. Tenders by Nov. 27.

Dewsbury.—The Corporation invite tenders for the supply of coal to the electric lighting station, Bradford-road, for 12 months from January 1, the coal to be delivered in such quantities as may be from time to time required. For further particulars apply to the Electrical Engineer, Electricity Offices, Bradford-road. Tenders, under sealed cover, marked "Tender for Coal," to be in the hands of Mr. G. Trevelyan Lee, town clerk, Town Hall, Dewsbury, by 6 p.m. on November 2.

Sheffield Prize Competition.—The Tramways Committee of the City Council of Sheffield invite designs for centre standards and side posts for use in connection with their proposed electric tramways and offer a prize of £10. 10s. for the design which, in their opinion, is the best submitted. Particulars as to dimensions can be obtained at the City Surveyor's Office, Town Hall, and designs must be deposited with the City Surveyor, endorsed "Designs for Tramway Standards," not later than the 30th inst.

Melbourne (Victoria).—The Agent-General for Victoria, 15, Victoria-street, Westminster, invites tenders for the supply of electric light cables and fittings, for the Railway Department of the Colony. The specifications and conditions of contract can be obtained at above address, where tenders must be delivered by November 10, addressed to the Victorian Railways Commissioner, accompanied by a preliminary deposit of £20 enclosed in a separate envelope addressed to the Agent-General. The tenders will be opened at Melbourne on December 20.

Burnley.—The Corporation invite tenders for the supply and delivery at their electric lighting station of lead-sheathed, armoured underground cables. Specification, schedule of quantities, and form of tender may be obtained on application to Mr. W. R. Wright, borough electrical engineer, on payment of a deposit of £1. 1s., which will be returned on receipt of a bona fide tender. Sealed tenders, endorsed "Tenders for Cables," and addressed to the Chairman of the Electric Lighting Sub-Committee, Town Hall, Burnley, must be delivered by November 17.

Singapore.—The Municipal Commissioners of the town of Singapore, Straits Settlement, invite proposals for the lighting of the public street lamps for five years from January 1, 1899. Tenderers may submit proposals for lighting by gas or oil, or partly with one illuminant and partly with the other. Further particulars may be obtained on application to Mr. C C. Lindsay, M.I.C.E, 167, St. Vincent-street, Glasgow, or to Mr. J. Polglase, secretary to the Municipal Commissioners of Singapore, Singapore. Tenders may be sent either to Mr. Lindsay, up to November 30 next, or to the Secretary up to December 31.

Queensland (Australia).—The Municipal Council of Ipswich, Queensland, is inviting tenders for the supply and erection of the following electric lighting plant, etc.: tubular boilers, pipes, pumps and heaters, alternators and exciters, switchboard, high and low tension mains, junction boxes, transformers, etc. Specifications and all particulars as to conditions, etc., may be obtained from Messrs. Gordon and Gotch, St. Bride-street, Ludgate-circus, London, E C., and tenders have to be forwarded to the town clerk (Mr. Albion Hayne), Council Chambers, Ipswich, Queensland. Tenders by November 15.

London, N.W.—The Vestry of St. Pancras invite tenders for supplying and fixing additional plant at the Regent's Park electricity works, comprising dynamos, engines, and switchboard.

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Copies of specification, conditions of contract, and form of tender to be obtained on application to the Chief Clerk, Electricity Department Offices, 57, Pratt-street, N.W., on payment of a deposit of £1, which will be returned on receipt of a bona fide tender and specification. Tenders to be sent to Mr. C. H. F. Barrett, vestry clerk, Vestry Hall, Pancras-road, London, N.W., endorsed "Tender for Engines and Dynamos, &c.," by 12 noon on November 2.

London, E.C.—The Shoreditch Vestry invite tenders for the supply and erection of additional engines and high tension continuous-current generators, with an extension of the existing switchboard. Specifications and forms of tender can be obtained at the offices of the engineers, Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, on payment of a fee of £5. 5s., which sum will be returned on the receipt of a bona fide tender. The contractor whose tender is accepted will be required to enter into a formal agreement, under seal, with sufficient sureties, for the fulfilment of contract. Trade union rates of wages and hours to be observed. Sealed tenders, endorsed "Electricity Supply, Tender for Contract No. 10," to be sent at or before noon on November 2 to Mr. H. Mansfield Robinson, vestry clerk, Town Hall, Old-street, E.C.

Hull.—The Corporation are advertising for tenders for the electrical equipment of their tramways, to the extent of about nine miles double track and half mile single track. It will be open to contractors to submit tenders for various systems, and the contract, which will not be divided, will include engines and generators, switchboards, feeders, poles, brackets, trolley wire, rail bonding, and all accessories, also the first instalment of cars (15 motorcars and five trailers). Copies of specification, etc., may be obtained from Mr. A. E. White, city engineer Town Hall, Hull, by persons proposing to tender, upon payment of a deposit of £10, which will be refunded upon receipt of a bona fide tender and return of the papers and plans supplied. Cheques to be made payable to Mr. Thos. G. Milner, city treasurer. Tenders, endorsed "Tender for Tramway Equipment," are to be addressed to the Chairman of the Works Committee, and delivered at the Town Clerk's Office, Hull, before noon on November 5.

Madras.—Tenders are invited for the utilisation of water flowing from the Periyár Lake for purposes other than irrigation and not incompatible with the use of the water for drinking. The irrigating season extends over nine to ten months, during which time the discharge is likely to be from 1,100 to about 500 cubic feet a second, according to the demands for irrigation and the available quantity in the lake. Subject to the risk of interruption by accident or drought, supply can be given throughout the irrigation season. No supply can be guaranteed at other times, but, so long as water is available, the Government will be prepared to issue it in such daily quantities as may seem to it advisable with reference to the time which is likely to elapse before the supply is replenished by the setting in of the rains. The fall from the tunnel to the foot of the hills is approximately 900ft., and the distance measured along the course of the stream about 6,800ft. One cubic foot per second falling 900ft. is estimated to produce over 60 effective horse-power. Intending lessees should state the quantity of water required in cubic feet per second and the annual rent offered for each cubic foot per second. No rent will be charged for the first year from the date of the concession; for the second year the charge will be one-fifth, and an additional charge of one-fifth will be made every year until the full rent is reached. The whole or part of the concession may be surrendered on a year's notice being given. Lessees will construct at their own expense, on plans to be approved by Government, all the weirs and other works required to divert the water from the river below the tunnel. For further information, application may be made to the Chief Engineer for Irrigation, Madras, by whom tenders will be received up to July 1, 1898.

BUSINESS NOTES.

Shoreditch.—The Vestry intend to borrow £15,000 for further works at the electric lighting depôt.

Heckmondwike.—The Council have resolved to apply for £250 for a new boiler at the refuse destructor works.

Paddington.—It has been decided to make an experiment with electric arc lamps on six refuges in different parts of the parish.

Chelsea Electricity Supply Company, Limited.—Letters of allotment and regret for the issue of 8,000 ordinary shares have been posted.

Dover.—The Electricity Supply Company intend to extend the mains to Buckland Bridge, Park-avenue, Salisbury-road, and Castle-avenue.

Rochdale.—An electric lighting installation is planned for the workhouse. The Guardians consider their gas bill of £282 per annum a little too high.

Ayr.—An incandescent lamp, designed by Mr. Fuller, the burgh electrical engineer, has been on trial in Hope-street. It is considered to have been highly successful.

Penn.—It has been decided by the Parish Council to recommend to the parish meeting shortly to be held that Penn-road be lighted. The cost of laying the mains is estimated at £520.

African Transcontinental Telegraph.—A despatch from Buluwayo says that Mr. Rhodes has ordered the material to construct a further 500 miles of the Transcontinental telegraph line.

Edinburgh.—Among the notices of motion given at the last meeting of the Town Council was one that powers should be got in the ensuing session of Parliament for further tramway extension.

Appointment Vacant.—The Glasgow Corporation invite applications for the position of chief resident engineer of their electricity department, for full particulars of which we refer to our advertising columns.

Loughborough.—The committee of the Town Council having considered the offer of the Electric Supply Corporation have decided that it was undesirable to make any such transfer as was proposed.

Stirling.—The Police Commissioners at their last meeting further discussed Prof. Kennedy's report upon the electric lighting of the district, but no definite result has as yet been arrived at.

Gosport.—The District Council have appointed the Drainage Committee, with a slight alteration in the *personnel* of the committee, to consider the advisability of lighting the town by electricity.

Russia.—A city railway or tramway is projected for Moscow. The length is 31 miles, and the cost is estimated at about 4½ millions sterling. There will be 25 stopping places, also stores, grain lifts, etc.

Monte Video Telephone Company.—Warrants for a dividend of 4 per cent. for the year ended July 31 last on the preference share capital of the Monte Video Telephone Company, Limited, have been posted.

Exeter.—A recommendation from the Electric Light Committee has been adopted by the Council that the borrowing powers of the Council with regard to the electric light undertaking should be increased from £11,000 to £15,000.

Bradford.—The Gas and Electricity Supply Committee have recommended to the City Council that the electrical engineer be authorised to erect four new arc lamps in Leeds-road, and to extend the electricity cables along Oak-lane.

Sussex.—The Duke of Devonshire is supporting a scheme for a light railway in Sussex. The new line will start from Berwick and proceed by way of Alfriston and Littlington to Birling Gap, where a new watering-place will probably be developed.

Stourbridge.—The Council will apply for a provisional order authorising the compulsory purchase of land belonging to Mrs. Cathcart, and situate on Forge Hill, on which a dust destructor might be erected; and for powers under the Electric Lighting Act.

Hamilton.—At a special meeting of the Town Council it was resolved to apply to the Board of Trade for a provisional order, under the Electric Lighting Act, 1882, to authorise them to supply electricity for public and private purposes within the municipal bounds of the burgh.

Yeovil.—It has been resolved by the Town Council that a Bill be promoted in the ensuing session of Parliament for the purpose of authorising the Council to supply gas and electricity, and to provide for the transfer to the Council of the undertaking of the Yeovil Gas and Coke Company.

Hebrides.—We hear that a syndicate has been formed in London for the construction of light railways in Lewis and Skye, with a proposed capital of £250,000, and that a report as to their suitability for the construction on them of railway lines and the probable amount of traffic is to be obtained.

Bridgwater.—On the recommendation of the Lighting Committee, the Council have decided to hold a special meeting on Thursday, November 18, to take into consideration and determine upon the expediency of applying to the Board of Trade for a provisional order for lighting the town by electricity.

Nantwich.—The National Telephone Company have obtained the permission of the Council to erect a pole at the back of the market hall in connection with the installation of the telephone in Nantwich, subject to the usual conditions, and also on the understanding that the position of the pole was satisfactory to the surveyor.

Sheppey.—Notices have been given for the construction of a light railway between Leysdown and Queenborough, in the Isle of Sheppey. The proposed line will run through the parishes of Eastchurch and Minster, connecting at Queenborough with the Sittingbourne and Sheerness branch of the London, Chatham, and Dover Railway.

Fulham.—The Electric Light and Dust Destructor Committee of the Vestry, after discussing the report of the deputation which was appointed by the Vestry to visit and report upon the destructors in operation at Oldham, Warrington, Cambridge, and Southampton, have decided to view the dust destructor and electric light works at Shoreditch.

The Electric Light at the Law Courts.—Arrangements are now being completed whereby the corridors and offices occupied by the officials of the Crown Office and the Associates' Department at the Royal Courts of Justice will in future be supplied with the electric light from an outside electric lighting company instead of from the inside source as at present.

Wimbledon.—The District Council is making application to the Local Government Board to borrow £32,000 to supply public arc lights and 5,000 incandescent lamps. It has been resolved that the buildings in the Lower storeyard be wired for the electric light; that three lamps be erected on the path between Malcolm-road and Sunnyside, and two in Clarence-road.

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Hanwell.—The British Electric Traction Company, Limited, has given notice of its intention to apply next month to the Light Railway Commissioners for an order authorising light railways in the suburban districts of Acton, Ealing, and Hanwell. It is proposed to construct a railway, with a 4ft. 8½in. gauge, from the tramway terminus at Acton-hill, through Ealing, and terminating at Hanwell-broadway.

Manchester.—The Electricity Committee have recommended to the City Council an extensive scheme of street-lighting by electric arc lamps. The arc lamps are proposed to be suspended in the centre of the streets from wires fixed to the sides of buildings, except where tramlines are laid, in which case steel posts are to be erected to carry the lamps, and also support overhead trolley wires, if adopted, for electric traction.

Tudor Accumulator Company, Limited.—The above is the title of a new company, into which the firm of A. B. Pescatore has been converted. We are informed that the business has been in no way changed, and that the staff remains as before, Mr. A. B. Pescatore being managing director of the new company, but the offices of the company will be transferred from Manchester to London in the early part of November.

Peterborough.—A special meeting of the Peterborough Town Council was held last week to consider the question of supplying the electric light. A motion, "That the Council proceed to sell the provisional order for electric lighting on the best terms that can be obtained," was lost, and it was resolved "That the Council apply to the Local Government Board for sanction to borrow £15 000 for electric lighting works, and that street-lighting be not included in the scheme."

Taunton.—The Light Railways Commissioners, comprising the Earl of Jersey G.C.M.G., Mr. G. A. R. Fitzgerald, and Colonel Boughey, C.S.I, held an enquiry last week into an application by the Taunton and West Somerset Tramways and Light Railways Company, Limited, for consent to the construction of a light railway in Taunton, from Rowbarton to the eastern end of the town. The proposed line is to be two miles long, it will be worked by electricity, and is estimated to cost £11,000.

Hackney.—The House Committee reported to the Vestry at the meeting of the 27th inst. as follows: "Your committee has had under consideration the desirability of protecting the town hall from lightning. They are of opinion, considering the height and size of the building, it is desirable that some precaution should be taken, and are of opinion that four lightning conductors should be erected. They therefore recommend that four lightning conductors be obtained and fixed at an estimated cost of £40."

St. Marylebone.—The report from the Electric Lighting Committee, which was submitted to the Vestry yesterday, recommends with respect to the proposed system of the Metropolitan Electric Supply Company, Limited, for the supply of electric energy in a part of the parish, that the Vestry's conditions be varied so as to permit of one connecting box being used for every two houses, provided that brickwork be not placed around such boxes, except when the company are compelled to fix the same in the carriageways.

Warrington.—The General Purposes Committee of the Town Council have considered a letter from Messrs. Crompton and Co., Limited, electric light engineers, of London, asking to have the powers of the provisional order when obtained transferred to them, and undertaking to establish and work an electricty supply station with a right of purchase by the Corporation at the end of a fixed period upon certain terms. A resolution has been passed that the committee is not in favour at present of entertaining such a proposal.

Perth.—The Town Council met in private last week to consider a recommendation by the Special Committee on Electric Lighting to apply for a provisional order for electric lighting within the burgh. It was proposed that a provisional order should be applied for. Other proposals were also made by members, but ultimately all were withdrawn, and a motion was carried that Prof. Kennedy should be asked to advise the Corporation on the whole question of the electric lighting before any steps were taken to secure a provisional order.

Dunstable.—The Town Clerk reported at the last Council meeting that the Water Purchase Committee had come to the following decision: "In the opinion of this committee it will not be in the interest of the borough to purchase the gas and water undertakings at anything like the price previously asked by the directors of the company; and, further, the committee recommends that the Council take into consideration the advisability of applying for a provisional order for electric lighting." The motion was carried.

New Warehouse.—We are informed by Mr. G. Braulik, of 218, Upper Thames-street, that owing to the very large and steadily increasing volume of his business he has found it necessary to rent two other large warehouses in the vicinity of the above address, which has permitted him to open a showroom in Thames street, a visit to which will well repay the trouble. He claims that a very large general stock enables him to execute orders promptly, a great desideratum in the trade. The firm makes a speciality of incandescent lamps of ordinary and high voltage.

Calverley.—A meeting of the Calverley District Council was held on the 27th inst. A preliminary notice was read of an intended application for an order authorising the construction of a light railway with electric power between Leeds and Bradford along the Leeds and Bradford main road in the Calverley district. The clerk was directed to suggest, in acknowledging the notice, that a branch from the proposed railway at Whitecote, passing along the Shipley and Bramley main road to Shipley, would be of much greater local advantage, and would probably be quite as profitable to the promoters.

Leeds Corporation Tramways.—The Leeds Corporation Tramways Committee met on the 25th inst. to consider the grievances of the electric tram drivers and conductors who came out on strike on Saturday against a reduction of two days' pay from their week's wages owing to a breakdown at the generating station, which stopped the cars from running two days. The men also applied for an advance of ½d. per hour, which they said was promised some time ago. Both demands were granted. The committee also decided that in future the men should work on the usual terms of a fortnight's notice on either side.

Norwich.—The question was raised at the last Council meeting when the tramways were to be commenced, and what proceedings were being taken in the matter. In reply, it was stated that communications were received from the Tramways Committee with regard to certain alterations which had to be made in the details of the scheme. That communication was referred to the engineer to consider as to the routes first to be taken in hand, and the committee were awaiting his report, and upon that the committee would meet and decide and give notice of the route, and then the work would commence as early as possible.

Burslem.—A special meeting of the Town Council was held on the 27th inst. for the purpose of considering the expediency of adopting electric lighting powers for the borough and the parish of Wolstanton. The Town Clerk reported that the consent of the Wolstanston Rural District Council had been obtained to an application by the Town Council for powers under the Acts, and it was decided that application be made to the Board of Trade for a provisional order under the Electric Lighting Acts, 1882-88, to supply electricity for public and private purposes within the borough of Burslem and the parish of Wolstanton.

Harrogate.—A Local Government Board enquiry with reference to the application of the Harrogate Corporation for leave to borrow £17,500 for electric light extensions, was conducted on the 27th inst. by Major General H. D. Crozier, R.E. It was stated that during the month of September the income from the light supplied was £251, and the expenditure, including repayment of interest and portion of sinking fund, was £253. The Corporation proposed to extend the lighting area and to illuminate the streets. It was believed to be unprecedented that the installation had paid all expenses in the fifth month of working.

Llandudno.—A special meeting of the Council was held last week for the purpose of passing a resolution in accordance with the Tramways Act, approving of the intention of the Council to apply to the Board of Trade for a provisional order to lay down tramways within the urban district of Llandudno. It was proposed that the resolution be withdrawn until the Electric Lighting Committee had had an opportunity of considering the proposals contained in a letter received from Mr. Warwick Webb. Finally, the resolution was passed *nem. con.*, and it was agreed that the letter be referred to the Electric Lighting Committee.

Sheffield.—Further extensions have just been completed at the Hartshead end of the buildings of the telegraph office. This enlargement of premises means more lighting and driving power. Failing to make satisfactory terms with the local electric light company, the authorities were obliged to order a 530-ampere dynamo from W. Hartnell, of Leeds. This is capable of supplying current for 1,060 incandescent lamps. A new switchboard of special construction is used to put the full load on the 530-ampere dynamo, or to divide it between two others of 240 amperes. When the load is a light one, a single small dynamo is switched into circuit.

Liverpool.—The County Council met on the 27th inst. The various routes for the proposed tramways and duplicating of existing lines were discussed and adopted, and the intention to make application to the Board of Trade under the Tramways Act, 1870, for a provisional order for the construction of tramways within the parish and city of Liverpool, the township of West Derby, the parish of Walton-on the Hill, and the township or extra parochial place of Toxteth Park was approved of. It was decided to insert in the provisional order clauses to enable the tramways to be worked by means of steam, gas, electrical, or other mechanical power.

Huddersfield.—The engineer's report on the electric lighting, which was adopted by the Council, shows that the number of consumers had increased from 497 in September to 514 in October, and the number of lamps connected from 35,423 to 37,222. The number of units metered was 35,931 in September, as compared with 21,403 during the corresponding period of last year, an increase of 14,528, which is equal to 67 per cent. Extensions have been sanctioned to Cleveland-road Marsh, Paddock, and Mill-hill (*viâ* Long-lane). The proposed extension to Fartown has been deferred for the present. Accounts amounting to £963. 13s. have been passed for payment.

Bromley.—In reply to the threat of the Postmaster General to appeal against the refusal of the District Council to allow him to erect a line of poles for telegraph between Chislehurst and Eltham, which had been submitted to the Chislehurst Parish Council, that Council now adhered to their previous recommendation, and stated as their reasons for the refusal that the erection of poles along the highway would cause inconvenience, and that the poles would be unsightly. In reply to the statements of the Postmaster that the road was free from houses, the Parish Council said there were houses on both sides for a great part of the distance, and where there were none at present, the land was being disposed of for building purposes. The reply was ordered to be sent to the General Post Office.

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Northallerton.—The quarterly meeting of the North Riding County Council was held on the 27th inst. The County Surveyor reported that the sum of £1,200 having been paid by the tramway company to the County Council for the improvement of the road between Middlesbrough and Thornaby, plans were now being prepared, and negotiations were in progress for the purchase of the requisite land for widening the roadway, culverts, and bridge for improving the footpath and channels, and for fencing off and laying new drains along the sides of the road. The works of the tramway were in full progress, and the tramrails would soon be laid along the whole length of the road.

Leicester.—At a special meeting of the Leicester Town Council held on the 27th inst. the following resolution was discussed: "That in the opinion of this Council the existing monopoly of the use of the telephone trunk lines between large centres of industry has become disadvantageous to commerce and other interests, and that greater advantages and a cheaper and more efficient telephone service generally would be secured by the establishing of competitive undertakings, and that the Postmaster-General be urged to sanction competition in the telephone service of the country." The resolution was, however, withdrawn, and it was stated that the committee would report as to whether it was desirable for the Corporation to acquire the right of working the local telephone system municipally.

Hornsey.—The Highways and Lighting Committee recommended to the District Council at the last meeting that the solicitor be instructed to take steps for obtaining a provisional order for electric lighting, and prepare and issue the required advertisements; and that the roads to be scheduled as streets in which it is proposed that electric mains be laid down within a specified time be High-street, Hornsey, Tottenham lane, Hornsey, and The Broadway, Crouch End. The recommendation was objected to because no particulars were given. A member characterised the report as a travesty of a scheme for electric lighting. The question of cost had not been touched; in fact, a scheme had not been considered at all. After further discussion it was agreed that the recommendation should be omitted from the report.

Skipton.—At the last meeting of the Urban District Council a discussion took place on the question of supplying the town with electric light. A short time ago a committee was appointed by the Council to look into the matter, the gas company having given notice of a rise in the price of gas. It was decided to consult Dr. Hopkinson, electrical engineer, as to what terms he would advise on the whole matter. The Chairman thought that they were going a little too fast. They might at the same time enquire into the question of the purchase of the gasworks. The Clerk said it was too late now to prepare the necessary notices so as to obtain a provisional order during the next session of Parliament. It was, therefore, decided to give up the idea for the present session, but Dr. Hopkinson is to be consulted on the matter.

Personal.—Mr. Charles Augustus Midgley, of the House-to-House Electric Supply Association, Leeds, was selected out of 23 applicants for the post of assistant electrician for the Wakefield City Council.—Mr. W. L. Phillips, who for the last five years has been on the Woolwich staff of Messrs. Siemens Bros. and Co., has been transferred to an important post in the Sydney branch of the same firm. Mr. Phillips is a native of Australia, and left Melbourne some years ago, after gaining a general engineering training, to obtain electrical experience in England. With Messrs. Siemens Bros. he had charge of the erection of several of our municipal central stations, and also carried out some valuable research work. Previous to his leaving by the ss. "Arcadia" on Friday last, Mr. Phillips was presented with a slide rule and some technical works by his colleagues on the staff.

Clontarf.—A trial trip was made on the electric tramway on the 21st inst., which appeared in every way most successful, the cars running very smoothly and being stopped whenever desired very quickly. The cars are similar to those on the Blackrock line, and the one used for the trial trip was built at the Dublin United Company's works at Inchicore. The journey from Annesley Bridge to the power station near the North Bull was made in nine minutes. Sir F. Marindin and Major Cardew, R.E., the inspectors for the Board of Trade, are expected to arrive in Dublin in the course of the next few days, and after their sanction has been given the new line will be opened for traffic.—A workman while employed on one of the upright supports of the electric wires on the Clontarf tramway fell off, falling a distance of 20ft. He was removed to Jervis-street Hospital, where he is detained a patient suffering from shock and concussion.

Blackpool.—A meeting of the Blackpool Town Council was held on Tuesday, when the only topic discussed was the proposal to run a tramway on the new promenade which is in course of construction at North Shore. Lively comments on councillors, as well as the scheme, were passed. The speakers in favour of the tramway being laid pointed out that it would be a great improvement, and a convenience to the ratepayers and the public generally. The opposition was led by the representatives of the Claremont Ward. They stated that instead of drawing the better-class people to Blackpool, the proposal would repel them. As for the tramways paying, they might do so for three months in the year, but for the remaining nine months they would be a dead loss. On a vote being taken it was found that there were eight for and eight against. The Mayor gave his casting vote in favour of the scheme, and it was therefore declared carried.

Chester.—It was resolved at the last meeting of the Town Council that the Lighting Committee be authorised to have a distributing main laid at a cost (exclusive of the street-pillars or brackets and lamps) of £139. Upon an enquiry how the electric light had answered financially, it was elicited that all were pleased with the light, which had given great satisfaction, but the members of the Council had had no information yet as to whether it was a success from a financial point of view. The Mayor replied that before they got in their accounts they should have to run for 12 months. At the last meeting of the committee it was reported that they had sold £2,300 worth of light, exclusive of the lighting of the streets, which was a very large amount For that, of course, the Watch Committee owed them, but they had not yet sent in their bill. He could only assure the Council that the electric light was a greater possible success than they anticipated.

Glasgow.—The cables for Cambuslang's electric lighting scheme are now being laid down. All the columns have been erected. At a recent meeting of the Council the resignation of Mr. W. Arnot, the chief resident electrical engineer was accepted, and his offer to assist the committee until a new appointment was made was agreed to, and the committee was instructed to advertise for a new chief resident engineer at a salary of not less than £800 per annum, and after considering the applications received, to report to the Corporation for their approval the name of the applicant selected by them to fill the position. The Chairman reported that Mr. William Lackie, the chief assistant to Mr. Arnot, had accepted an offer made to him to become the chief assistant to the electrical engineer of the Corporation of Edinburgh. After consideration it was agreed that it be remitted to the Works Committee, with power, to try and arrange for retaining Mr. Lackie in the service of the Glasgow Corporation.

Hastings.—Notices appear in the local papers showing that application is intended to be made in the month of November next by the Hastings, Bexhill, and District Light Railways (Electric) Company, Limited, to the Light Railway Commissioners, under the provisions of the Light Railways Act, 1896, for an order for the following, or some of the following, among other purposes: To authorise the company to make, maintain, work, and use as light railways certain railways described or some of such railways in the county of Sussex, with all necessary and proper stations, junctions, sidings, roads, approaches, and other works, and conveniences connected therewith or incidental thereto; powers to construct and work light railways between Hastings, St. Leonards, and Bexhill, in the county of Sussex: gauge; motive power; purchase of lands, compulsory or by agreement; power to open surface of streets and roads; tolls, rates, and charges; by-laws; incorporation of Acts.

G. R. Blot and Co., Limited.—A company has been registered under this name, with a capital of £75,000 in £1 shares, with the object to acquire certain patents granted to G. R. Blot relating to improvements in the manufacture of electric accumulators or secondary batteries, and generally to carry on business as electrical and mechanical engineers and electricians, and to deal in and manufacture or obtain the manufacture by others of any articles, machinery, materials, stores, appliances, plant, and apparatus of every description applicable for or in connection with the supply, carriage, storage, accumulation, or use of electricity or magnetism for any purpose, and more particularly of the Blot electric accumulator, and to generate, accumulate, distribute, and supply electric force for any purpose; as company promoters, etc. The first directors—of whom there shall be not less than three nor more than seven—are T. Parker, F. H. Kirby, and E Honey. Qualification, £500. Remuneration to be fixed by the company.

Cardiff.—It was proposed at the meeting of the Town Council on the 25th inst. that the resolution, "In the event of the Corporation deciding to apply next session for power to extend the boundaries of the borough, that authority be sought at the same time to construct and work the tramways indicated by dotted red lines on the aforesaid map, should be rescinded, and that the following should be substituted: "That the Parliamentary Committee be authorised to give an undertaking to the local authorities of the districts proposed to be added to the borough, that in the event of such districts being included within the borough boundaries, the Corporation will apply to Parliament in the succeeding session for powers to extend the tramways to those districts as indicated by the dotted red lines upon the borough engineer's plan, or as may be agreed upon." Instances were quoted where electric tramways had proved more successful than tramways by horse locomotion. The alteration was unanimously agreed to.

St. Mary Abbotts, Kensington.—The Vestry having received notices and plans relative to extensions of their mains from the Kensington and Knightsbridge Electric Lighting Company, the Notting Hill Electric Lighting Company, and the House-to-House Electric Light Supply Company, have resolved that permission be given for the works being proceeded with subject to the following conditions—viz., that the ends of proposed pipes and conduits in Lenthal-mews and Westbourne-grove, which will not at present be used, be plugged, and that the consent of the owners of Iverna-gardens be obtained to the laying of the proposed mains in that new street; also that the plans be approved by the Vestry's surveyor and lighting engineer, and that the works be carried out under their supervision and to their satisfaction. Further, that the works be executed in conformity with the regulations of the Board of Trade, and be completed within three months of the date of the Vestry's sanction.

Grimsby.—A meeting of the Electricity and Public Lighting Committee of the Corporation has been held in order to take steps upon the resolution passed by the Town Council approving the use of electricity in the public lighting of the town, and authorising the committee to take steps to prepare plans and specifications and appoint an expert to carry out details. The Chairman

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remarked that they ought to get a sub-committee who would give a good deal of time and thoroughly master all the details for themselves. A Councillor said they would do well to get some knowledge themselves before they put themselves in the hands of an expert. They ought to empower some gentlemen who could give the time to go and see other towns lately lit by electric installations and find what was the best system now in existence. He therefore moved that before they employed an expert they should appoint a sub-committee to visit other towns and get necessary information. Ultimately a sub-committee of seven was appointed.

Colwyn Bay.—The Council, owing to the steam-roller being required for its legitimate use, have discontinued the temporary arc lighting of the promenade, and have decided upon a permanent installation. The temporary plant has been purchased by the proprietors of the Rhyl Pavilion, who are fixing it for the lighting of the outside of the building.—A special meeting of the District Council was held last week, when the surveyor presented a report on the permanent lighting of the new promenade by electricity. The Surveyor stated that the temporary installation hitherto in use had proved highly satisfactory, and proved also that electricity would be the light of the future. His estimate of the cost of the new permanent installation was £1,455, and he recommended the Council to obtain the money on loan for 25 years, and estimated the annual charge for repayment of principal and interest would be £260, and this would include attendance. It was decided to apply forthwith for a loan of £1,500 for the purpose, the details being referred for consideration to the next Highway Committee.

Rangoon.—For the past year the Municipality of Rangoon (Burmah) have had under consideration the report of their engineer, Mr. J. Stirrat, upon the advisability of undertaking the supply of electricity within the city. In August last the sub-committee reported on the whole subject to the Council, and made the following recommendation: "That a full statement of particulars of the electric lighting required be sent through the municipal agents for the purpose of obtaining a report and an estimate from an electrical expert on a scheme for electric lighting for Rangoon, alternative estimates to be given either including or omitting the lighting of 30ft. streets. The fee to be paid to be limited to £50, and the consultant to be Mr. Robert Hammond, or failing him, Mr. Shoolbred, or failing Mr. Hammond or Mr. Shoolbred, Dr. Hopkinson." This recommendation the Council adopted, and we understand that Mr. Robert Hammond has accepted the appointment as consulting engineer to make a preliminary report upon the scheme. As soon as this report is submitted, the Municipality will at once proceed with the establishment of the necessary works.

Swansea.—A meeting of the Tramways Committee of the Swansea Corporation was held last week for the purpose of considering the bills of costs incurred in promoting in Parliament the Swansea triple scheme. The Chairman said there had been already paid £2,921. 19s. 3d., and there were now bills amounting to £2,817 remaining to be paid. The unpaid bills included £1,427, agents' charges; £538. 10s., Messrs. Kincaid, Waller, and Manville, the engineers; Lord Kelvin, £216. 8s. 9d.; Mr. W. H. Preece, £136. 10s.; Prof. Thompson, £105; Mr. Geo. Thompson, C.E., £157. 10s.; Mr. Wright (Brighton), £52. 10s; Sir Robert Morris, £25; Mr. A. Mason, £21. 16s. 9d.; Mr. W. Thomas, £60. 2s. 9d.; Mr. Glyn Price, £28. 2s. 9d. A question if the Local Government Board had not to be consulted before the accounts were paid started a protracted and angry discussion. Finally, it was suggested that the law as to the necessity for the interference of the Local Government Board should be more closely looked into. The Mayor tried to obtain from the proposer of this enquiry whether his object was not to make the promoters of the Bill personally responsible for the costs, and, finally, when it was too dark to see, the meeting unanimously agreed to adjourn for a month.

Aston.—In accordance with the resolution passed at the last meeting of the Aston District Council, the Clerk has communicated with the Board of Trade, directing attention to the complaints with regard to the steam trams, and asking that the Board hold an enquiry in the matter. The complaints made in the letter are classified as follows: (1) that the tramways and rails need considerable repair, and in some instances are positively dangerous; (2) that the rolling-stock is defective, worn out, and obsolete; (3) that the engines emit sulphurous fumes, dense smoke, and steam, to the discomfort and annoyance of those who reside on and traverse the various tram routes; (4) the engines discharge water at most, if not all, the stopping stages on the line of route, and liberally distribute live coal and ashes during the journey; (5) the engines are so defective and out of order as to be incapable of doing their work. Notwithstanding the remonstrances of the Council, the outcry in the Press, and the almost universal indignation everywhere expressed, little or no heed has been paid by either of the companies, and the state of things complained of still remains. In these circumstances the Council ask that an enquiry may be held by the Board of Trade in the hope that some satisfactory remedy may be found for the existing state of things.

Brighton.—The Lighting Committee have passed the following resolution: "That as the committee are not at present able to estimate the profit on the Corporation electricity undertaking for the current year, the town clerk be instructed not to include in the estimate for the next general district rate any sum to be paid over from the electricity account in aid of the general district fund."—An application has been submitted to the Council from the Postal Telegraph Department for permission to open the roadway in Trafalgar-street, and it has been resolved that the permission requested be granted, subject to the usual conditions and the work being carried out to the satisfaction of the borough surveyor.—The Town Council will shortly have to consider one of the most important matters which could come before a municipality—viz., its attitude towards a proposal to establish an electrical tramway system in the town, with lines along the three principal traffic routes from north to south. The proposal takes the form of a scheme under the Light Railways Act, 1896, the promoters being the British Electric Traction Company. The proposed lines are from the Old Steine up Lewes-road, from the Old Steine up Preston-road as far as the north end of Preston Park, and from the Clock Tower (top of North-street), up the Dyke-road, as far as the Upper Drive. This latter line especially the promoters think would be a great boon to the many people who at present have to walk up this severe gradient. The promoters, for whom Mr. Henry Reason, of the Reason Manufacturing Company, Gloucester-road, Brighton, is acting locally, are prepared for some opposition to their scheme, but they hope to be able to meet all reasonable objections, and to show that the introduction of the system, without any danger to carriage traffic, would be a great boon to the public.

British Thomson-Houston Company.—This Company has been most successful lately in obtaining traction contracts. Our readers will recollect that two sections of the tramway system in Dublin have already been equipped by this firm, the latest of which is that running from Annesley Bridge out to Clontarf and Dollymount, the formal opening of which is to take place within the next few days. The other section referred to—viz., that from Ballsbridge through Kingstown to Dalkey—has been running successfully for some 18 months, and additional machinery is at this time being installed in the Ballsbridge station. A still larger scheme has now been decided upon, which will be served from a big central station, details of which are now being worked out by the Company. When this contract, just closed by the Dublin United Tramways Company, is completed, Dublin will be in the proud position of possessing the largest tramway system operated electrically in the British Isles, covering, as it will, over 110 miles of track on which will be operated over 200 motorcars. An inclusive contract for the equipment of the tramways now being built between Middlesbrough and Stockton-on-Tees has also been placed with the British Thomson-Houston Company, Limited, which will include all the power-house machinery, complete line equipment with 45 cars, and complete distribution system. Amongst foreign contracts may be mentioned one at Colombo, from which town an inclusive contract has just been given the Company for the entire equipment with electric traction of that portion of the tramway system which is now worked by horses. Again, at Barcelona and Madrid the contract for the electrical equipment (power-house and rolling-stock) of both these tramway systems has just been placed with the same Company. There will be 85 cars on the Barcelona system and 55 on the Madrid line, all operated on the overhead system.

Leeds.—The Yorkshire House-to-House Electricity Company, Limited, announce a further reduction in price of electric energy. Their new plant, the erection of which has been delayed by labour disputes, is now in working order, and will enable the company to meet a greatly increased demand. It has always been claimed that the supply in Leeds has been among the cheapest in the country, and the company believe that the revised scale of charges will place their claims in this respect beyond dispute. For the last two years the standard price has been 6d. per unit. This is to be reduced to 5d. per unit, and where the consumption for three months is 1,000 units or upwards the supply will be charged at 4¾d. per unit. Special discounts are also offered to customers (whether their lamps be many or few) who use those lamps for moderately long hours. Thus, for not less than 300 hours' use in the quarter a discount of 5 per cent. is allowed, and where the lamps are used 450 hours in the quarter this discount is increased to 10 per cent. All customers are entitled to a cash discount of 5 per cent. for payment within one month of the date of rendering accounts. It will therefore be seen that any customer (however small his demand, and however irregular his use of the light) can obtain a supply at 4¾d. per unit (5d. less 5 per cent), whilst some others will pay no more than 4·06d. per unit (4¾d. less 10 per cent. and 5 per cent.). The price of current for heating, cooking, and power purposes has also been reduced from 3d. to 2d. per unit, which price is subject to the 5 per cent. discount for cash. Another not unimportant concession is the abolition of the charge hitherto made for connecting consumers' premises to the mains. In the case of electric supply, this work is a good deal more expensive than the cost of connecting gas, and it has been the usual custom of electric supply companies to require this cost to be borne by the intending consumer. From now, however, the Yorkshire House-to-House Company will make connections free of charge where the distance of the premises from the road does not exceed 10ft.

York.—A special meeting of the City Council was held on the 25th inst. for the purpose of receiving the report of the Electric Lighting Committee. The committee had asked a number of firms to state definitely on what terms they would be prepared to take over the electric lighting of the city, but none of the offers were such as the committee could recommend the Council to accept. The only alternative was for the Corporation to undertake the electric lighting themselves, and they saw no reason why the Corporation should not be able to manage the undertaking and make a satisfactory profit. The committee therefore recommended the Council to accept the tenders as recommended by Prof. Kennedy in his report of January 7, and to instruct the town clerk to apply for leave to borrow the requisite amount—£20,000. The Chairman of the com-

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mittee moved the adoption of the report, and pointed out that the Government had given to the Corporation a provisional order which was equivalent to a monopoly to provide electric light for the city. He thought that some members of the Council were influenced by outside uneducated opinion. Some people argued that such an undertaking would cause an increase in the rates, but he believed that they could work the scheme at a profit. Other persons objected that only the ratepayers in a small area would derive benefit from the electric light, but he pointed out that it would be available to all, and that the profits would be shared by all. An amendment was proposed to the effect that the Council, not being satisfied that a certain profit would be made out of the electric light for some years at any rate, felt that they should not take upon themselves the critical risk. The resolution was carried, the voting being 26 for, 7 against, 8 neutral. It was also decided that application be made to the Local Government Board for sanction to borrow £20,000 for electric lighting purposes.

Wigan.—A meeting of the General Purposes Committee of the Wigan Corporation was held last week. The recommendation of the Tramways Committee to apply for parliamentary powers to construct additional tramways came before the meeting. The following are the additional tramways named: (1) from the existing terminus opposite the borough courts, along Rodney-street, up Library-street, to the present terminus of the Pemberton section; (2) from the terminus of the present Pemberton section in the Old Market-place, along Standishgate, Crompton-street, School-lane, and Warrington-lane, to unite with the Hindley and Platt Bridge sections at the junction of Darlington-street East with Warrington-lane; (3) from the Old Market-place, along Station-road and Rodney-street, to unite with the Library-street line opposite the Westwood estate offices; (4) commencing at the southern terminus of the Platt Bridge line in Ince, passing along Warrington-road (across Borsdane brook), and terminating at Abram Brow, near Abram parish church; (5) from the Old Market-place, along Market-street, Parson's-walk Park-road (including the portion recently constructed across Mr. Bryham's estate), and Woodhouse-lane, and terminating at or near Martland Mill Bridge. The Town Clerk reported that the undertaking referred to in the minutes had been sealed by the Wigan and District Tramways Company, and was in the possession of the Corporation. It was suggested that a clause be inserted in the Bill giving the Corporation power to work the tramway. The Town Clerk read the undertaking, which was as follows: "To the Mayor, Aldermen, and Burgesses of the county borough of Wigan, and to the Town Council of the said borough, acting as the urban sanitary authority for the borough and district of Wigan.—We, the Wigan and District Tramways Company, Limited, the lessees of your Pemberton, Hindley, and Platt Bridge sections of tramways, request you to apply to Parliament in the ensuing session for power to construct the following additional tramways. (Then follow list of routes). And in consideration of your agreeing to do so, we hereby undertake and agree to pay to you on demand a moiety of the whole of the costs, charges, and expenses of and incidental to such application to Parliament, whether the same be successful or not, and we further undertake and agree at our own expense to give the application our best support. As witness our common seal this 15th day of October, 1897.—ROBT. HALLIWELL, JOHN GEE, JOHN WOOD, directors; S. GRAHAM, secretary." In reply to a question whether there was any likelihood of the company objecting to the Thornhill extension, it was said that the directors at the meeting were in favour of any other route being put in which would be likely to be convenient to the inhabitants. No other route was mentioned, but it was thought the directors would not object to the extension. Unless the company constructed that line, objection would be taken to others being laid down unless they were worked by the Corporation. The motion was passed unanimously.

Wolverhampton.—Colonel C. H. Luard, R.E, the inspector appointed by the Local Government Board, attended the Town Hall, Wolverhampton, on the 26th inst. for the purpose of hearing evidence in support of an application made by the Town Council for the sanction of the above-named authority to borrow the sum of £9,000 for the extension of the present electric lighting system, and a further sum of £1,000 for the laying-out of St. George's Churchyard as an open space. The Town Clerk, in stating the objects of the application, said the original loan contracted for electric lighting purposes in the borough was £30,000, and the sum of £882, which had been overspent beyond the amount of the loan, formed an item in the present sum they proposed to borrow. Of the balance the erection of new buildings and foundations for a 140-unit steam dynamo, a steam exhaust pipe connected therewith, a fuse room and fuses, and other apparatus, representing altogether £5,330. Then there was an item of £1,000 for extending the mains and services; a third item of £1,500 for the extension of the present service to Chapel Ash, including the erection of a subway connecting station. These, with other items, made up a total expenditure for new plant, etc., of £7,830; contingencies, £288; and the overspent balance of £882, making a grand total of £9,000. The Town Clerk went on to say that the total plant capacity of the present undertaking was equal to 15,100 8-c.p. lamps. Setting aside 4,380 lamps as spare power in case of a breakdown, that left a working capacity of 10,720 lamps. Last year the maximum load generated was equivalent to 7,440 lamps, leaving a margin of 780. As, however, last winter 2,337 new lamps were installed, the Lighting Committee might fairly assume that a similar, if not a larger, increase would arise during the ensuing season. Deducting 2,337 lamps from the margin of 3,280, it would only leave a surplus of 943. But considering that 2,050 additional lamps had been installed this year, that margin was very nearly reached. With respect to their financial position for the year ending last March, the receipts were 26 per cent. above those of the previous year; and for the half-year ending September there was an increase of 25 per cent. over the corresponding half year of 1896. Assuming that the application was granted, and the proposed works carried out, they would then have an additional capacity of 4,000 8-c p. lamps. By the extension of the service to Chapel Ash and the erection of an additional sub-station there, they would be enabled to carry the light into another area of the town. Some time ago he received a letter from the Local Government Board referring him to the report of proceedings which had been brought against the Mayor and Corporation of Tunbridge Wells, prohibiting the construction by them of an underground station. Against that he would refer the inspector to the reported action of the Wandsworth District Board of Works and the London County Council, respecting an application for a similar injunction. In that case Mr. Justice Stirling decided that as the transformers, connecting the iron receptacles to be placed underground, tended to decrease the pressure, the Local Government Board had not exceeded their powers in permitting their construction. Mr. F. A. Lewis, electrical engineer of the borough, was then called, and produced plans of the proposed works. He entered into details as to the various items of expenditure, and generally confirmed the town clerk's opening statement. He said the addition of 4,000 lamps would enable them, through the medium of the Chapel Ash sub-station, to extend the light to the top of Compton and Tettenhall roads and a little way down the Merridale-road. In reply to the inspector, he stated that the principal item in the £882 overspent capital was a sum of £693 owing to unexpected difficulties in the construction of the principal generating station. The Inspector: What is your position as to your income and expenditure so far? The Town Clerk: Last year we made a profit of £224. No further questions being put, this portion of the enquiry was brought to a close.

TRAFFIC RECEIPTS.

Bristol Tramways.—The traffic returns for the week ending October 22 were £2,613. 5s. 9d., compared with £1,988. 5s. 4d. for the corresponding period of last year, being an increase of £625. 0s. 5d.

Birmingham Tramways.—The traffic receipts for the week ending October 23 were £3,679. 16s. 5d., as compared with £3,203. 11s. 1d. in the corresponding week in 1896, being an increase of £474. 5s. 4d.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended October 24 amounted to £1,335, as compared with £1,092 in the corresponding week of the previous year, being an increase of £243.

City and South London Railway.—The returns for the week ended October 24 were £970, compared with £1,003 for the corresponding period of last year, being a decrease of £33. The total receipts for the half-year 1897 amounted to £15,520, compared with £15,695 for the corresponding period last year, being a decrease of £175.

South Staffordshire Tramways.—The traffic returns for the week ending October 22 were £664. 8s. 0d., as compared with £596. 3s. 8d. in the corresponding week of the previous year. The aggregate receipts so far this year were £26,848. 8s. 0d., as compared with £26,051. 5s. 2d. in the corresponding period in 1896.

S.D. Tramways, Dublin.—The traffic receipts for the week ending October 22 were £492. 4s. 8d., as compared with £424. 8s. 10d. in the corresponding week in the previous year, being an increase of £67. 15s. 10d. The number of passengers carried was 77,670 in 1897 and 63 862 in 1896. The aggregate returns up to date are £11 790. 6s. 1d., as compared with £12,460. 13s. 10d. last year, being a decrease of £670. 7s. 9d. The mileage open is the same as last year—viz., eight miles. There were 291 cars running, against 159 in 1896; the number of miles travelled being 24,083 (16,640 in the same period of 1896).

PROVISIONAL PATENTS, 1897.

OCTOBER 18.

23914. A receiver for electric oscillations. George M. Minchin, the Royal Indian Engineering College, Cooper's Hill, Staines.

23979. Improvements in or relating to switches for controlling electrical currents. James Booth and Samuel Hobday, 50, Cherry-street, Birmingham.

23987. Improvements in dynamo-electric machines. Mark Heaton Robinson and Matthew Henry Phineas Riall Sankey, 24, Southampton-buildings, Chancery-lane, London.

23988. Improvements in apparatus especially suitable for grinding and polishing the commutators of electrical apparatus. Henry Harold Perry, 24, Southampton-buildings, Chancery-lane, London.

23999. Improvements in electricity meters. Sebastian Ziani de Ferranti, Hollinwood, Lancashire.

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Good Hope, gave some interesting facts and figures at a meeting of the members of the Colonial Institute on Tuesday. Communication in the Colony by means of the electric telegraph has, he says, increased wonderfully in the last few years. The number of miles of wire worked in 1896 was 16,326, and the number of miles of line 6,464. The revenue last year amounted to £252,910, and the total number of messages forwarded was 2,229,663. These telegraph lines cost a little over half a million, which sum was raised on loan, and the surplus interest on this investment is considerable.

Penny-in-the-Slot Meters.—The progressiveness of the Shoreditch Vestry in utilising the heat generated in the refuse destructor for the purpose of producing electricity is more than a nine days' wonder. It is still the subject of comment all over the country, and that comment is continually being fed by remarks about it in the newspapers. The latest item has been contributed by the *Daily Mail*, who announced a novel departure in connection with the new artisans' dwellings which the Vestry are erecting—namely, the provision of penny-in-the-slot electric light meters. The writer also states that the penny-in-the-slot customer will find that for 2s. 10d. he will be provided with electricity equivalent to 1,000ft. of gas.

North-East Coast Institution of Engineers and Shipbuilders.—The first business meeting of the session will be held in the Lecture-hall of the Literary and Philosophical Society of Newcastle-upon-Tyne to-day (Friday), November 5, at 7.30 p.m. The minutes of the closing business meeting of last session will be submitted for confirmation; the ballot for new members will then be taken; the council will submit for adoption the thirteenth annual report and financial statement; and, after some opening remarks by the president, a paper on "The Comparison and Construction of Ships' Lines" will be read by Mr. Archibald Hogg, followed by a discussion. The second general meeting of the session will be held in Sunderland on Monday, December 6, 1897. A paper on "The Theory of the Centrifugal Pump and Fan" will be read by Mr. C. H. Innes, M.A. (Cantab).

Acetylene Gas.—The foremost question the Swedish Tariff Association dealt with at its meeting held on the 4th ult. was that relating to the risk of acetylene gas, both as regards explosion and fire. It was submitted that prior to the acceptance of a proposal an expert should be commissioned to fully investigate the risk, and an examination should take place every 30 days during the currency of the insurance. Several members also considered it of importance that every policy-holder should be duly warned against the introduction or installation of the gas in question without having first received sanction from the insurance company. In reference to the next matter on the agenda—viz., "factories"—it was suggested that greater stress than ever should be laid on the matter of construction, since the special tariff for this class of risks allows a considerable reduction in cases where buildings are of massive construction.

The Engineering Strike.—This weary dispute is dragging on week after week, and seems as far off a settlement now as ever it was. The Amalgamated Society of Engineers is to issue a manifesto to the labour unions of the United States, and make a general appeal for money, but American correspondents do not anticipate that it will be productive of much success, because the people of the United States of America have not yet got into the way of subscribing to aid strikers. Other manifestoes have been issued by the men to workmen in different countries, and it is now an undisguised fact that they are getting uncommonly short of funds. This may be the beginning of the end, because we learn that the masters have during the past week received some very important adherents to their cause. The Board of Trade negotiations have not been successful, and the question of an arbitration conference seems to have been dropped out of the issue for the present.

The Tables Turned.—We read in one of the financial papers that the telegraph, telephone, and express companies in Nebraska have been called upon to defend their rates against complaints brought under a new law giving the State Board of Transportation jurisdiction over these public conveniences. On complaint of a single citizen a telegraph company and three express companies have been cited to appear and show why their rates should not be reduced, the declaration being that such rates are "unjust, unreasonable, and exorbitant, and so great as to yield large and inconceivable profits." The telephone company, which was the first object of attack, secured protection by a restraining order from the Court, and it is not unlikely that the others will have to take similar action, pending a decision as to the constitutionality of the Nebraska statute, which the corporations deny. Probably a good many people in England wish they could send our telephone system to Nebraska!

Roller Bearings.—The advantages arising from the application of roller bearings formed the subject of a paper read by Mr. Thomas W. How, of London, at the meeting of the Manchester Association of Engineers. The author discussed the requirements and details of construction of roller bearings, and the results already obtained. In the case of railway vehicles fitted with such bearings the starting effort had, he said, in many cases been found to be as low as 3lb. per ton of load. There was shown to be a large saving in the consumption of fuel, and the contention that the application of roller bearings in the case of electrical traction would show a great economy under the head of maintenance of motors had been amply borne out by the experience gained at Liverpool. Careful experiments had been made to ascertain the relative starting effort and running friction of tramcars fitted with ordinary and roller bearings, and it had been found in the case of a tramcar weighing 4 tons 15cwt. that there was a saving in favour of roller bearings of 84 per cent. Other tests made in the adaptation of roller bearings to tramcars were equally satisfactory.

Vagrant Electricity.—Instances of horses being thrown to the ground by electricity escaping from a main seem almost to have passed into the realm of things forgotten, but a curious case of a somewhat similar nature is reported from Dublin. At about half-past nine o'clock on Saturday night a clerk named Thorpe was walking near one of the electric lamps at the corner of Nassau-street, when he got a severe shock, which, as he states, paralysed him, and he fell to the ground. Two other young men came to his help, but each as he touched him had the same experience. They lay helpless on the ground surrounded by a crowd, who, realising the danger, did not venture to touch them. After a short time the current was turned off, and the men were released. The assistant engineer at the electric light station states that about the time of the occurrence described he noticed something wrong with the circuit which supplies the lamp where Mr. Thorpe was standing, and at once turned the current off. There was no doubt a leakage in the lamp column, and the probability is that the man unconsciously completed the circuit by leaning against or placing his hands on the metal.

London Electric Railways.—It appears that the great difficulty in the way of adopting electric traction

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on the Metropolitan Railway is the fact that there are so many trains starting at once. There are 27 stations on the circle, and to start trains from several stations at the same time would require so great an amount of power that at present it is looked upon as prohibitive, although we are assured that the subject is receiving the continuous attention of the directors. We also hear that there are two suburban electric light-railway schemes projected. The Finchley District Electric Traction Company have given notice of their intention to apply to the Light Railway Commissioners for powers to construct and work light railways between the Metropolitan Railway Station, Finchley-road, Hampstead, and the adjoining suburbs of Finchley and Hendon. It is also proposed to construct a railway, with a 4ft. 8½in. gauge, from the tramway terminus at Acton-hill, through Ealing, and terminating at Hanwell Broadway. The British Electric Traction Company, Limited, has given notice of its intention to apply to the Light Railway Commissioners for an order to carry out the work.

Fact and Finance.—It appears that the publication last month of the report of the Board of Trade Committee appointed to consider the system of ventilation adopted by the Metropolitan Railway Company has caused a good deal of excitement in "Underground" railway stocks. The stocks of the Metropolitan Company and of the District Company rose considerably on the assumption that the introduction of electricity as a mode of traction would prove an advantage to the companies from a shareholder's point of view, on account of the suggested reduction in working expenses. They have since fallen again a little, probably through want of knowledge of the subject. Various figures have been published showing the difference in the cost of working, and the public have believed that electric traction would effect a saving of half the running expenses, and again they have been shown that that comparison is too fragile for belief. The comparison is mostly made with the Liverpool Overhead, but far more satisfactory results could be obtained from the City and South London Railway. This railway would show a great saving as compared with the Underground, but few people would pretend to a reduction by half.

Engineers at the Camera Club.—On Friday evening, the 29th ult., the Camera Club entertained Sir John Wolfe Barry, C.B., president of the Institution of Civil Engineers, and other engineers, only a few of whom are members of the club. After the dinner, Sir John Wolfe Barry referred to the numerous ways in which photography has become of importance to engineers. Amongst other instances he mentioned the valuable assistance which photographs of buildings, taken before railway and other works were constructed, had been when owners of certain kinds of house property had afterwards sought compensation for alleged damage in the form of cracks and settlements. The photographs had then been brought forward, and became silent but graphic witnesses of the state of the buildings before tunnelling and other works had commenced. They were witnesses who took no oath, but whose testimony was never doubted. Other aids by photography were mentioned, such as brevity of reports on progress of works in distant parts, frequent photographs telling much at a glance, and affording other valuable information beside simply progress. Mr. Lionel Clarke gave other examples, and said photo-printing of various kinds might have been added. The chair was taken by Prof. A. B. W. Kennedy, and amongst those present were: Mr. J. W. Godfrey, Mr. H. P. Powles, Mr. James Swinburne, Mr. W. Worby Beaumont, Mr. Addingbroke, Mr. Hall, and Dr. Norman Colly. An interesting exhibition was open of very fine examples of photographs of interiors, lent by Sir Benjamin Stone.

The Legal Definition of Electricity.—In view of the connection between English and Continental electrical engineering, it will be useful to know what rights and restrictions appertain to electricity. A jurist, writing in a Swiss paper, opens up the question of the legal definition of electricity, and as to what extent it can be treated as property. Gas, for instance, is a property because it can be put in receptacles and even turned into fluid, but electricity is difficult to store, and when stored only develops chemical energy. If one refers to a recent extraordinary decision of the Imperial Courts of Germany, then no magistrate can ever commit anyone who, without being entitled, took electricity to a point called C from a wire connecting A and B, but as the axiom holds good, *Nulla pœna sine lege*, the nearest category under which it may be classed would be fraud. Referring to the Civil Code, the question is asked, "What is the delivery of current?" Customer D gets current direct from the central station and gives it to E. Is that on the part of D a lease or a purchase? It must be a purchase, because the power is not only used but consumed—that is to say, it cannot be used over again. A point which is especially advocated in legal circles as being a matter that should be brought before the legislature is that rights of expropriation over power-current conduits or over private electrical apparatuses should be recognised as soon as a perceptible increase in the national wealth is evident as the result of the establishment of those works. That is only just, because at present there are such stringent regulations as to security against accidents, and under the existing law the Government can disturb any of these works for the "public good" without giving any compensation. A man who is enterprising enough to start these works under such conditions is at least entitled to rights of expropriation.

The Institution of Junior Engineers.—On Saturday, October 30, a party of about 100 members of this institution paid a visit to the Queen's-road station of the Central London Railway, through facilities kindly afforded by the engineer, Sir B. Baker, and Mr. F. Hudleston, engineer of the Electric Traction Company. They were received by Mr. Knowles (of the engineers' department), and Mr. A. W. Manton (the manager to the contractor, Mr. John Price). After inspecting the surface machinery for air-compressing, haulage, etc., a descent was made down the 30ft. lift shaft. On arriving at the bottom the members passed through the 8ft. temporary connecting heading, and the south station Greathead tunnelling shield, 22ft. 10in. in diameter, was seen in operation. It is fitted with 22 hydraulic rams, the pressure upon which is one ton per square inch, and the working face is held up by hydraulic rams, which return automatically as the shield advances. The segments of the tunnel lining are put into place by hydraulic erectors having extension and slewing cylinders, the pressure being kept uniform by an accumulator actuated by an air-driven pump. The method of driving the smaller tunnels proper was also witnessed, and it was stated that the rate of progress here was often as much as 23 yards per week. The visitors evinced great interest in the work proceeding, and in the many features of engineering construction incidental to it. Before dispersing, Mr. H. S. Vorley, chairman of the institution, expressed the members' acknowledgments for all that had been arranged for their reception. The opening meeting of the seventeenth session takes place this (Friday) evening at the Westminster Palace Hotel, when the retiring president, Sir A. R. Binnie, chief engineer to the London County Council, will be succeeded by Mr. John A. F. Aspinall, chief mechanical engineer to

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the Lancashire and Yorkshire Railway, who will deliver a presidential address on "Some Aspects of Railway Work."

Mechanical Engineers.—The Institute of Mechanical Engineers held a meeting on Wednesday and Thursday evenings at the Institute of Civil Engineers, in Great George-street. The chair was occupied by Mr. E. Windsor Richards, president. A paper on "Propeller Ventilating Fans Driven by Electricity," intended as a supplement to one read in the spring before the institute, was delivered on Wednesday by Mr. William George Walker. The author has since his first paper given further attention to the subject, and carried out additional experiments on the subject of the propeller or helical form of fan, and the results were placed before the meeting. We reproduced the first paper with illustrations in our issue of May 14 last. One of the directions in which Mr. Walker pursued his experiment was as to the number of blades most suitable. The experiments resulted in the decision that very little or no advantage could be gained by increasing the number of blades, and that the mechanical efficiency of the three-bladed fan was the highest. The conclusion was also arrived at that the velocity of the air passing through a fan should be as slow as possible, the diameter being as large as practicable, while the pressure of the air passing through the fan should be as small as practicable. The feature of propeller ventilating fans was that they could be made to comply as nearly as possible with these conditions. Further, while a 2ft. centrifugal fan with free discharge delivered 1,995 cubic feet at 1,324 revolutions per minute, giving a mechanical efficiency of 5·2 per cent., and requiring 1·92 h.p., therefore discharging 1,039 cubic feet per minute per horse-power, an air propeller of the same diameter had been shown to give 5,400 cubic feet per minute per horse-power. In the course of his demonstrations with apparatus at the close of his paper, Mr. Walker showed that the power of the fan was increased by round backs, and that for the purpose of ventilating a room, and for only that purpose, induced draught was better than forced draught. The position of the motor to drive the fan depended upon whether the fan was working with a contracted or free orifice, the best position being generally found to be at a little distance in front of the fan.

Civil Engineers.—Sir John Wolfe Barry, the president of the Association of Civil Engineers, delivered a speech at the opening meeting on Tuesday full of thought and interest. We publish in another column an abstract of that address, but there are one or two passages not included there which demand careful perusal. For instance, Sir John expressed the opinion that it was a matter for satisfaction that the institution had recently undertaken functions of great utility which might formerly have been considered as outside their sphere of duty. He alluded to such matters as the determination of standards of the thermal efficiency of steam-engines, a committee on which subject, consisting of 10 thoroughly representative persons, under the presidency of Dr. Kennedy, was nominated by the council in 1895, under the auspices of his predecessor, Sir Benjamin Baker; and again to the consideration of the best method of tabulating engine and boiler trials, upon which an equally efficient committee, of which Sir William Anderson was chairman, was appointed by the council this year. In connection with the subject of the widely-spread interests of engineering, he expressed his individual opinion that it was for the good of the institution and of the profession that the class of associates—not entitled to the privileges of corporate membership—should be carefully encouraged and developed. Dealing with matters which had occurred during his term of office, he said a new departure was made in the inauguration this year of their engineering conference in London, which occupied three days, and in respect of which a great success was achieved. The result of the whole experience indicated that they were right in thinking that those resident out of London would welcome the opportunity of making a more intimate personal acquaintance with their metropolitan brethren, and that the latter would highly prize the opportunity of meeting the engineers from other parts of the kingdom. The numbers attending the meeting were approximately half from London and half from other places. The address was listened to by a large assembly, including Sir Frederick Bramwell, Sir George Bruce, Sir William H. White, Sir Benjamin Baker, Sir William Anderson, Sir Douglas Galton, Sir A. Binnie, Sir M. Nelson, Dr. Hopkinson, Dr. Kennedy, Colonel Pennycuick, and Prof. Unwin. The president presented the medals and prizes awarded by the council for the last session, and a reception was afterwards held in the library of the institution.

A New Thermometer.—A firm in Vienna is making a thermometer by the aid of which it will be possible to keep rooms at an even temperature, and at the same time it may be used for indicating that temperature at a distance. The construction of the apparatus which has up till now served similar purposes, does not permit of a change in the degree of temperature. These instruments are mostly only applicable for a certain temperature ranging between any two fixed limits which may be required. This new thermometer is supposed to remedy that defect. It is made of glass, and consists of a glass tube the upper extremity of which fits into a long glass bulb. To this tube three capillaries are annexed. The capillaries are fixed on to platinum contacts for connection with the electric current. The apparatus is partly filled with fluid suitable for thermometric purposes, but a bad conductor of electricity. As regards the capillaries, two of the three are always dipped at the same time into the quicksilver. In the bulb there is present, besides the quicksilver and the thermometric fluid, a vapour of that fluid, so that when the temperature rises it pushes the quicksilver upwards, while when the temperature falls of course it goes down. This acts on the platinum contacts, so there is always an automatic interruption of the electric current simultaneously with the proportion of the new wave of current which is accelerated when a new impulse is given by the quicksilver being moved again by change of temperature. It is possible through a combination of these instruments, each fixed for a degree of temperature following the other, to register or to indicate the various degrees of temperature, but the same result is obtained by using only one of these apparatuses with several contacts, while instead of having several magnets it is easy to construct a single apparatus for a particularly high temperature. In this case the principal vessel is filled with quicksilver, and the part usually occupied by quicksilver is occupied by the fluid above spoken of. The only other difference between this apparatus and the other is that the first of the three contacts is duplicated. In this apparatus the current is immediately interrupted automatically even when the temperature remains for a time at the fixed degree at which the contact was closed, while with the apparatus formerly used the current remained closed as long as the temperature remains at the degree at which the current was stopped. The new apparatus is consequently much more economical, as it uses less electrical current.

The Telephone Question.—At the last meeting of the Lambeth Vestry the members engaged in a long discussion as to the efficiency of the telephone service in the metropolis. The National Telephone Company wished to lay underground mains in the inner and outer wards of the

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parish upon paying a yearly rental of two guineas per mile and the entire cost of taking up and relaying the roads. Mr. Ogilvie said everyone was complaining of the bad telephone service, and what was proposed by the committee would continue in force until 1911 if granted. He asked the Vestry to strengthen the hands of the Commission of Sewers by adding an addendum that the permission sought be granted under conditions that the company undertake to provide an improved service at a reduced cost. Other members having condemned the telephone service, the addendum was carried by a large majority. At a recent meeting of the City Commission of Sewers an application was received from the Post Office authorities asking for leave to lay wires from Holborn to Fleet-street. This was agreed to, providing that the National Telephone Company were not allowed to use any of the wires. The Commission has also decided to send to every town council, vestry, district board, and district council copies of the correspondence with reference to underground telephone wires, and directing their attention to the action of the Post Office authorities in laying wires for the use of the National Telephone Company without having first obtained consent for the opening of the street, a course to which Parliament had always been opposed. A letter has been published in the *Times* dealing with the proposal of the London County Council to take steps to procure a cheapened, a more effective, and possibly an extended service in the metropolitan area. The correspondent points out two pitfalls. One is that as Parliament has by statute conferred a monopoly of the telephone on the Post Office no municipality would be likely to be able to procure a license to establish local telephony, and the other is that a plan of action which did not include the City as well as the Council's area would be wrecked by its own incompleteness. He considers that the Post Office should have a clear mandate to cover the Metropolis with telephone exchanges in every locality and lay wires in mains as plentiful as water-pipes. Then, the charges should be according to a statutory tariff, in which a £5 note ought to command a great deal more in this direction than it does now. He thinks, and rightly so, that no private company can give that completeness which is necessary, and which the Government through the Post Office can do.

Physical Society.—At the ordinary meeting on October 29 (Mr. Shelford Bidwell, president, in the chair) Prof. Stroud exhibited and described the Barr and Stroud "Range-finder." The problem of finding the distance of a given object at sea, or in the field, is complicated by shortness of the trigonometrical "base" and by restrictions of time. As a rule the apparatus must be self-contained, and "snap-shot" readings are obligatory—*i.e.*, the range has to be determined from a single instrument and from a single observation. At 3,000 yards the errors must not exceed 3 per cent. In foggy weather, or when viewing a nebulous object, this degree of precision is difficult to attain, but under favourable circumstances the authors have determined ranges, at that distance, within 1 per cent. of accuracy. At shorter ranges measurement is more exact; thus an object at about 2,000 yards may be estimated to within about 12 yards. Prof. Stroud gave some account of the history and of the general methods employed in these instruments. Two images of the distant object, preferably of a line such as a flag-staff, are received respectively upon two mirrors, two lenses, or two prisms, placed one at each end of a fixed support. From each of these the light is then directed towards the middle of the instrument, where the two images, after further reflection, are viewed by one eye-piece. The optical system has finally to be adjusted so that the two images, as now seen in the eye-piece, lie in the same straight line. In the instrument designed by the authors this coincidence is attained by translating a small prism parallel to the axis of the supporting rod. The extent of this translation is a measure of the range. Both eyes are used: the right for bringing the two images into alignment, the left for "finding" the object through a small field glass, and for reading the scale of distances. At night sightings have to be taken from "points" of light, and as these are unsuited to measurement, the authors convert them into "lines" by the use of cylindrical lenses. Various devices are introduced to prevent overlapping of the images. The instrument is about 5ft. long, and tubular in form, and it is made of copper so as to have high thermal conductivity to reduce differential heating. Within the outer tube is the interior supporting rod, designed to equalise so far as possible the effects of interior radiations. Several forms of "separating" prisms were exhibited; the best for the purpose consists of two "reflecting" prisms; these receive the two rays, and direct both of them into a third prism, whose angle lies in the space between the angles of the others. Mr. Barr drew attention to the gimbal arrangement and the three struts that keep the supporting rod central in the tube. To give some idea of the precision and scope of the range-finder he observed that they were there using the equivalent of a 25ft. "circle," and their measurements were comparable to the measurements of 20 seconds of angle on such a circle. The instrument is handled by ordinary seamen, and stands rough usage on board ship for years without injury. Prof. Stroud then exhibited a focometer and a spherometer. He explained that in determining curvatures and focal lengths some telemetric method was necessary, and that, owing to want of parallelism of the beam and duplication of images, a short-focus telescope was always an inefficient telemeter. For the measurement of inaccessible lengths it was, therefore, better to use some simple form of "range-finder." Such an apparatus could be made with a set of small mirrors arranged in such a manner as to direct two images of the distant object into an eye-piece, with a fixed prism in the path of one of the incident beams. By sliding this instrument along the optical bench one position could always be found at which the two images, as seen through the eye-piece, were in coincidence. He also described a method for determining curvature by interposing a plate of plane glass between a curved mirror and a source of light. Mr. Ackermann exhibited two experiments: (1) the blowing-out of a candle-flame by the air from a deflating soap-bubble. The bubble was blown at the mouth of an inverted beaker by breathing into a hole cut out at the top. This hole was then presented to the flame, and the flame was immediately quenched. But if the bubble was blown from ordinary air with bellows, the flame was merely deflected without being extinguished. (2) It was shown that a miniature boat, provided with a false stern, consisting of a linen diaphragm, could be propelled by filling the hollow stern space with ether, or with some liquid similarly miscible with water. The motion is due to the continuous release of surface-tension behind the boat. Prof. Boys said that when he tried some years ago to blow out a candle with a soap-bubble filled with common air, he found the operation very difficult—so difficult that, having once succeeded, he never repeated the attempt. It had not occurred to him, as it had to Mr. Ackermann, that the CO_2 present in the breath played a part in the quenching. With regard to the second experiment, he had seen a small boat propelled by dissolving camphor astern, but he thought the use of a liquid for that purpose was a novelty. The President proposed votes of thanks, and the meeting was adjourned until November 12.

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CAMBUSLANG ELECTRIC LIGHTING.

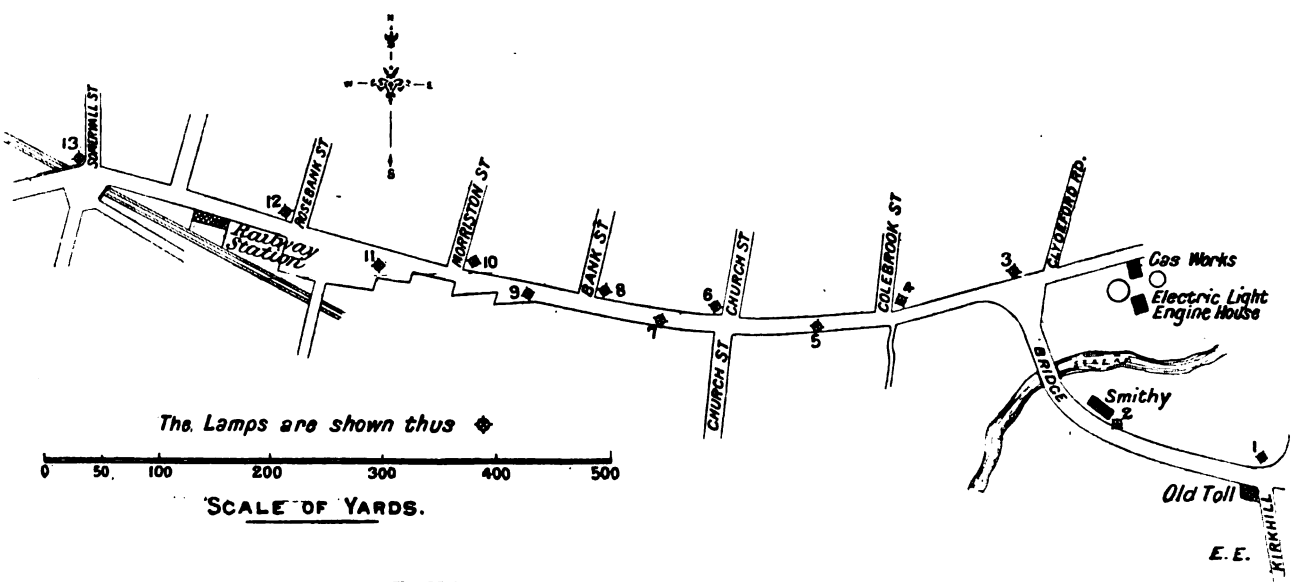
Cambuslang is a small town situated some five miles to the south-east of Glasgow, on the Hamilton-road. It consists principally of one street, about a mile long, of shops, etc., but branching from this there are numerous streets and roads springing up, and being built in with residential villas. The town stands on the south bank of the River Clyde, which here begins to emerge from the smoke and fog-laden atmosphere of Glasgow, and to assume some of the picturesqueness for which its upper reaches are so celebrated.

This, then, is the latest town—or we should more correctly say village—to become up to date in adopting the electric light. The history of the enterprise reflects great credit upon the authorities who were responsible for the undertaking, and the fact of the introduction of the illuminant, although at present on only a very small scale, places the town in an almost unique position, for it is, we venture to think, almost the only small town of its size where you may walk through the main street and see a continuous row of arc lamps illuminating it from end to end, and these not fitted up on wooden poles or connected together by overhead leads, but all erected in a manner worthy of the Metropolis itself, on highly ornamental cast-iron pillars, the cables also being properly laid underground.

The village was originally lighted as a country district, when the Mid-Lanark County Council, under whose charge the lighting came, seeing the rapid growth that was taking place, and its increasing importance as a residential suburb of Glasgow, decided that it would either be necessary to increase the gas-lighting or to lay down electric light plant. Partly, doubtless, on account of the gas-lighting being in the hands of a private company, and partly because the Council realised that the electric light was bound to come sooner or later, they were wise in their generation and decided to lay down electric lighting plant, a decision which all advocates of the modern illuminant will highly commend.

As was only to be expected, as soon as this decision was arrived at, various schemes—good, bad, and indifferent—were pressed upon the Council. The one, however, which met with most favour was for the Council to retain the work in their own hands, and lay down a plant of sufficient size to both light the streets and also to supply current for private consumers, the power for which was to be obtained from the River Clyde. However, the gas company, unwilling doubtless to see the street-lighting slip entirely out of their hands, came forward with a proposal in which they offered to lay down a plant at the gasworks of suitable size to light the main street, and to carry out the necessary works to the satisfaction of the Council. After careful deliberation this offer was finally accepted, the chief reason being the very heavy initial cost of the water-power scheme; this scheme has therefore been deferred in the meantime, and the installation placed in the hands of the gas company, as before mentioned. In connection with these negotiations we should mention the names of W. Barns-Graham, Esq., of Graigallian, chairman of the Mid-Lanark County Council, and Mr. J. T. T. Brown, clerk to the local section of the Council, who have made themselves conspicuous by the energy with which they have pushed forward this matter.

The first step taken was to appoint Mr. C. Crighton Fulton, of Glasgow, consulting engineer on behalf of the County Council, and under his guidance the gas company issued their specification for a small installation early in the summer. It was estimated that 20 arc lamps would be required to thoroughly light the main street of the village; of these, 13 would be along the principal portion of it. Although it was decided to put down a plant for the full number of lamps needed, it was arranged only to fit this part at first. There were numerous estimates received for this work from the well-known firms of electricians, and after careful consideration the one sent in by Messrs. Hunter and Jack, electrical engineers, St. Vincent-street, Glasgow, was deemed the most suitable, and was therefore accepted. The plant is arranged in a Gothic-looking brick building in the gasworks yard. The following are the details of the various component parts of the installation.



The Main Street at Cambuslang, showing Position of Arc Lamps.

Gas-Engine.—The gas-engine is one of the well-known "Otto" make, built by Messrs. Crossley Bros. It is one of the S.E. type of engines, and it is a special design built for this job, and it is hoped that its success will warrant its being permanently introduced as their standard type of electric light engines. It will give an output of 36 i.h.p. at full load at a speed of 250 revolutions per minute, and it is claimed that it will give out more power for its size than any other engine in the market, and that with a reduced gas consumption. At full load the gas consumption of this engine was found to be 14 cubic feet per indicated horse-power. It is fitted on one end of the crank with a 3ft. pulley for driving the dynamo, and on the other side with an exceptionally heavy flywheel, weighing about two tons, supported on an outside bearing.

Dynamo.—The dynamo was supplied and built by the Electrical Construction Company, of Wolverhampton, and is of their well-known standard design. It is wound for a current of eight amperes at 1,100 volts when running at 850 revolutions per minute. It is a continuous-current series-wound machine of the vertical two-bearing type; the magnets are wrought iron and are laminated. The armature is wound on the Eikmeyer principle, in which each coil is self-contained, and can be replaced without interfering with the rest of the windings. The dynamo is belted on to the engine by a canvas belt; at present it is running off a small pulley so as to reduce the voltage of the

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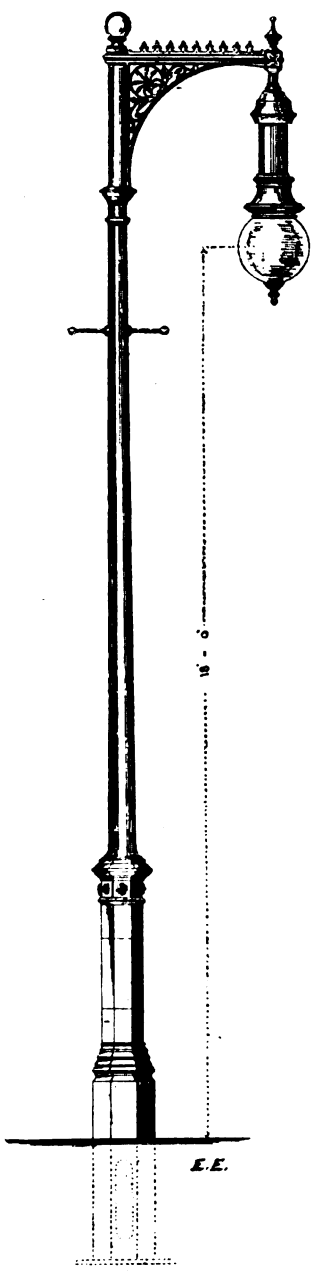
dynamo, seeing that only 13 lamps are at present on the circuit, so that next year, when the other seven lamps are fitted, it will only be necessary to put on a larger pulley.

The Switchboard.—The switchboard is placed in the engine-room alongside the dynamo. It consists of a white marble tablet mounted on a suitable frame, and held well off from the wall. The instruments were made by Jas White, of Glasgow, and are of their well-known Kelvin make, the voltmeter being one of Lord Kelvin's latest pattern of central-station electrostatic instruments, and the ammeter one of his ampere-gauges. There is also fitted on the board a double-pole switch and fuse arranged in a glass-fronted metal case, and suitable for breaking the



The Cast-Iron Lamp-Pillars used at Cambuslang.

high voltage without danger. The fuses are contained in glass tubes to prevent oxidisation. Alongside the switchboard is placed a large resistance frame for regulating, the current being passed through the lamps. It has a multi-contact switch mounted on white marble base, the resistance coils being mounted on porcelain, which is supported on an iron frame.

Cables.—The cables were supplied by Messrs. Walter T. Glover, of Manchester, and consist of $^{7}/_{19}$ vulcanised rubber cables, braided, hemped, and armoured, and then again compounded and braided, the insulation resistance being 5,000 megohms per mile. The lamps being all connected in series, the arrangement of laying followed was to run one main to the farthest lamp and the other along the same side of the street in the same trench, and crossing over to the opposite side of the street and back again for every alternate lamp, of course picking up the lamps on the same side of the street as they passed them. The leads are laid direct in the ground without any further protection whatever.

Arc Lamps.—The arc lamps were made by the Brockie-Pell Arc Lamp, Limited, and are of exactly the same type as the whole of the lamps just supplied to the Glasgow Corporation for the lighting of their streets, and which have replaced the whole of the other makes previously used. These lamps are wound for a current of eight amperes, and will burn from 16 to 18 hours with one pair of carbons; they are fitted with opaline globes, and are hung from weather-protecting hoods, as will be seen on reference to the illustration. In the base of each lamp pillar is placed a short-circuiting switch of special high insulation type, fitted from an oil insulator to make sure of no risk of leaking from the point.

Arc-Lamp Pillars.—The order for the cast-iron pillars for carrying the arc lamps was placed with Messrs. McDowall, Steven, and Co., of the Milton Ironworks, Glasgow, who submitted an excessively neat design, which was unanimously approved of as being just suitable for the surroundings. The base and column are hexagonal in section, the base being finely proportioned, giving the pillar a slender and neat appearance; it is fitted with a door, and the cutting-out switch is fitted inside it. The bracket arm springs from the column at right angles, the column itself being finished off with a ball finial, and the bracket being supported with neat cast scroll work, the top edge being finished off with a "fleur-de-lys" looking design, which takes off the severeness so often noticed with brackets of this kind.

Engine-House.—As before mentioned, this is a small building erected in the gasworks yard. It is built of brick, and is of neat elevation. The main portion, in which is placed the engine and dynamo, is panelled with wood, with a 4ft. painted dado. In a small annexe are placed the necessary water-cooling tanks for the gas-engine.

The inauguration of the electric light took place on Wednesday, October 27, when, at the invitation of the Cambuslang Gas Company, a large gathering of local gentlemen and others interested in the undertaking assembled at the gasworks to be present at the official turning on. We noticed also among the number several prominent electricians from Glasgow, who had doubtless come down to see "how things were done in the country." It had been arranged that Mr. A. G. Barns-Graham, the chairman of the County Council, and the chief promoter of the electric lighting scheme, should consummate his work and personally turn on the light. However, at the last moment he was unfortunately prevented from being present, and Mr. Lindsay Millar, the chairman of the gas company, was asked to undertake this function in his stead.

Mr. MILLAR, in a short speech, said that he had now been resident in the village for 30 years, and during that time he had seen its growth from small beginnings, till now it rivalled in population and importance many large towns. Mr. Millar referred in bantering tones to Mr. Barns-Graham's scheme for deriving the power for the production of the electric light from the water-power of the Clyde, and doubtless he considered it a far preferable arrangement that his company had been allowed to provide the power from their own gasworks. Mr. Millar further stated that he believed they had as perfect an installation (as far as it went) as any town in the country, and also that they were in the premier position of being the only gas company having both gas and electric light plant working in the same premises and under the same management.

Mr. JACK (of Messrs. Hunter and Jack, the contractors for the installation) then came forward, and in a few well-chosen words presented Mr. Millar with a silver knife with which to cut the silk cord that held off the switch, and said that, as regarded the plant, it was all of the very best possible make, and however much his firm had been paid for the work, they could not possibly have made a more perfect installation. He remarked that it was said that Cambuslang was the first village in Scotland, but that now, with the electric light, it would have to be considered the first village in the universe.

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Mr. Millar accepted the knife, and proceeded to the dynamo-house, where a convenient arrangement had been set up for switching on the current. This consisted of a strong spring attached to the switch to hold it in the "on" position, to which a silk cord was attached, and stretched across the room, the cord holding the switch at the "off" position, which when cut allowed the spring to act and close the circuit. Mr. Millar duly proceeded to carry out his portion of the work, and immediately the cord was severed the main street of the village was brilliantly illuminated, the whole of the lamps and plant working without the slightest hitch.

After the usual votes of thanks, and due attention to the refreshments provided by the directors of the gas company, the company found their way into the street, and the general opinion that was heard expressed on all sides was that a better fitted-up installation could not be wished for, and great praise is due to Messrs. Hunter and Jack, the contractors, for the insistance that every portion of their contract and every individual portion of apparatus should be of the very best make on the market regardless of price, and we venture to think that there will be few among our readers who will question their selections.

Now that the lighting of this village is so successfully started, it is to be hoped that others in similar positions will take up the matter and set about installing a plant. It is a common custom for corporations and municipal authorities who have control of gas undertakings to also lay down electric lighting plant. Why, then, should it not be equally to the advantage of private gas companies to adopt the same course, more particularly when they could, where they have sufficient gas, work the plant on a small scale by means of gas-engines? They would in this way be prolonging their own existence by keeping the lighting in their own hands, and as the places grew more populous they could, while still keeping their gasworks fully occupied, extend their electric lighting plant until they were earning good dividends for their shareholders, and at the same time giving the public the benefit of a better light in every respect.

PERMANENCY OF RESISTANCE COILS.

BY W. E. AYRTON.

In order that an idea may be formed of the change that may have occurred in the resistance of the four coils used by Prof. Viriamu Jones in his 1894 determination of the ohm at Cardiff, and in our determination this year in London, I append the actual values given for these coils by Mr. Glazebrook and by Major Cardew, to both of whom we have to express our thanks for their kindness in making the measurements:

Coil. No.	A. Mr. Glazebrook. Jany.-March, 1894.	B. Board of Trade. November, 1896.	C. Board of Trade. August, 1897.
3,873	9·9919 at 14 8° C.	9·992994 at 14·86° C.	10·00712 at 19·3° C
3,874	9·9926 at 14·9° C.	9·993213 at 14·91° C.	10·00775 at 19·3° C
4,274	·100050 at 15 2° C.	·1000595 at 14·77° C.	·100078 at 19·4° C
4,275	·100053 at 15·2° C.	·1000722 at 15·14° C.	·100081 at 19·4° C

The coils Nos. 3,873 and 3,874 were stated by the makers—Messrs. Nalder—to be wound with platinum-silver wire, and the two others, Nos. 4,274 and 4,275, with manganin.

On comparing the results obtained at Cambridge in 1894 (A) with those given by the Board of Trade in 1897 (C), we see that there is a good agreement. For example, in both cases the temperatures of the third and fourth coils—Nos. 4,274 and 4,275—were the same, and in each of these two cases the resistance of the fourth coil exceeded that of the third coil by 0·000003 ohm. Again, in 1894 the second coil, No. 3,874, was slightly warmer than the first, No. 3,873, and its resistance was 0·0007 ohm higher; whereas in the test of 1897 these two coils had the same temperature, and the resistance of the second exceeded that of the first by 0·00063 ohm.

On calculating the temperature coefficients from the results A and C and comparing them with those given originally by Messrs. Nalder, we find:

Coil.	Temperature coefficient of resistance per 1deg. C.	
	From tests A and C.	As given by Messrs. Nalder.
No. 3,873	0·000360	0·000276
,, 3,874	0·000344	0·000300
,, 4,274	0·0000667	0·0000127
,, 4,275	0·0000667	0·0000127

The values calculated from tests A and C are therefore somewhat higher for the platinum-silver coils than those given by Messrs. Nalder, and much higher for the manganin. But there is this similarity about them, that just as Messrs. Nalder obtained exactly the same values of the coefficients for the two manganin coils—viz., 0·0000117—so the tests A and C give exactly the same values—viz., 0·0000667.

But when we compare the results of the 1894 tests (A) with the 1896 tests (B) we see that there is a want of agreement. For example, the temperature of coil No. 3,873 was practically the same on both occasions, and yet the 1896 result exceeded the 1894 result for the same coil by 0·001 ohm. Similarly, although the temperature of the second coil, No. 3,874, was also practically the same on both occasions, the 1896 result exceeded the 1894 one by 0·0006 ohm. Further, although the temperatures of the two manganin coils Nos. 4,274 and 4,275 were slightly lower in 1896 than in 1894, the resistances were respectively 0·000009 and 0·000019 ohm higher.

Lastly, if we calculate the temperature coefficients from the 1896 tests (B) and the 1897 tests (C), we obtain:

Coil.	Temperature coefficients per 1deg. C. From tests B and C.
No. 3,873	0·000318
No. 3 874	0 000331
No. 4,274	0·0000399
No. 4,275	0·0000207

Which makes the coefficient for the manganin coil No. 4,274 almost double that for the manganin coil No. 4,275.

There seems, therefore, reason for concluding that the coils were in some abnormal condition when tested in 1896.

Surprise may be felt that such small discrepancies as those referred to are worthy of comment, but it must be remembered that Prof. Jones and I were aiming at obtaining the true value of the international ohm with an accuracy of 0·01 per cent., and, judging from the results given above, it would appear that these four coils, manufactured by Messrs. Nalder, could only be relied on to transmit the value of the international ohm with an accuracy of about this amount.

One of my students is at present engaged in ascertaining what is the present value of the temperature coefficient of these four coils.

NOTES ON ACCUMULATOR CONSTRUCTION.

BY DESMOND G. FITZ-GERALD.

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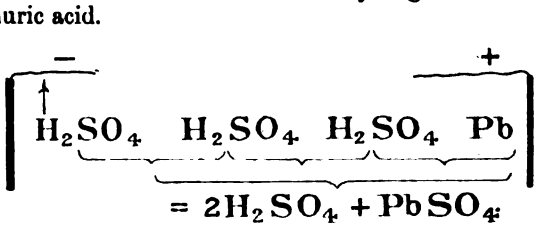
XIX.

The conditions which, it may be assumed, obtain in the initial stage of Planté's process of formation—(X. *c.*)—are illustrated in the following scheme, where, by the effect of the electric current, sulphate of lead is formed by the substitution of this metal for the hydrogen molecule in sulphuric acid.



The production of persulphuric acid by the elimination

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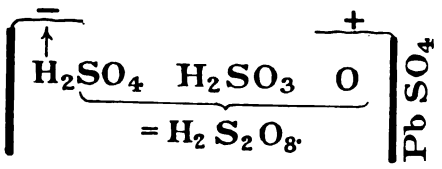
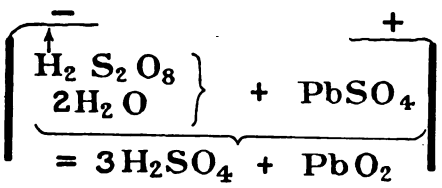
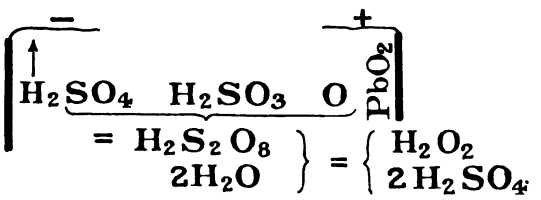
of a further molecule of hydrogen may be represented as follows:



The next scheme may explain the formation of peroxide of lead by the reaction between persulphuric acid and sulphate of lead in presence of water.



Lastly, the production of a second molecule of persulphuric acid by the current proceeding from the peroxide-coated anode, and also the decomposition of the persulphuric acid, in presence of water, which results in the formation of hydrogen peroxide and the regeneration of sulphuric acid (XVII.), may be exhibited as follows:



XX.

Further experiment is no doubt required before the view here presented can be definitely adopted. One objection (XIV. note and XVII.) can at once be removed. I find that persulphuric acid in comparatively large quantity can readily be produced by electrolysing sulphuric acid of density 1·3 Moreover, it was stated by Mr. Robertson, not that this acid yielded practically no persulphuric acid, but that it yields practically no hydrogen peroxide. From this it has been erroneously inferred that the persulphuric acid from which this usually originates was absent, the fact being that it is very stable in acid of the given density, and does not therefore give rise to hydrogen peroxide.

Another objection is that the view in question is not in accord with the double-sulphatation theory, and that the latter has been fully established by reference to thermo-dynamic data. But in the first place, the present view is not in itself necessarily in antagonism to the theory in question; and in the second place, it can, I think, be shown that the thermo-dynamic proof of the latter proves a great deal too much. This proof, based upon the double-sulphatation theory, consists in showing that the algebraic sum of the affinities acting in a charged reversible lead cell, throughout the whole period of its discharge to zero potential, constitute a force equivalent to nearly the maximum E.M.F. of the couple—*i.e.*, to nearly two volts. But the electro-chemical equation applicable to the whole period of discharge should correspond to the *mean*, not to the *maximum* E.M.F. Now, as was pointed out by Prof. Sir E. Frankland at the Montreal meeting of the British Association, "the energy of a charged storage cell is delivered in (at least) two separate portions, one having an E.M.F. of two volts and upwards, the other an E.M.F. of ·5 volt and under. . . . The suddenness of the fall of potential indicates two entirely distinct chemical changes. The chemical change producing low E.M.F. is the first to occur in charging and the last in discharging."

The inertness, in regard to metallic lead, sulphate of lead, etc., of persulphuric acid, when its action is not supplemented by that of the voltaic current, is also a difficulty requiring some explanation.

XXI.

Whatever may be the theoretical bearings of the phenomena resulting in the production of persulphuric acid and hydrogen peroxide, their practical bearings—stolidly neglected as they have been—are clear enough. "What is required," as Mr. Robertson pointed out in his paper above referred to, "is some substance which can be added to the acid to check the formation of the oxidised bodies in it which cause sulphating, without at the same time injuring the plates in other ways." The detrimental effects of these bodies are not confined to those which occur when the battery is at rest or discharging—viz., the reduction of lead peroxide by the hydrogen peroxide formed from persulphuric acid, the consequent sulphatation of the peroxide plate and the wasteful sulphatation of the spongy-lead plate. They include also a considerable loss of efficiency during the operation of charging, due to the abnormally high "back E.M.F." consequent upon the presence of persulphuric acid in contact with the peroxide plate.

It is interesting to observe that a substance such as that which Mr. G. H. Robertson emphatically indicated as a desideratum in December, 1891, was accidentally introduced into some of my lithanode accumulators at some period prior to March 17, 1887. At a meeting of the Society of Telegraph Engineers and Electricians held on the latter date, Prof. George Forbes, referring to the accumulators in question, made the following statement: "There is one point that has puzzled me very much indeed—that is, as to its cause—but which seems to me to add a new feature to the form of battery at present before us. You all know that when we are charging an ordinary secondary battery, an E.P.S. cell, or any other, we have what can be called a spurious E.M.F.—*i.e.*, we have the natural E.M.F. of the battery, which is almost exactly two volts, but at the first moment after charging it we find that the E.M.F. of the cell is at least 2¼ volts, sometimes a bit more than that; and it follows that during the whole of the latter time that we are charging up the cell we are charging against an E.M.F. of 2¼ volts, and when we discharge it we discharge at two volts, because this spurious E.M.F. disappears almost immediately. Therefore, neglecting all other causes of loss of efficiency in a secondary battery, we have simply, owing to this cause in itself, a loss of efficiency in the ratio of 2¼ to 2. Now, in the cell which is before us, in the whole of the tests which I have made I have never seen any spurious E.M.F. such as I have mentioned. The highest E.M.F. which I have ever got from a cell immediately after charging has been considerably under 2·1, and the terminal E.M.F. when I was charging it—that, of course, depending upon the resistance of the battery—was never in excess of 2·15. This, then, seems to me to be an enormous advantage that has been gained in this cell—viz., that instead of having a necessary loss from this cause, however much we may improve the battery, in the ratio of 2 : 2¼, you certainly have not more than 2·0 to about 2·1. This is a very remarkable thing. I have had a great many secondary batteries to test at different times, and I have never seen one doing the same as this. What is the reason of it I cannot say. The general assumption as to the cause of that spurious E.M.F. is that it is due to bubbles of hydrogen sticking to the plate.* But if it is due to bubbles of hydrogen, then the depolarising action, as you may really call it, seems to be something like the action of the platinised plate of the Smee cell. The surface of the plate seems to have some action in allowing or not allowing of the attaching of hydrogen bubbles to the plate; probably smoothness of surface has something to do with it."†

In the batteries referred to by Prof. Forbes celluloid was used—I believe for the first time—as a support for the plates. The depolarising or reducing effect which was so observable was traced—at least, in some degree—to a component of the solvent which had been used with the celluloid. I much regret that from want of time and from pressure of other work in connection with problems of at least equal importance, such as the invention of an indestructible lead support for the peroxide active

* It is now understood to be mainly, if not wholly, due to the presence of persulphuric acid in the substance of or in contact with the peroxide plate.

† *Journal* of the Society of Telegraph Engineers and Electricians, vol. xvi., 1887, p. 194.

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material—I have been unable to investigate thoroughly the means, thus accidentally suggested, of increasing the efficiency of secondary batteries by reducing or altogether obviating the spurious back E.M.F. which, down to the present time, has been passively allowed to waste energy in the operation of charging. But, in view of the shortcomings of my own modest laboratory, I am inclined to ask whether investigations of such practical importance—I may say of national interest—should not be carried out in some of the splendidly-endowed laboratories of which we occasionally hear—institutions which are inaccessible and virtually non-existent to workers like myself, who have neither the time nor the wish to cultivate a clique through which an "open Sesame" may be obtained.

XXII.

In peroxidising a Planté (or any other) lead element by means of a single cathode, the peroxidised surface will, of course, by reason of expansion, become convex towards the cathode. With two cathodes, at precisely the same distance from their opposed anode surfaces, the peroxide plate will remain flat and will be only slightly increased in area. The layers of peroxide, as well as the lead plate, will consequently be in a condition of strain or compression; and there will be a tendency in the peroxide to "shed," or to become detached in flakes If the peroxide could expand freely as it formed, the area of the plate would be increased approximately in the ratio 1 : 1·253 (VIII.); and in this case the adherence of the peroxide to the lead surface would be very great; there would be little or no tendency to shed or flake.

Some 16 years ago a process was devised for minutely perforating or puncturing lead plates by drawing them between two flat surfaces, one of which has a reciprocating motion of small range, and is provided with a number of fixed points, such as pin or needle points.* A machine for carrying this process into effect was devised and constructed by Mr. W. W. Beaumont. Now, it will be readily understood that when every portion of the surface on both sides is perforated with conical punctures in close proximity, the area of the plate will be increased; and the area might thus be increased from unity to 1·253. Under these conditions we are able to form peroxide in the plate, until the perforations are filled, without subjecting either plate or peroxide to any considerable strain. This process, although likely to be of practical value, has, like many other promising inventions in connection with secondary batteries, never been utilised outside of the laboratory.

XXIII.

Giving now our attention to the second stage—the first reversal—in the Planté process; peroxide of lead is now formed, on the plate which was previously the cathode, in precisely the same manner as on the plate which was previously the anode; whilst hydrogen is in some way absorbed by the peroxide on the latter plate. The action which here takes place is usually expressed, and is in some measure explained by the equation:

$$PbO_2 + 2H_2 = Pb + 2H_2O.$$

Here we have another example of an empirical formula, which is not only plausible, but correct in its indication of the ultimate result of the reaction; but which nevertheless is misleading from the point of view of theory, since it gives no indication of the intermediate reactions and stages by which the ultimate result is reached. In fact, it may be, and has been, taken to indicate that metallic lead is produced, by the reaction between two molecules of hydrogen and one molecule of lead peroxide, in actual contact with residual lead peroxide. But, in spite of the extraordinary phenomenon referred to in Section XVI., it is very doubtful whether the electrolytic reduction of a body so strongly electro-positive as lead, in contact with a substance so strongly electro-negative as lead peroxide, could under any conditions be exhibited. However this may be, careful observation of the peroxide surface in the first stages of its reduction disproves the assumption that any particle of metallic lead is liberated in contact with it. The analysis of partly-reduced peroxide plates leads to the conclusion that the compound which is formed in the first stage of the reduction is $PbO_2 2PbO$, which, in presence of sulphuric acid, is at least partly converted into $PbO_2 2PbSO_4 = S_2Pb_3O_{10}$, or Frankland's "red-lead salt." Subsequently, a basic sulphate of lead appears to be formed; the peroxide disappears from the compounds initially formed by it, and then only does metallic lead appear.

It appears now quite certain, from the researches of Schutzenberger on the molecular constitution of metals, taken in conjunction with the work of our own countryman, Dr. Gore, in relation to the allotropic forms of antimony, and with the experiments of M. Darrieus, that the lead reduced in the spongy form at the cathode differs essentially in its electrical properties from ordinary lead, and that its conversion into the latter is accompanied with the production of heat. According to the last-mentioned experimenter, if we take an ordinary peroxide element, free from persulphuric acid, the E.M.F. produced by it when opposed to ordinary soft lead in dilute sulphuric acid is only 1·46 volt; whereas, when it is opposed to electrolytically produced spongy lead the E.M.F. is 1·94 volt. It should be observed, however, that, as has been shown by Dr. Gladstone and Mr. Hibbert, the degree of strength of the dilute sulphuric acid would affect the result.

* Patent No. 5,338, December 6, 1881.

THE MECHANICAL CONSTRUCTION OF ELECTRICAL MACHINERY.

BY F. M. WEYMOUTH.

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THE DYNAMO.

(Continued from page 555.)

Brush Gear.—Inasmuch as designs of brush gear are so numerous, and as almost, if not quite, every maker has his own special form for this item in a dynamo, any attempt at illustrating particular examples out of those based on the most generally accepted principles would not afford the satisfaction to be obtained by a wider treatment of the subject. It appears to the writer, in fact, that it would be greatly preferable to discuss the general principles on which these designs are based, rather than any particular case. Designs innumerable may all possess the same fundamental idea, or set of ideas, and will thus in this respect be similar. Difference in principle, on the other hand, will necessitate further illustration.

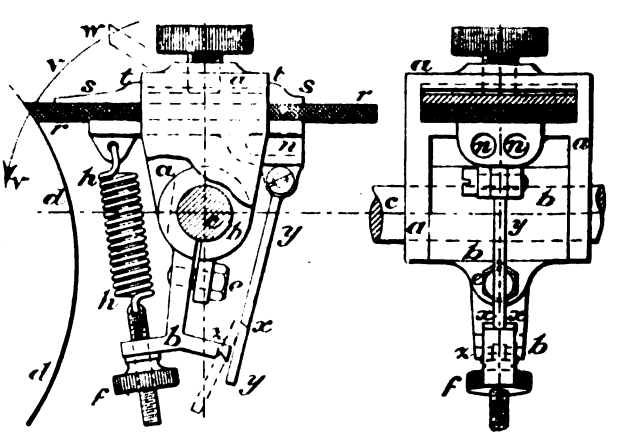

FIG. 311.

In Fig. 311 herewith is presented a sketch design of a brush-holder, in which are illustrated the special points to be found in most examples of such gear. It also shows one great fault, common to this general method of design, which is now so stereotyped in practice. To consider this more closely, therefore, we may observe that it consists chiefly of two parts: of these the one is a gun-metal casting, or bracket, *a a*, which contains the brush, *r r*, and so forms the actual holder, and this is free to rotate round the "brush spindle," *c*. The other part, *b b*, also fits the spindle, but is made to grip it tightly—the method for so doing in this case being that of splitting the sleeve portion

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on one side, and using a clamping screw, *e*, as shown. Some makers do not adopt the split method, but merely put a set screw through the sleeve with its point bearing on, or penetrating, the spindle. The method illustrated, however, gives probably the firmest grip. A curve, *d d*, indicates the outline of the commutator.

It will now be seen that a spring, *h h*, in tension, having one end attached to a downward projecting part of the casting, *b*, and the other end to the rotatory part, *a a*, holding the brush, will have the effect of keeping the brush tight on the commutator as depicted; and this tightness is adjustable by means of the milled nut, *f*. The upper part of the holder, *a a*, forms a rectangular tube, through which passes the brush, and a boss above is penetrated by a set screw with a milled head for gripping the brush within. A brass plate, *s s*, is interposed between the screw and the brush so as to spread the pressure on the brush, inasmuch as the latter by itself would be too soft and would become indented by the screw end, which would interfere with the accuracy of its adjustment, besides that it would also not be firmly held. Raised ridges or lips, *t t*, on the plate prevent its displacement when the brush is in position: or other means may be adopted to the same end. The plate may also be extended toward the commutator as shown, so that, in the case of a flexible gauze brush being used, it may be kept at its work, and be debarred from becoming turned up at the contact end. Some makers, however, carry the brush between brass plates, or retain it within a rectangular tube nearer up to the commutator than here depicted. As sometimes the brush requires holding off the commutator, for this purpose the holder, *a a*, is tipped back till the brush point is raised as shown dotted at *w*, which is counter to the pull of the spring, *h h*, and the holder needs to be fastened back. This latter has thus to be accomplished by an additional feature symbolised in the diagram by the spade-ended bolt or rod, *y y*, and catch, *z*: for it will be noted that when the brush point reaches *w*, the rod, *y y*, will sink so that the shoulders, *x x*, of the spade end may become engaged with the catch, *z*, as shown dotted. Thus the brush may be held off.

The method of taking the current from the brush, or brushes, requires consideration. It has been, and apparently is, still considered sufficient in practice to trust to the contact between the rotatory holder, *a a*, and the spindle, *c*; and so to let the current pass from the holder into the spindle, from which latter it is finally led off by a cable and socket at its end where bolted into the rocker or bracket carried by the bearing. But this method is not entirely satisfactory. For inasmuch as it is imperative to let the rotatory holder, *a a*, freely answer to the pull of the spring, *h h*, its fit on the spindle is necessarily an easy one, and consequently not good as an electrical contact. Though flat copper clips have been used to assist this contact, an alternative is to lead off the current direct from the holders, *a a*, themselves, by means of small flexible cables attached to each. It is for this latter purpose, therefore, that in the diagram, sockets *n n* are shown cast on the holder for the cable ends to be sweated into. One socket and cable may be used instead of two: but two small cables will obviously be more flexible. A slight disadvantage of this method is that in some positions of the brush the weight of these cables will tend to interfere with the due action of the spring, *h h*. This, however, is perhaps not more than a question of making the spring of sufficient strength to meet all requirements. The group of small cables from the brushes on one spindle will then be led to a compound terminal socket at the end of the spindle, where it is attached to the rocker, into which terminal there will also be sweated an end of the main cable, thus making the electrical connection with the latter: or else the group may be led to a compound terminal on the magnets. They will, of course, in all cases hang in a festoon of sufficient length not to interfere with the adjustment of the brushes. These small cables are an extra expense, but their use thus obviates a possible source of heating at the brushes due otherwise to imperfect contact between the brush-holders and the spindle.

As intimated, the action of the spring, *h h*, is to rotate the holder, *a a*, round the spindle: this is indicated by the curved arrow, *v v*. Different designs may show this spring in different positions, but with the same result. The holding-off arrangements, *x y z*, also specifically admit of nearly infinite variation in design and idea. But with all these, a fundmental matter of consideration yet remains, that as the contact end wears away under friction against the commutator, this end is also gradually dropping away from its proper position: the brush becomes more nearly radial to the commutator, and the contact end tends to become square across, instead of being chisel-edged. A necessity hence arises for a distinct operation, that of resetting the brushes at intervals, in which the brushes, especially when of stencil plate, require to be taken out of the holders, and each one to be filed up to its proper angle at the contact end, and to be reinserted once more in the holder in the required position against the commutator, all of which takes labour and time. This latter position is, of course, that in which there is the least amount of sparking: and it will thus be seen that, in the case of machines wherewith a very small movement of the brushes will make a considerable difference in the sparking, this gradual dropping away of the brush end from its proper position becomes of proportionate consequence. It is hence in this respect that the ordinary type of brush gear may be said to be not a truly mechanical apparatus, inasmuch as it fails to feed up the brush as it wears without at the same time permitting the contact end to move away from its assigned position in relation to the commutator.

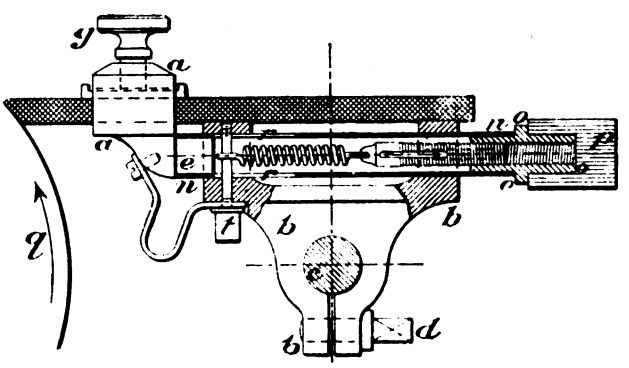

FIG. 312.

The above considerations have led, therefore, to the production of designs of brush gear which better fulfil their object in the respect referred to. Such gear is stated to have "straight feed," or "forward thrust." The brush, wear notwithstanding, always remains in the same plane, at the same angle with the horizontal at which it may have been originally set. The contact area between the brush and the commutator does not vary in position; and consequently also the angle of the chisel edge of the brush does not alter. From this latter point, therefore, the advantage is reaped that the operation of resetting the brushes is simplified, being reduced to the mere setting of the brush further forward in the holder.

In Figs. 312 and 313 are depicted two examples of such "straight feed" brush-holders. Of these, the first (Fig. 312) is a design patented by Messrs. P. R. Jackson and Co., Limited, Manchester (Patent No. 6,791, 1895). This is described in the patent specification as being more particularly intended for use with carbon brushes. It is noticeable, in fact, that "straight feed" has from the beginning been mostly used in connection with carbon brushes. Though shown here at an angle, brushes of this material are used more generally perhaps in a position radial to the commutator. When used at an angle as shown, the chisel edge, owing to the brittleness of the carbon, is apt to break away in small grains, thereby causing a certain amount of sparking. With the brush radial, the edges at the contact end are practically right angles, and therefore stronger and less liable to disintegrate. An advantage, however, attending the use of the radial position, which has probably been the chief cause of its adoption, is that in the case of motors the commutator may rotate in either direction with equal impunity as regards the brushes. But it would not do obviously in the case illustrated (Fig. 312) to let the commutator rotate in the direction opposite to that indicated by the arrow, *q*.

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The brush gear now before us will be seen to consist principally of a main casting or bracket, *b b*, Fig. 312, made stationary on the spindle, *c*, by the gripping screw, *d*. This bracket has two horns or bosses, rising above at either end with holes drilled through them, so that they jointly carry a tube, *n n*, as shown. The brush-holder, *a a*, has a projection, *e*, cast on it, which fits within the end of the tube, *n n*. Slots, *r r*, in the tube permit the passage through it of the screw, *t*, and, being slightly wider than the diameter of the screw, a small angle of rotation round its own axis is allowed the tube, so as to permit of the brush being set fair at its work. A spiral tension spring inside the tube has one end fastened to the screw, *t*, and the other end to a screwed and slotted rod as shown, which latter engages with a long nut, *o o*, carrying a handle of insulating material, *p*, by means of which it may be rotated. The rotation of the screwed rod with the nut, *o o*, is prevented by a pin, which passes both through it and the tube and the boss; and the tube has side slots, shown dotted, by means of which the pin passing through them does not interfere with longitudinal movement of the tube. It will thus be seen that the spring pulls the tube forward towards the commutator, and with it consequently the brush carried on its end; and thus, as the brush wears, it is continually fed forward and maintained in constant contact with the commutator, but without the point dropping away from its assigned position as in the case of a brush-holder which rotates round the spindle. By means of the nut, *o o*, and handle, *p*, the pressure of the brush on the commutator may be regulated while the machine is running: while at longer intervals the brush may be set forward in the holder by operating the screw, *g*; and there is no further trouble as regards re-setting.

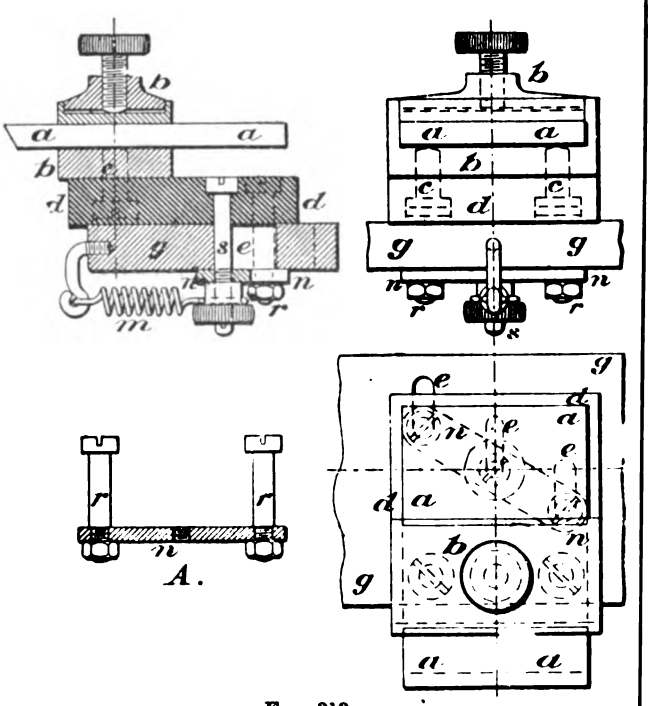

Fig. 313.

Fig. 313 illustrates another example of straight-feed brush gear, patented by the late Mr. F. V. Andersen (Pat. No. 13,549, '92). This was originally designed for use in small enclosed motors. The brush, *a a*, is held in a box or holder, *b b*, fastened by two screws, *c c*, shown dotted, to a block of insulating material, *d d*. This latter rests on a shelf or web, *g g*, forming part of the main frame of the motor. Three slots, *e e e*, through the web, *g*, admit the passage of three bolts, *r r* and *s*, which unite the block, *d d*, to a plate, *n n*, below. This latter, with the two bolts, *r r*, are shown separately at A, and it will here be seen, therefore, that these two bolts are shouldered at their lower ends, and are screwed into the plate up to the shoulders, and lock-nuts are then added below. The distance between the heads of these screws and their shoulders is then so regulated in respect of the block, *d d*, that when these screws are tight in the plate they do not hold the block, *d d*, tight on the web, *g g*, but merely retain it thereon with an easy sliding fit. A tension spring, *m*, attached to the centre bolt, *s*, which latter is also screwed into the plate, *n n*, has the effect of pulling the block, *d d*, so that the screws come to the ends of the slots nearest the spring, as shown. In use, of course, with the brush against the commutator, the block, *d d*, would be further back, and the screws nearer the further ends of the slots, *e e e*, and the brush would be free to travel forward as it wore. The brush, hence, does not leave its original plane, and the angle of its chisel point remains unaltered. It may be noted that in this instance, owing to the web, *g g*, being a fixture, there is no circumferential adjustment of the brushes round the commutator. The pressure of the brush on the commutator also, inasmuch as there are no special means for so doing, can only be regulated by adjusting the brush within the holder.

(To be continued.)

THE GENERAL ELECTRIC SYSTEM OF ELECTRIC TRACTION WITH SURFACE CONTACTS.

The demand for a system of electric traction without overhead wires has caused a number of engineers to give careful thought to the matter, and we have had in our columns descriptions of many new methods of connecting the car with the mains. The General Electric Company of America has now made public the methods of solving this problem which it has decided to adopt, and which is of the surface-contact type. Both positive and negative contacts are provided, as shown in illustration, Fig. 1. These contacts consist of iron discs, with convex surfaces raised about 1in. above the surface of the street. These discs are placed in iron boxes surrounded by insulation. The contact plates consist of two parts, so that the wearing part can be renewed. The collecting shoes for ordinary cars are about 13ft. long. The general arrangement of these shoes, and the method of suspending them, is shown in Fig. 2. The connections of the system are shown in Fig. 3, where A, A′, A″ are the negative plates, B, B′, and B″ the positive contact plates, placed equal distances apart, a little less than one-half the over-all length of the shoe. C, C′, C″ represent the automatic magnetic switches, and D, D′, and D″ their armatures or contact makers. F is the positive or collecting shoe, E the negative or return shoe, and G the track return. H and K are switches which form part of the controller, the latter connecting-in or cutting-out the cells of a small storage battery, which is used only to energise the coil of the first switch through the plates over which the car passes in starting. After the armature of the first switch has been raised into contact and the line current has completed its circuit, the battery is cut out by the forward movement of the controller handle. In the diagram the car is to move to the right and all the magnetic switches are open. The handle of the controller is turned to the first notch and switches H and K closed. Current from the battery flows through a small portion of the motor resistance to the shoe E, thence to contact plate A′ and the coil C′, completing the circuit to the ground. The coil C′, thus energised, raises the armature D′, closes the circuit through the automatic switch, and the line circuit completes its path through the motors and through the greater part of the motor-starting resistance shown by the arrows, through the positive B′, and shoe F. Part of the return circuit goes to the storage cells, which are kept continually charged, and part through shoe E, negative contact plates A′, and coil C′, to ground, keeping the latter energised and the automatic switch closed so long as the shoe E remains on the contact plate A′. Moving the controller handle forward from the first notch to the second notch opens the switch, K, cuts out the battery, and sends all the return current through the coil C′. The shoes, E and F in the diagram, are a little longer than the distance between contact plates. Thus, when the car moves forward slightly the shoe E will be in contact with the two contact plates, A′ and A″, and the return circuit will divide, half going through coil C′, and half through coil C, energising both, and closing the armatures in the switches D′ and D. The car moves

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forward, and the shoe E passes beyond the contact plate A'. The circuit in the coil C' is broken, the armature D' drops, cutting out entirely positive plate B'', leaving it dead, but allowing B' still to receive current through the closed switch at D. Shoe F, moving forward, then makes contact with plate B before it leaves plate B', and the current is uninterrupted.

The automatic switches are not placed immediately under the contacts, but are grouped together in vaults placed at intervals along the track, where the switches can be readily inspected. The switches themselves have been most carefully designed with magnetic blow-outs in case an arc

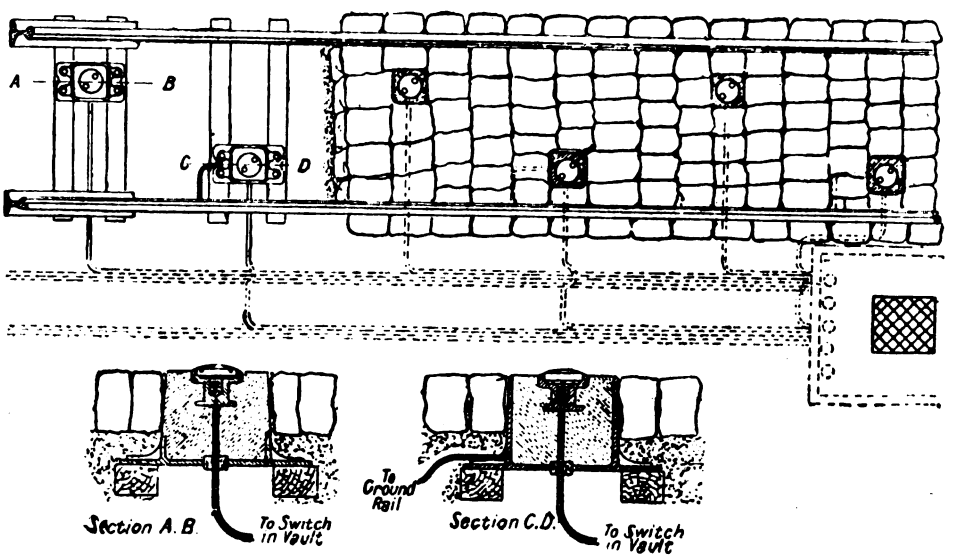

FIG. 1.

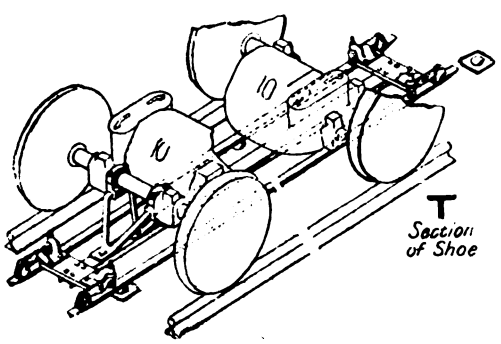

FIG. 2.

should be set up on breaking circuit. The battery on the car consists of 10 accumulators, with a normal capacity of 50 ampere-hours at a five-ampere discharge rate. The first line to be laid down on this system is at Monte Carlo, where some three miles are now being equipped. We are

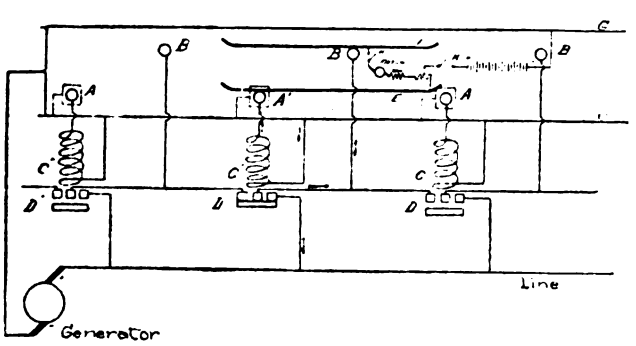

FIG. 3.

indebted to the *Street Railway Journal* for the above blocks and for some of the information. As a contact railway the arrangement appears likely to give satisfaction, but the two rows of contacts projecting above the roadway will not please the other users of the roadway.

A NEW PRINCIPLE IN DYNAMO DESIGN.

Prof. S. H. Short, who enjoys the distinction of building one of the first, if not the first, commercial electric roads in America, at the early date of 1885, and whose name is identified with gearless electric motors, such as are used in the Baltimore and Ohio Tunnel and the City and South London Railway, has just developed a new principle in the design of direct-current dynamos which is very valuable and reduces the cost of construction. The substance of his investigations is herewith presented in condensed form, and will interest everyone using machines of this character.

The term "bucking" as applied to direct-current dynamos was formerly employed to designate any sudden and violent pyrotechnic display at the brushes that could not be conveniently accounted for. The term has, however, a definite

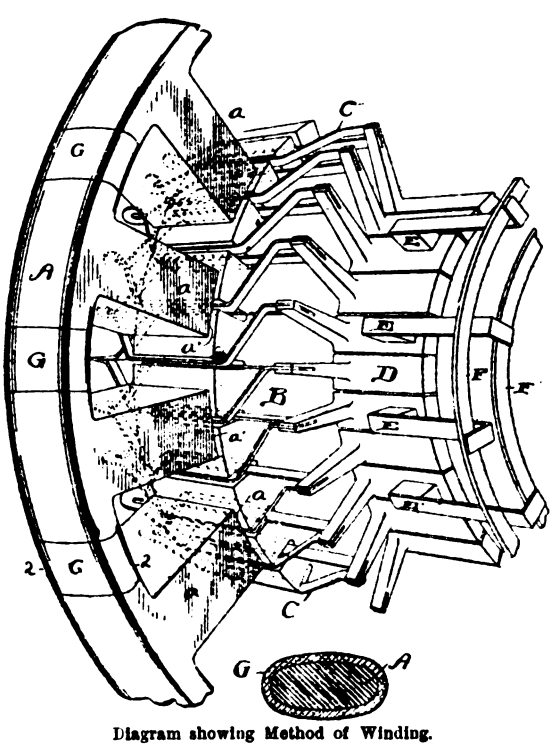

Diagram showing Method of Winding.

meaning, and may be briefly described as the local interchange of current between parallel-connected dynamos or motors, such interchange being entirely independent of the line that feeds, or is fed, in the system. Thus, two railway motors connected in parallel may buck each other, one acting as a dynamo and driving the other as a motor. The motoring of power or lighting generators that work in parallel is a form of bucking.

A multipolar generator the armature winding of which consists of a number of sections which are connected in

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parallel by the brushes will sometimes buck of itself, for it really consists of a number of relatively small bipolar dynamos connected in parallel. Such a winding is called a parallel or lap winding, and by consulting the diagram it is seen to be a very popular and familiar one. We may consider the two upper poles and the windings between the two upper brushes to constitute one dynamo, and the two lower poles and the corresponding portion of the winding to constitute another machine, which, it will be seen, is connected by the brushes in parallel with the first. Now, if the poles over one winding are for any reason weaker than the adjacent set, the E.M.F. that they generate in the armature winding will be less than that produced in another portion, and the former will feed current to the latter and drive it as a motor. It will be remembered that the armature reaction of a motor strengthens its field, and the field of a dynamo is weakened by the armature reaction, for an analogous but inverse cause. So it is in this case, and the effect is to presently cause the dynamo and motor part of the armature to exchange functions and then to re-exchange them. This process begins slowly, but increases in rapidity till some part of the machine gives way or is brought to a standstill.

The practical results of this action are very destructive. The enormous currents often heat the brushes white hot, and the powerful magnetic forces often displace the frame or even spring it till the pole-pieces are struck by the revolving armature, and the latter is injured. Bucking is particularly liable to occur while the machine is building up, but often continues after full voltage is reached. It is obviously a phenomenon the elimination of which is imperative. Hitherto the cause of this trouble was not generally known, though the results were very familiar. It was experimentally found that increasing the air-gap and highly saturating the fields or the teeth of the armature would reduce bucking for the now obvious reasons that the armature ampere-turns found it harder to disturb the magnetic induction in a highly-saturated section of the magnetic circuit. Every dynamo designer knows that highly-saturated fields and large air-gaps are very expensive, both in field current and in copper, but until Prof. Short's invention there appears to have been no other feasible method of accomplishing the result. In investigating the phenomenon, Prof. Short early realised that it was essential to the production of bucking that the armature should rapidly vary the strength of induction in the magnetic circuits, and his invention simply consists of a damper to prevent this action.

A heavy, closed circuit of low electrical resistance is made to enclose the magnetic field at some place outside the armature. The instant that a rapid change takes place in the strength of the field magnet it is checked by the counter magnetic effect of this band, in which the disturbing flux induces heavy currents. This band only operates when quick changes in flux density are attempted, and does not interfere with the relatively slow ones caused by regulating devices. This simple means effectually stops bucking, and enables the machine to successfully operate with just enough clearance for mechanical purposes, and with magnetic circuits of very low magnetic reluctance.

Prof. Short's preferred form is a heavy copper band, through which the frame is cast, so that the band occupies a recess and is flush with the frame, but it can be easily seen that the device can be applied in scores of convenient ways.—*Street Railway Journal.*

SUPPLEMENTARY EXPERIMENTS UPON PROPELLER VENTILATING FANS.*

BY MR. WILLIAM GEORGE WALKER, OF LONDON.

Since the reading of the paper on this subject at the spring meeting of the institution [*E.E.*, May 14, 21, 28, 1897] the author has carried out some further experiments on propeller ventilating fans.

Fans with Different Numbers of Blades.—These experiments were made with fans of six, three, and two blades. Each fan was 24in. diameter, and the blades were all flat and set at an angle of 30deg. to the plane of rotation, and were all exactly alike in shape and area for each fan. The fans were driven at 600 revolutions per minute by belt from a shunt-wound motor. The six-bladed fan was tried first, and then its alternate blades were removed without altering the position of the fan or angles of the remaining three blades, which was easily done by unscrewing the blades from the boss; afterwards the two-bladed fan was tried. The six-bladed fan discharged 2,350 cubic feet of air per minute, while the three and two bladed discharged 2,535 and 2,140 respectively; their respective volumetric efficiencies were 62 and 67 and 57 per cent. These experiments show that in the fans of 24in. diameter little or no advantage can be gained by increasing the number of blades; also that the mechanical efficiency of the three-bladed fan is the highest, the motor taking less current and the fan propelling more air than either of the other two. The number of blades which gives maximum efficiency is probably governed by their width or area of surface—that is, the efficiency of the six-bladed fan might have been higher with smaller blade area and therefore with narrower blades. On this point reference may be made to the author's former experiments on screw-propeller surface, which were carried out with screw-propellers 38½in. diameter; a two-bladed screw was first tried, and was then divided into two parts, forming a four-bladed screw, with blades at right angles, and having exactly the same area and pitch as the two-bladed; with the four blades a very slight increase in efficiency was obtained, of only about 1½ per cent. A three-bladed screw of the same diameter was also divided into six blades at equal angles, and only a slight increase was obtained; at the lowest speeds no gain in efficiency resulted from multiplying the number of blades. In larger fans the author has found that the number of blades may be advantageously increased.

Experiments with Helical Blades.—All the fans previously mentioned in this paper have blades with their leading and following edges in the same plane. Consequently the pitch throughout this plane is not uniform, but varies from a maximum at the tips of the blades to a minimum at their roots. The variation in the axial discharge of the air might therefore have been expected to be due to the varying pitch. Practically, however, the same variation in discharge was obtained with helical blades—that is, with blades of uniform pitch. The 24in. helical fan tried was made with a uniform pitch of 36in., so that the angle of the tips is about 27deg. to the plane of rotation. The helical blades were carefully made from sheet brass 1-16in. thick, and the true helical surface was cut on a wooden block, to which the blades were pressed until their surface coincided with that of the block. The fan was run at 600 revolutions per minute. Anemometer readings were taken at a distance of 18in. in front of the fan. No delivery tube was employed, the fan being entirely open in front as well as behind; the conditions were thus the same as in the former trial described above. The maximum axial velocity was 1,340ft. per minute at a radius of 5in., and the minimum velocity 230ft. at 12in. radius. A comparison showed that the helical form of blade has not rendered the velocity of discharge more uniform than it is with flat blades.

The rotary velocity of the air was also measured at the same distance in front of the fan, by placing the face of the anemometer in the same plane as the axis of the fan. The author showed by a diagram the rotary velocity at different radii, ranging from zero velocity at zero radius to a maximum rotary velocity at 5⅛in. radius, and falling off again at larger radii. It is noticed that the maximum rotary velocity occurs at the same radius as the maximum axial velocity. The efficiency of the helical fan was increased by putting rounded backs on the blades, in the same way as with ordinary flat blades. The experiments accordingly showed that the helical blades did not possess advantages over the ordinary non-helical blades.

Negative Slip.—The apparent negative slip sometimes noticed in a screw-propeller occurs when the speed of the ship is greater than the speed of the screw-propeller—that is, greater than the product of the pitch multiplied by the revolutions, the pitch being calculated from the front or face of the blades. It has been regarded by the author as probably due to the effect of the thickness of the blades and their round backs. On this point he has since carried out some further experiments. A three-bladed helical air-propeller was tried at 600 revolutions per minute. The angle of the tips of the blades being about 10deg. to the plane of rotation, the pitch was 1·1ft. The speed of the screw was, therefore, 660ft. per minute at 600 revolutions per minute; while the mean velocity of the air, as measured in the delivery tube, was 650ft. per minute, showing a small positive slip. The blades were of sheet brass 1-16in. uniform thickness, so that the pitch of their back and front faces was the same. Curved backs were then slipped on, giving each blade a plano-convex section. The mean velocity of the air now obtained at 600 revolutions per minute was 783ft. per minute, the air travelling 123ft. faster than the speed of the screw when the pitch is measured from the front face of the blades. The apparent negative slip was therefore 18½ per cent. With finer pitch the negative slip for thick blades was further augmented. With a coarser pitch of 3ft. the results were reversed, and a fair amount of positive slip was obtained. In screw-propellers it has been noticed that negative slip occurs

* Paper read before the Institution of Mechanical Engineers.

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when the pitch is fine; moreover, for reasons of strength a screw-propeller has its blades made with rounded backs of varying thickness, so that the transverse section of the blades is nearly plano-convex. These experiments show that the phenomena and conditions of apparent negative slip in air propellers and in water propellers correspond closely, and they seem to lead to the conclusion that apparent negative slip is due to not considering the effect of the backs or non-propelling faces of the blades.

Relation of Revolutions and Air Discharge.—The law of discharge, which was verified in the six fans numbered 1 to 6, has since been again verified with two fans of the same diameter—namely, 2ft.—but more powerful as air dischargers—that is, having higher volumetric efficiencies. The measurements of the less powerful of the two new fans gave curves which form practically a straight line. At 400 revolutions, 2,150 cubic feet were discharged per minute; at 600, 3,420; at 800, 4,440; at 1,000, 5,700; and at 1,200 revolutions per minute, 6,790 cubic feet were discharged. The volumetric efficiencies at their respective speeds were 86·0, 90·6, 88·4, 90·8, and 90·2 per cent. These figures give a mean volumetric efficiency of 89·2 per cent. The sections of the blades were plano-convex. The second new fan, being a still more powerful air discharger, delivering about 4,000 cubic feet at 600 revolutions per minute, followed also the same law. Thus, for the fans tested, the law seems to hold good within ordinary limits of speed, inasmuch as it is not the general practice to run a 2ft. fan above 1,200 revolutions per minute.

Calculation of Horse-Power and Size of Fan.—The horse-power necessary for driving the fan to produce a given discharge of air is as follows: taking the barometer at 30in. of mercury and the air temperature at 60deg. F.—which are atmospheric conditions near enough for ordinary calculations—and the mechanical efficiency at 30 per cent. If d be the diameter of the fan in feet, a the area of the fan disc in square feet, V the velocity of the air in feet per second, and Q the quantity of air discharged in cubic feet per second—

$$\text{Mechanical efficiency} = 0{\cdot}3 = \frac{\text{horse-power in air discharged}}{\text{horse-power to drive fan}}.$$

Whence by substitution from formula (1)

$$\text{Horse-power to drive fan} = V^2 Q \times 0{\cdot}00000215 \div 0{\cdot}3 \quad (3)$$

Substituting the value of $V = \frac{Q}{a} = \frac{4Q}{\pi d^2}$,

$$\text{Horse-power} = \frac{Q^3}{d^4} \times 0{\cdot}0000115 \quad . \quad . \quad . \quad (4)$$

Taking the volumetric efficiency at 90 per cent., this for a 2ft. fan means a discharge of 3,400 cubic feet at 600 revolutions per minute, inasmuch as 3,420 cubic feet were discharged at 600 revolutions per minute by the less powerful of the two new fans tried above. Then $0{\cdot}9 = \frac{Q}{U r^2}$, where $U = 2 \pi r \times R$ = velocity of tips of blades in feet per second, and r = radius of fan in feet, and R = revolutions per second. Hence,

$$R = \frac{Q}{0{\cdot}9 \times 2\pi r^3} = \frac{Q}{5{\cdot}7 r^3} \text{ nearly.}$$

The mechanical and volumetric efficiencies here assumed may approximately be obtained with fans working under ordinary practical conditions and with free inlet and outlet.

These relations mean that for a given discharge of air the horse-power required to drive the fan varies (3) as the square of the velocity of the air; and also that the horse-power varies (4) directly as the cube of the quantity of air discharged, and inversely as the fourth power of the diameter of the fan. With the same fan the horse-power varies (4) as the cube of the air discharge; and the air discharge varies (5) as the speed of revolution. The height of the column of water in a water-gauge varies as the square of the velocity of the air.

The three following recommendations are therefore arrived at. First, the velocity of the air passing through a fan should be as slow as practicable; second, the diameter of the fan should be as large as practicable; third, the pressure of the air passing through the fan should be as small as practicable. The great feature of propeller ventilating fans is that they may he made to comply with these conditions as nearly as possible. This kind of fan is essentially a ventilator, and its principal object is to move a large volume of air at a slow velocity and at atmospheric pressure.

In order to show the great effect of the area of the fan and the velocity of the air passing through it, the horse-power has been calculated as follows for driving five fans, ranging from 2ft. to 4ft. diameter, and each propelling 6,000 cubic feet of air per minute:

Diameter.	Horse-power.	Velocity of air.
2ft.	0·72	1,910ft. per min.
2½ft.	0·29	1,224ft. ,,
3ft.	0·14	848ft. ,,
3½ft.	0·071	623ft. ,,
4ft.	0·045	477ft. ,,

Here it is seen that the largest fan would require only 6¼ per cent. of the horse-power required by the smallest for propelling the same volume of air.

For tunnel ventilation, upon which the author was consulted by the Board of Trade, and gave evidence before the Ventilation of Tunnels Committee in connection with the Metropolitan Railway, it might well be required to deliver 250,000 cubic feet of air per minute. Then employing formulæ (3) and (5) for determining the power and size for a suitable propeller fan, with free inlet and free outlet, the horse-power, diameter, and speed of the fan, and the dynamic pressure and velocity of the issuing air would be severally as follows:

Diameter.	Horse-power.	Revs. per min.	Water gauge.	Air velocity.
10ft.	83	348	0·65in.	3,180ft. p. min.
12ft.	40	201	0·31in.	2,214ft. ,,
14ft.	22	127	0·17in.	1,626ft. ,,
16ft.	12	106	0·10in.	1,242ft. ,,

The calculations for the larger fans are made on the assumption that these follow the same laws as the smaller.

It will thus be seen that, while the mechanical efficiency of a series of fans can be the same, yet their efficiency as ventilators, reckoned in volume of air moved per horse-power, can vary to a considerable extent; and a fan of high mechanical efficiency may discharge a small quantity of air per horse-power, as occurs in centrifugal fans when pressure is necessary. For example, in a test carried out by Mr. Bryan Donkin of a 2ft. centrifugal fan, with free discharge, the fan delivered 1,995 cubic feet at 1,324 revolutions per minute, giving a mechanical efficiency of 5·2 per cent. and requiring 1·92 horse-power; it therefore discharged 1,039 cubic feet per minute per horse-power. When the outlet was baffled so as to give a mechanical efficiency of 40 per cent., the discharge per horse-power fell to 700 cubic feet per minute. Now, an air propeller of the same diameter, tested by the author at the same speed of 1,324 revolutions per minute, moved 7,550 cubic feet per minute, and absorbed 1·4 h.p.; this is equivalent to 5,400 cubic feet per minute per horse-power. The relatively greater amount of power required for the centrifugal fan with free discharge was here due to a high velocity of the air passing through the small inlets at the centre and the small outlet of the centrifugal fan; while in the propeller fan the area of passage for the air was nearly equal to the fan disc. In the centrifugal fan there was also the greater internal loss due to skin friction. The purposes of the two fans were of course quite different; the propeller fan was for volume of air without compression, the centrifugal for volume with compression. Where the propeller fan is employed in drawing air through contracted holes or tortuous flues, the adoption of the central disc becomes important. In Table 5 are given results of experiments with contracted inlet, and with the fan revolving partly outside the air delivery tube. The fan has since been tried completely inside the tube, and drawing air through a tortuous flue; and it has been found that, with the same power and speed of fan, the presence of a central disc of slightly conical shape increases the amount of air discharged by between 40 and 50 per cent.

The author's thanks are due to Mr. H. G. Wooley for assistance in carrying out the experiments and working out the results, and to Mr. A. M. Morgan for the preparation of the drawings.

FORTHCOMING EVENTS.

The following are some of the announcements for the forthcoming week:

To-day (Friday).—Institution of Junior Engineers, at Westminster Palace Hotel, 8 p.m. (inaugural meeting seventeenth session; presidential address by Mr. John A. F. Aspinall, M.I.C.E.).—North-East Coast Institute of Engineers and Shipbuilders, meeting, at the Literary and Philosophic Society's Hall Newcastle-on-Tyne, 8 p.m.—The Röntgen Society, opening meeting and exhibition, at St. Martin's Town Hall, 9 p.m. (presidential address by Prof. Sylvanus Thompson).

Monday, November 8.—Northern Society of Electrical Engineers, at the Palatine Hotel, Hunt's Bank, Manchester, 8 p.m. (Mr. C. H. Wordingham, member, on "The Distribution of Electrical Energy").

Tuesday, November 9.—Institution of Civil Engineers, meeting, 8 p.m. (papers on the "Manchester Ship Canal," by Sir E. Leader Williams, Mr. Whately Eliot, and Mr. W. O. E. Meade King, M.I.C.E.).

Thursday, November 11.—Opening meeting of the Institution of Electrical Engineers, 8 p.m. (Mr. L. Epstein on "Accumulator Traction on Rails and Ordinary Roads").—Finsbury City and Guilds Technical College, Leonard-street, City-road, E.C., 8 p.m. (Mr. Philip Dawson on "Electric Traction").

Friday, November 12.—Physical Society, meeting, at the rooms of the Chemical Society, Burlington House, Piccadilly, 5 p.m. (Mr. J. Rose-Innes "On the Isothermals of Ether"; Mr. F. S. Spiers and Mr. F. Twyman "On the Variation in Temperature of the Electromotive Force of the H-form of Clark's Cells").—Council meeting at 4 p.m.

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LEARNED SOCIETIES.

As a rule, learned societies are very much dormant during the summer months, and awake to activity when the temperature is lower. Long nights and short days seem suited to mental activity. We are more especially concerned with the proceedings of those associations dealing directly with electrical matters. At the head of these is the Institution of Electrical Engineers. It is the oldest of purely electrical institutions—hence should deserve our respect. Unfortunately, for some reason or other, 90 per cent. of the people interested in the question of efficiency incline to the opinion that its efficiency is very low, while that of its younger rival, the Northern Association, is increasing by leaps and bounds. It is clearly the province of the premier electrical society to lead the van; its papers, discussions, *Transactions*, should contain the very latest and most perfect or comprehensive information upon all branches of electrical work. Just examine one phase of electrical work during the past few years, and consider what information the institution has given upon the subject. The technical press shows that millions of capital have since 1881 been absorbed by lighting and power works, but it is just possible that even more capital has been and is utilised in electro-chemical work. The views of chemists and metallurgists in regard to the theories of electrolytic action have during the period above mentioned undergone complete change. We find no scrap of information on this branch of electrical work in the papers presented to the Institution. Why is this? Is it that the society cannot obtain papers? Is it that the members of council have overlooked the matter? Is it that the importance of the subject is not understood by the council, or where lies the fault or blame? The ordinary Englishman seeking for knowledge in this direction is driven absolutely to the pages of the reports of the British Association. There are a few papers to be found elsewhere, but these are known only to the few and not to the multitude. We have three elementary books on the subject in the language, only one of which, that on "Solution and Electrolysis," is by a native hand; the other two are translations. Questions on the new theories are asked in examinations, and the new theories are being taught in our schools and colleges. Prof. Sylvanus Thomson, F.R.S., is giving a special course of lectures on the subject. It would seem, then, that these new theories are forcing their way to general acceptance, notwithstanding that they have never been broached in the sacred halls of the institution. Can we, dare we, say the Institution of Electrical Engineers is duly fulfilling its functions when so important a branch of electrical work is wholly ignored? Our opinion is that the Institution is somewhat hampered because the members of council do not take a sufficiently active interest in the subject matters to be brought forward for discussion. It is their business to see that the *Transactions* shall annually show records of improvements in the profession, and to spare no pains in persuading

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suitable men to read such communications. It is necessary to be aggressive in the matter of papers and not to remain satisfied with such as happen to be sent in for examination. The applications of electricity are progressive, and one of the constant aims of the Institution should be to keep its members acquainted with the newer developments. Authentic, authoritative information in the earlier stages of a new development is far more valuable than descriptions of apparatus in general use. To obtain early information means enterprise and energy, and these personal endowments are by no means lacking in some members of the council. Their works show that they possess them, and we would urge greater utilisation for the benefit of the Institution. When the members agree that it is an honour conferred to be able to claim membership, and to have a paper accepted, it will be easier for the council to get good papers than it is now, when the giving of a paper savours somewhat of conferring a favour. It is better to speak pretty plainly on this matter, because next week the members will have before them the house list of proposed officers for the ensuing year, and in which we hope the old attempt, to be all things to all men, will not be repeated. We have taken one branch of electrical work to inculcate a moral; we might have referred to other branches, and pointed out many a hiatus which for some reason or other exists. When we turn from the principal Institution to the Northern Association and to the Municipal Electrical Engineers, we find a different state of things. Neither of these societies is constituted upon so broad a basis; neither aims at so high an ideal, and perhaps for that very reason there seems to be less internal friction and far better visible results. It is to be earnestly hoped that times will change for the better with the Institution, so that its membership may aid in the collective advancement in knowledge, and hence, naturally, to individual advancement in business.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ELECTRIC GOVERNORS.

SIR,—In your issue of the 29th ult. there is a description of a recently-patented electric governor, consisting of a solenoid, core, and lever working on to a throttle-valve, also automatic stop, which comes into action in case of broken current. There is further an arrangement of air-compressor driven by the steam-engine to be regulated, which compresses air to act as a relay of power to work the expansion gear of large engines.

So far, however, from there being anything essentially novel in either of these pieces of apparatus, every point in the first is covered by my patent taken out in January, 1881, No. 288, and in the relay system by an invention of Mr. Willans which was made shortly after. Mr. Willans, however, used hydraulic pressure instead of compressed air to work his relay.

Neither system of relay, however, is necessary. The further patent taken out by Mr. Ralph Nevile and myself in 1886, No. 5,025, shows a system of governing the expansion gear of even the largest engines directly from the solenoid with a very small current and without any relay. These electric governors have been in regular use in many places from that date to the present time. Both the systems are more fully described and illustrated, together with means for working the sluice of a turbine, in a paper read by me before the Institution of Civil Engineers in February, 1895. The first patent has, of course, expired by effluxion of time—*i.e.*, the one for working a throttle-valve by solenoid. The latter, covering the expansion gear of large engines, will not expire until 1900.

A very exhaustive series of experiments was carried out in connection with the 1881 patent by Prof. Silvanus Thompson in 1883, and have been published at various times in several scientific papers, and also in his book "Dynamo-Electric Machinery," page 504, 1886, and subsequent editions.—Yours, etc.,

Lincoln, November 2, 1897. JOHN RICHARDSON.

REVIEWS.

Lectures on Physiology. First Series: On Animal Electricity. By Prof. AUGUSTUS D. WALLER, M.D., F.R.S. Longmans, Green, and Co., London. Price 5s.

It may be remembered that Prof. Waller delivered a series of 12 lectures at the Royal Institution in the spring, which lectures were duly noted in these columns as delivered. The matter of this volume is not coextensive with that of the lectures, and, as will be seen from the title, will probably be followed by a second series. The first chapter deals with the texts (1) that active or more active matter is electro-positive to passive or less active matter, and (2) that greater or smaller electrical effect corresponds with greater or smaller physiological activity, putting forth the law that electrical changes are a measure of physiological activity, and giving experimental details in proof of this law. The second chapter, in the first place, describes the method and nomenclature employed, then goes on to show the nerve sensitiveness to various substances—such as tobacco smoke, strong alcohol, carbon dioxide, etc. Singular to say, the nerve quickly gets dead drunk to alcohol and to pure water. The most interesting and important experiments described are those with carbon dioxide, to which the nerve is extraordinarily sensitive; and Chapter III. continues the discussion of the varying effects obtained. The next chapter deals with polar reactions of living matter, and more especially with Pflüger's propositions, which are thus stated: (1) that the "make" excitation arises at the kathode; (2) that the "break" excitation arises at the anode; (3) that during the passage of the constant current excitability is raised at and near the kathode; (4) that during the passage of the constant current excitability is depressed at and near the anode.

The author says: "Subject to a possible exception in the case of non-fibrillated protoplasm, 'these four propositions' express the law of response of living matter to electrical currents." Chapters V. and VI. deal with du Bois-Reymond's electrotonic currents. The great value of this book is not in the theories propounded, but in the experimental proofs put forward in proof of the theories. To the physiologist and to the biologist the work must prove useful, as nothing is taken for granted, and only accepted after actual demonstration. Hitherto, what may be termed the "exact methods" of determining the effects of various substances upon nerve and muscular tissues have been wanting, but gradually electricity is providing the investigator with a weapon of research far more subtle and exact than any gone before, and hence for the general practitioner evidence is being accumulated that must greatly assist him in so dispensing his drugs as to gain the effect he desires.

INSTITUTION OF CIVIL ENGINEERS.

At the first ordinary meeting of the seventy-ninth session, held on Tuesday, November 2, the PRESIDENT, Sir John Wolfe Barry, K.C.B., delivered a short address to the members, dealing with various matters concerning the present and future welfare of the institution.

After expressing his appreciation of the honour conferred

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by his election a second time to the presidency, and having addressed the institution at length last year on engineering, past and present, he preferred this year to confine his remarks to matters of a domestic nature affecting the home of the profession and the welfare of the members. He referred to the increasing duties devolving upon the council in proportion to the growth and importance of the institution, now numbering on its roll 7,075 persons. In expressing his thanks to the members of the council for the cordial support accorded to him as president, he desired that the numerous advisory and other services rendered to the body corporate by its members in all parts of the world should be recognised at large, as it was appreciated by the council and executive, who fully realised its value in the conduct of affairs.

The President proceeded to refer to the engineering conference held by the institution in May, the estimated attendance at which was 850. He thought it would be acknowledged that the interest exhibited in the numerous subjects brought forward for discussion, in which upwards of 300 speakers took part, and the fact that 2,000 tickets of admission were applied for in respect of the visits arranged in connection with the gathering, justified the council in believing that it had given general satisfaction to the members. The division of the conference into seven sections, representing more or less distinct lines of engineering thought and practice, afforded a useful means of meeting the overlapping of ideas and treatment in the various departments of engineering activity embraced by the institution.

Reviewing the subject of the examinations recently instituted, the President pointed out how they were intended to show that candidates for election into the class of associate members were acquainted with those general principles which had always been and must be recognised as the basis of the engineering profession, and also to make clear that each candidate possessed a somewhat fuller scientific knowledge of the elements of the particular branch in which his special training had lain. Although an advocate of examinations for the purpose of ensuring the possession among those who entered the institution of proper qualification in respect of theoretical knowledge, the President desired to avoid being understood to claim for such knowledge one whit more than its real worth in the equipment of an engineer. Practical knowledge was no less necessary now than formerly, and in the engineer's office, in the workshop, and on works of construction, and there only, could a young engineer learn by experience to modify and correct theoretical conclusions by practical considerations. The examinations had not been instituted in lieu of other qualifications set out in the by-laws, but in addition to and supplementary of them. In the case of persons whose experience and attainments were such as to entitle them to the grade of full member, no question of examination arose under the provisions of the by-laws, and the Council had power to deal with exceptional cases of candidature for associate membership also without examination. He had every confidence in the future advantage to accrue to the institution from the step now taken, and whilst at the outset no doubt there might be some special cases in which the council might wisely exercise the discretionary power vested in them, he believed such cases would gradually diminish in number, and disappear altogether.

After referring to the accommodation for the ordinary work of the institution afforded by the new premises, the President alluded to the advantage that might be enjoyed in the possession of a great hall for gatherings of a special character, with the adjunct of a museum of engineering materials and models. Whilst having regard to the expenditure already incurred in rebuilding, the institution itself might not be justified in entertaining such an idea. He hoped that the institution might some day possess a hall not inferior to those which had in late years been erected by the munificence of the donors of the Bute, the McEwen, and the Usher Halls at Glasgow and Edinburgh.

After presenting the medals and prizes awarded by the council for the last session (a list of which is given below), the members and others attending the meeting were received in the library.

Awards.—The medals and prizes awarded for papers during session 1896-97 comprised the following: The Howard Quinquennial Prize to Hilary Bauerman, A.M.I.C.E. Telford Medals and Premiums to H. A. Humphrey, A.M.I.C.E.; Colonel J. Pennycuick, C.S.I., R.E.; E. C. Shankland, M.I.C.E.; T. Holgate, A.M.I.C.E.; and D. Drummond, M.I.C.E. George Stephenson Medals and Telford Premiums to G. E. W. Crutwell, M.I.C.E., and to Prof. W. C. Unwin, B.Sc., F.R.S., M.I.C.E. Watt Medals and Telford Premiums to D. Hay, M.I.C.E., and to M. Fitzmaurice, B.E., M.I.C.E. Telford Premiums to H. F. Donaldson, M.I.C.E.; W. Ripper, M.I.C.E.; H. W. Ravenshaw, A.M.I.C.E.; J. E. Worth, M.I.C.E.; W. Santo Crimp, M.I.C.E.; S. G. Homfray, M.I.C.E.: Major Leach, Corps of Engineers, United States Army; O. F. Nichols, M.I.C.E.; J. Ramsay, M.I.C.E.; and H D. Smith, A.M.I.C.E. For paper read before meetings of students: The James Forrest Medal and a Miller Prize to A. H. Jameson, B.Sc., Stud.I.C.E., for a paper read before the Manchester Association of Students; the James Prescott Joule medal and a Miller prize to H. W. Barker, Stud.I.C.E.; and Miller prizes for papers read at the institution to W. Beer, Stud.I.C.E., H. F. Brand, Stud.I.C.E., H. Berridge, Stud.I.C.E., and J. W. Kitchin, Stud.I.C.E.; and for papers read before local associations of students to C. H. Godfrey, Stud.I.C.E. (Manchester), R. H. Garvie, B.Sc., Stud.I.C.E. (Manchester), T. Carter, Stud.I.C.E. (Newcastle), and F. W. R. Hurt, Stud.I.C.E. (Leeds).

It was also announced that at an ordinary meeting on Tuesday, November 9, at 8 p.m., the following papers would be read: "The Manchester Ship Canal" (four papers), by Sir E. Leader Williams, Mr. Whately Eliot, and Mr. W. O. E. Meade-King, M.I.C.E.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. The answers to any question should be sent within 10 days after the question has appeared. Questions may be sent at any time. In both of the questions this week the real difficulties of the subjects are only implied. We trust those who know what these difficulties are will come forward and give our readers the benefit of their experience.

QUESTIONS.

8. In an alternating-current system using concentric feeders with the outer earth at the generating station and with switches on the inners only, is it advisable to use switches and fuses on both poles of the transformers feeding on to the low-tension network?—T. A. LOCKE.

9. Is there any reliable method of indicating at the central station the E.M.F. at the farthest end of a long alternating-current feeder without the use of pilot wires? If so, give details of the method.—J. PILLING.

ANSWERS.

Question No. 3. What is the best and most practical method of determining the calorific and relative cash values of samples of coal supplied for central stations?

Best Answer to No. 3 *(awarded* 10*s.).*—The best way of testing the properties of coal for a certain work is undoubtedly to try it under the same conditions and on the particular plant for which it is required, but it would be quite impracticable to test all the samples offered for a coal contract at an electricity supply station in this way, as it would, of course, take too long, for the writer has sometimes had as many as from 40 to 50 samples to test which have been submitted for a contract. In this case the best way to treat them is to test the whole lot chemically, and by this means select, say, the best three and give each one a week's trial on the boilers. To get the calorific properties chemically is not a sufficient test, and does not necessarily mean that that particular coal would give the best results on the particular boilers in which it is intended to burn it; but it is a very good guide, and saves a lot of time in assisting to select the few better samples for

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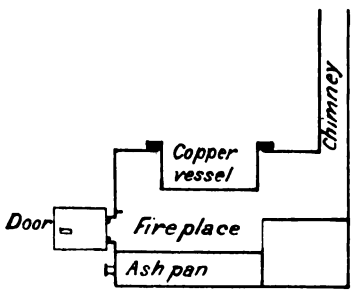
the practical test. The following method of finding the calorific property of coal is founded on the two following principles—viz., (1) that the latent heat of steam is equal to 967deg. F.; (2) that coal burnt in oxygen evolves the same amount of heat as when perfectly burned in atmospheric air. From No. 1 it follows that if we heat 967 parts of water one degree we have employed as much heat as would have boiled off one part of water from 212deg. F. If the same quantity of water had been heated 10deg., then we would have used heat enough to boil off 10 parts of water, and so on continuously, the thermometer indicating the number of parts of water capable of being boiled off by the heat excited. If, therefore, we can continue to burn one grain of coal in the midst of 967 grains of water, it is evident that the temperature acquired by the water will show us the number of grains of water which one grain of the coal in question is able to convert into steam from boiling point, and by substituting pounds for grains we have the evaporative value of the coal. As it is better to use a larger quantity than one grain, it is usual to use 30 grains and a corresponding quantity of water. The *modus operandi* is as follows: Powder a sample of the coal, and mix well 30 grains of this powder with 10 times its weight of a mixture of three parts of chlorate of potash ($KClO_3$) and one part of nitrate of potash (KNO_3) which has been well dried and powdered together. The whole is now introduced into a furnace and a fusee attached and lighted. On ignition taking place the whole is immersed into a vessel holding 967 × 30 = 29,010 grains of water, whose temperature has previously been taken. The difference of temperature of water before and after the experiment shows the number of pounds of water which 1lb. of the coal would convert into steam from boiling point. The following is an example of a test taken:

Quantity of coal used	= 30 grains.
„ „ potash mixture used	= 360 grs.
„ „ water.....	= 29,010 grs.
Temperature of water at beginning	= 64·0deg.
„ „ „ finish	= 77·5deg.
Heat absorbed in apparatus, say, 10 per cent.	= 1·35deg.
∴ pounds of water evaporated per pound of coal	= 14·85.

After the samples have all been tested as above, the three best ought to be selected, and each given a week's trial in the boilers, and during this time note made of the water-meter and the station wattmeters at the beginning and end of each week; and from these a very good idea is given of the value of the coal under the actual conditions for which it is required, as, by knowing the weight of coal burned, the quantity of water evaporated, and the number of units generated, we have the pounds of water per pound of coal and the pounds of coal per unit, and can then compare the values of the different samples.—W. WYLD, A.I.E.E.

Answer No. 3.—The most practical way in which to test the calorific value of coal is to find how much water it will evaporate in a boiler per pound during, say, 24 hours. By taking a long test, any error due to the fire being already burning when the test starts, and being left burning at the end, would tend to be eliminated. By making trials with several different kinds of coal, we can find that which evaporates the greatest amount of water and leaves the least ash. The choice of coal to be used in a certain locality depends not only upon the calorific value, but also upon the price. A coal of high evaporative power may cost more than one of a little lower; but the percentage increase in evaporative power may be more than the percentage increase in the price, and so the more expensive coal would be the more economical. The higher the freight the more economical would a higher-priced coal become. The quantity of ash to be carted away must be considered. If the matter is looked at from the point of view of so many heat units, with so much dross, upon which latter double carriage has to be paid, it may be clearer to understand.—T. A. LOCKE.

Answer No. 3.—Take a sample of the coal fairly and weigh, say, 10lb., breaking large lumps to a reasonable size, and then put it into a small furnace made as sketched. Light it with as small a quantity of paper and sticks as possible, and having filled the copper vessel with water at, say, 60deg. F., note the time of starting, how long the coal burns, and how much water it will evaporate. It is advisable to use distilled water, which must be carefully weighed or measured, and a little must be added every few minutes to replace that lost by evaporation and to maintain a definite bulk of water in the copper vessel. The fire should be kept stirred and bright, and the length of time it burns should be noted, as also the weight of ash left. These figures will give the necessary data for comparison of any number of samples, both for the calorific value and the cash value, since both these values are in direct proportion to the weight of water evaporated.



The above illustration gives a side section of sheet-iron furnace and copper evaporating vessel. N.B.—An extra length of chimney can be added if necessary for hard steam coal, anthracite, etc. The temperature of the water at starting each experiment should be the same, say 60deg. F., as above. Each 20lb. of water evaporated may be reckoned as the horse-power. The object in ascertaining the proportion of ash left after burning the coal is to give information as to the amount of labour required in keeping the stoke-hole clear, etc.—F. G. A.

[The first answer is undoubtedly the best, as it continues a preliminary examination with a practical test of the best examples. The 24-hour test as suggested by Mr. Locke would necessitate 14 days' working to evaluate 14 kinds of coal, and the repeated changes would not tend to economy in working the stations. The samples required would also run into truck-loads.—ED. *E. E.*]

Question No. 4. A water-gauge shows a "full glass." After blowing it through the water rises again as before. Might not the gauge be showing a false level? How would you find out? What generally are the indication failings of a gauge, and how can they be known?—NEMO.

Best Answer to No. 4 *(awarded* 10*s.).*—Let the tap at the top of the gauge glass be called the steam-tap, that at the bottom of the gauge-glass the water-tap, and the other the exit-tap, since it leads to the open air. Suppose the water-tap tube blocked up by "scale," then opening the steam-tap and exit-tap to blow through would give a good blow of steam. Now close the exit-tap, and soon steam will condense in the glass and so fill it with clear water. This state of affairs would be known by the water trickling down the tube and slowly filling it with clear water irrespective of the level of the water in the boiler, which water is generally turbid from the action of the heat on its lime and magnesia salts in solution. A further and more rapid test for this fault would be to close the steam-tap and open the water-tap, when no water would flow. There is another serious fault which might possibly occur, though not very probable—viz., the steam-tap tube might get choked from priming, scum, excessive ebullition, or neglect. In this case, the steam-tap and the exit-tap being open no steam would issue, but of course if the exit-tube were connected to a pipe, and so the water and steam conducted away unseen, this might not be noticed, and the result would be that water would rise in the glass, because the water rushing through the water-tap and exit-tap would exhaust more or less the glass, and so when the exit-tap is closed water would soon rise in the glass. In this case turbid water from the boiler would probably rise rapidly to a certain level, and then a little further more slowly, as the steam in the top of the glass condensed. This fault might also be caused by the glass being inserted too high in the top holder and so having its end blocked, unless special provision were made in the brass socket to prevent

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this accident. The following may be considered general indications of failure in the correctness of the gauge: the water lying too still in the glass; exceptional clearness of the water in the glass; any loss of usual turbidity in the water in the glass; the water rising too slowly in the glass after opening the water-tap and closing the exit-tap; the level of the water in the glass should fall whilst the boiler is giving steam, and more rapidly as more steam is required, or as more rapid firing is required; the level of the water in the glass should rise when fresh water is being injected or pumped into the boiler.—F. G. A.

Answer No. 4.—A water-gauge showing a "full glass" may not always indicate the true level of the water in the boiler. The steam-way cock may have become choked, thus forcing the water to the top of the glass. To prove this, shut off water-way cock and open drain-cock. If after the glass empties itself no steam comes, then the steam side is choked. To clear it, shut off the cock and remove the outside plug. Open the cock gradually and insert a piece of stiff wire bent at right angles, standing, of course, to one side to avoid scalding. Having removed obstruction, close the cock again, replace the plug, open steam and water-way cocks, and after blowing through the water will rise to the same level as in the boiler. A gauge may also show no water in the glass and on blowing through only steam comes, giving one to suppose that the water is dangerously low in the boiler, or that the water-way cock had become choked. To prove this, shut off steam cock and open drain. If no steam or water comes, then the water-way cock is choked. To clear it, shut off the cock, remove the outside plug, and open water-cock slowly. Insert the bent wire, observing the same precaution as before. Having cleared it, shut the cock, replace the plug, and open both cocks. On blowing through the gauge will indicate the true level of the water.—NEMO.

Answer No. 4.—It is quite possible that a water-gauge may be showing a false indication even when the water rises in the glass to full level after blowing through. This would occur (though it very seldom happens in practice) in the event of the steam passage being furred up. To prove the value of the indication, I should first close the steam-cock and blow through from the water, then close the water-cock and blow through the steam end of the gauge. If both passages are open, I should conclude that the indication was the true level of water in the boiler. Gauges more frequently fail to indicate accurately owing to the water passage becoming sealed up. If on blowing through the water in the glass rises slowly, it is caused probably by the water passage being almost blocked. But in this case, also, the water level is not absolutely reliable, as the water passage may be thoroughly closed, and the rise of water in the glass simply caused by condensation of steam. To determine what is the fault, shut the steam-cock and blow through water, and if there is a passage the indication is true. Then, again, if the rise is due to condensation of steam, the water will continue to rise in the glass until full. In some of the early forms of automatic self-cleansing gauges, there is a danger when blowing through of entrapping in the glass a false level of water. However, this fault has been remedied in the improved forms of automatic shut-off gauges now on the market. All boilers for supply station work should be provided with duplicate sets of gauges, thereby securing almost absolute safety, as it is very unlikely that both gauges will go wrong at the same time.—JOHN PILLING.

ALTERNATOR DESIGN.*

BY J. FISCHER-HINNEN.

This is an essay on the calculation of alternate-current machinery, with special reference to the drop of pressure in the armature windings. It may in a measure serve to complete the method of Dr. Behn-Eschenburg, which was published some time ago. As the latter way of calculating the loss of pressure has been frequently discussed in this paper, we presuppose that our readers are acquainted with the same. The various objections which have been raised against this theory may, the author thinks, be disregarded, because the recorded variations from the results of experiments evidently only arose from the fact that the law connecting inducing or induced magnetomotive force was extended to cases where there was a lag between them, while in reality it is only applicable to displacements of 90deg. When an alternating-current machine is short-circuited, a current is caused, the maximum value of which occurs at the moment when the poles of the armature are directly opposite the magnet poles, and when the armature's magnetising, or rather demagnetising, forces nearly equals that of the field magnets.

We may, therefore, without touching the only too frequently neglected self-induction coefficient, assume that the ampere turns in armature and field are approximately equal to each other. The results of experiments give in reality a pretty good confirmation of the assumption, as long as the phase difference between the terminal pressure and the current is nearly equal to 90deg. In the case of smaller angles the influence of the armature reaction generally decreases somewhat as compared with the magnetic induction, which must be taken into account in order to avoid larger errors. The reason for this is to be found in the larger magnetic resistance which the armature lines of force have to overcome in this position. For example, a 600-kw. alternator gave the following results when experimented on at continuous excitation (167 amperes):

	Amperes.	Volts.
No load	—	4,400
Short-circuited	320	—
With non-inductive load	200	3,900

This gives an apparent resistance for $\cos\phi = 1$ of

$$R = \frac{1}{200}\sqrt{4{,}400^2 - 3{,}900^2} = \text{about 10 ohms};$$

for $\cos\phi = 0$ $\quad R_0 = \frac{4{,}400}{320} = \text{about 14 ohms.}$

The difference is therefore about 30 per cent. A large number of other machines which the author tested gave similar results.

One will, therefore, not go far wrong by taking as a first approximation the apparent resistance for $\cos\phi = 1$ is equal to about two-thirds of that obtained on short-circuit. It would be too complicated an affair altogether to define the apparent resistance for other phase differences either by experiment or by calculation. Two calculations or experiments are, as a rule, sufficient—that is, one at short-circuit and another for a load without self-induction. It is then assumed that R changes for the angles which lay between according to a straight line below, which line goes through the two points ascertained. Although we may not get in this way the absolutely true values, yet the errors which are then possible are smaller than those which will occur if we leave this circumstance entirely out of our calculation.

General Formulæ.

Φ = the maximum number of lines of force which emanate from one magnetic pole.
N = the total number of armature turns in series (not wires) per phase counted right around the armature. With machines with two armatures and equal windings (per phase) the number in each armature is added.
m = the number of turns on a field-magnet circuit.
i = the exciting current.
n = the number of phases in the machine.
c = the number of complete periods.
$2p$ = the number of poles.
K = Kapp coefficient which gives the voltage, and which is for pure sine wave $= \frac{2\pi}{\sqrt{2}}$.

The E.M.F. of a single phase is given by the following equation:

$$E = \frac{K \cdot c N \cdot \Phi}{10^8} \text{ volts} \quad . \quad . \quad . \quad (1)$$

* From the *Elektrotechnische Zeitschrift.*

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At the same time the E.M.F. of the self-induction is

$$e = \frac{K^1 \cdot c N \cdot \phi}{10^8} \quad . \quad . \quad . \quad . \quad . \quad (2)$$

K and K^1 may be of different value according to the construction;

ϕ stands here for the maximum number of lines of force emanating from an armature tooth;

e is also often indicated thus $2 \pi L J$: in this phrase J signifies the total current which circulates per phase inside the armature.

With regards to ϕ and Φ, the usual expressions apply.

$$\phi = \frac{4 \pi}{10} \cdot \frac{J N \sqrt{2} \left(\frac{n}{2}\right)}{p \mathfrak{R}_a} \quad . \quad . \quad . \quad (3)$$

and

$$\Phi = \frac{4 \pi}{10} \cdot \frac{i m}{\mathfrak{R}_m} \quad . \quad . \quad . \quad . \quad . \quad (4)$$

$\mathfrak{R}_a$ = magnetic resistance to the lines emanating from the armature;

$\mathfrak{R}_m$ = magnetic resistance to the lines emanating from the magnet.

For one and two phase machines we get $\left(\frac{n}{2}\right) = 1$.

The factor $\left(\frac{n}{2}\right)$ corrects for the influence exerted by the rest of the phases upon a single phase. It is to be noted that this relation is in reality not always accurately defined by the above expression, and this is especially the case for rotating-field machines, when it should be higher. For instance, the rotating-field motors (*motors* with an equal number of armature teeth and poles), the correct coefficient is 0·665 n instead of 0·5. This, however, does not affect our calculation, as we allow for this difference in the coefficient K″.

If we divide equation (2) by equation (1), putting in the values of ϕ and Φ according to equations (3) and (4), we get:

$$\frac{e}{E} = \frac{K'' . J N \sqrt{2} \left(\frac{n}{2}\right)}{p . i m} \cdot \frac{\mathfrak{R}_m}{\mathfrak{R}_a} = \frac{K'' . J N \sqrt{2} \left(\frac{n}{2}\right)}{p . i m} q \quad . \quad (5)$$

This equation (5), which gives the relation to the E.M.F. induced by the magnets of the counter E.M.F. caused by self-induction, has, as we will observe later on, a special significance, because it allows the calculation of the loss of pressure in the machine.

The quotient $\frac{e}{E}$ may therefore be used to a certain extent to estimate the value of an alternating current machine from an electrical point of view. This is so because the working qualities and the output of an alternating-current machine (without taking into consideration its mechanical qualities) will solely depend upon the loss of pressure in the same—that is to say, of the allowable fall of voltage between no load and full load determines the output of the machine.

Further,

$$e = J \times R,$$

R, the apparent resistance $= 2 \pi L$.

Hereby we neglect the ohmic resistance which is permissible in most cases.

If we short-circuit an alternating-current machine at a certain excitation, i_0, and pressure, E, then the terminal pressure falls to zero, and the armature current has the value

$$J_0 = \frac{e}{R_0} = \frac{E}{R_0}.$$

We know that the phase difference between pressure and current is 90deg. in this case, so that

$$\frac{\mathfrak{R}_a}{\mathfrak{R}_m} = q = 1.$$

If we put this value into equation (5), then the apparent resistance, R_0, of the machine when short-circuited is ascertained as follows:

$$R_0 = \frac{K'' N . \sqrt{2} \left(\frac{n}{2}\right) E}{p . i m} \quad . \quad . \quad . \quad . \quad . \quad (6)$$

or generally for any given phase difference:

$$R = \frac{K'' . N \sqrt{2} \left(\frac{n}{2}\right) E}{p . i m} q \quad . \quad . \quad . \quad (7)$$

By dividing the right side by $2 \pi C$ we obtain the self-induction coefficient L expressed in henries; q as a rule diminishes as the phase difference decreases and becomes smaller than unity, especially in multiphase machines. This is easily explained through the fact that the air path of the lines of force emanating from the armature is smallest in the neutral zone. The constant K″ depends entirely on the construction of the machine—*i.e.*, of the relative width of the armature winding to that of the magnets, method of winding, leakage, etc. The coefficient K″ is identical with the coefficient K in the paper of Prof. Arnold which appeared in the *Elektrotechnische Zeitschrift*, Nos. 48 and 51, 1896.

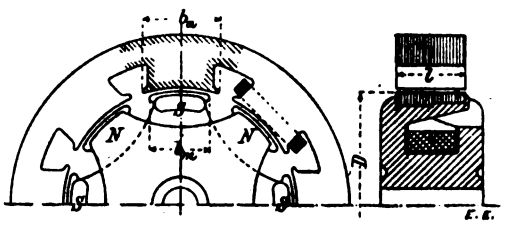

FIG. 1.

The following table gives particulars of 13 machines obtained from tests with different machines:

TABLE I.

H.P.	Type.	N.	m.	p.	E.	J_0.	i.	K″* calculated	Notes.
50	Fig. 1	300	850	5	600	28	2·5	0·9	
					900	50	5	1·0	
					1,200	114	14	1·22	
100	,,	400	700	6	1,500	16	2·6	1 2	
					2,000	25	4·6	1·36	
					2,500	37 5	8	1·58	
150	,,	300	805	6	1,000	35	3 7	1 2	
					1,500	54	6	1·27	
					2,000	83	10·5	1·44	
200	,,	400	950	8	2,000	27·5	2·3	1·12	A.
					3,000	42·5	3·6	1·13	
					4,000	66	6	1·22	
100	Fig. 2	1,106	372	7	880	30	8·7	0·48	
					2 000	—	21	—	
600	Fig. 3	960	540	40	2,200	125	5	0 64	
					2,800	164	6·7	0·65	B
					3,600	250	10·5	0·66	
					4,200	420	17·5	0 66	
2	Fig. 4	160	1,370	2	120	4·5	0·25	0 62	
					180	8 5	0·50	0·65	
					240	21·5	1·25	0·66	
15	Fig. 5	28	1,600	2	60	200	2	0·54	
					110	285	2·8	0·53	
					180	450	4·5	0·54	
30	Fig. 6	64	1,110	4	87	100	2·2	0·71	
					115	160	3·5	0·71	
					135	240	5·5	0·75	
30	Fig. 7	42	950	4	80	95	3·3	1·23	C.
					120	154	7·4	1·86	
					150	210	13	2·4	
325	,,	858	500	26	2,000	35	7·2	1·46	
					2,400	47	10·2	1·60	
					2,900	77	20	1·85	
225	Fig. 8	28	340	7	50	206	2·2	0·42	
					75	320	3·6	0·44	
					100	634	7·85	0·48	D
						830	13·3	0 63	
350	Fig. 3 †	54	648	36		860	3·75	1 33	
					110	1,980	8·7	1·33	E.
					115	2,600	15·6	1·83	

A. Single-phase. B. Magnets fitted with damping coils. C. Three-phase. D. Magnets fitted with damping coils (*vide* below). E. Two-phase magnets fitted with damping coils (*vide* below). * As this coefficient K″ is deduced from the experiment, it consequently allows also for the ohmic resistance. † As Fig. 3, but with bars and drum winding.

K″ is, as a rule, larger for machines with rotating field than for single-phase machines. The reason is simple. Calculating the relation of $\frac{b_m}{b_a}$ (Figs. 1, 6, and 7) for a

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number of machines, we arrive approximately at the following result: $\frac{b_m}{b_a}$ = on an average ·77 with single-phase alternating-current machines, and 1·25 with rotating-field machines.

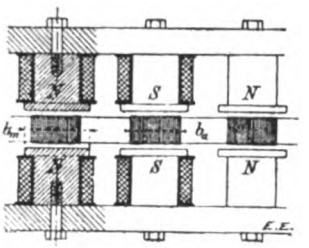

FIG 2.

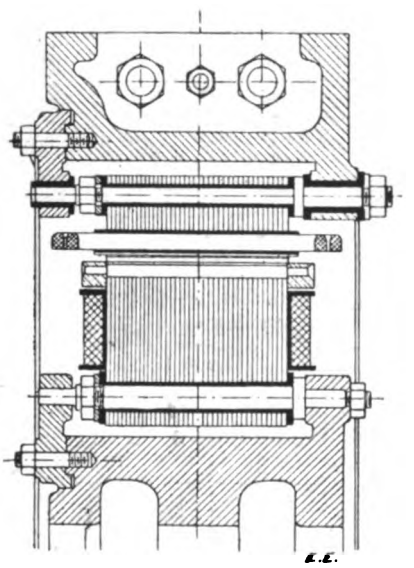

FIG. 3A.

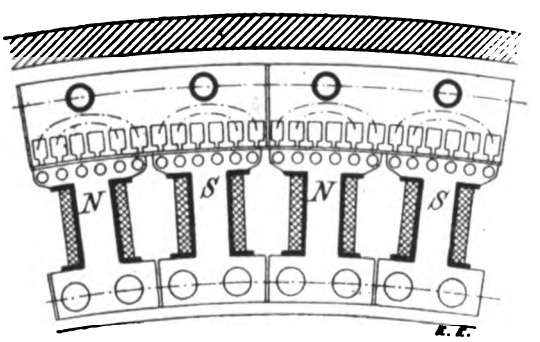

FIG. 3B.

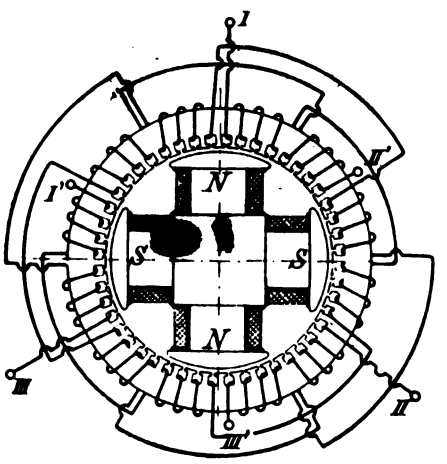

FIG. 4.

The width of an armature coil is consequently, in a rotating-field machine, 25 per cent. smaller than the width of the magnet poles, so that in rotating-field machines local magnetic fluxes may be set up by the armature currents, which enter the pole-pieces and which are not balanced by the counter-magnetisation of the magnets. If we combine the results of Table I. with those contained in Prof. Arnold's article we arrive at Table II., which may be used with advantage for purposes of design.

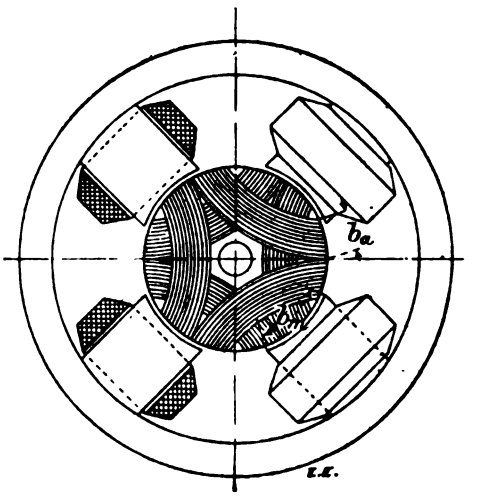

FIG. 5.

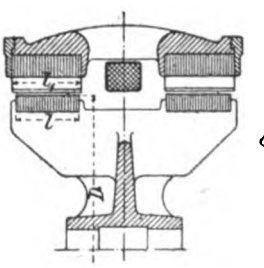

FIG. 6A.

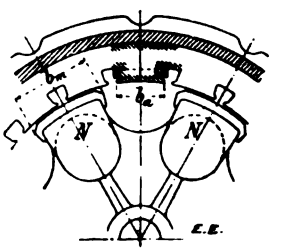

FIG. 6B.

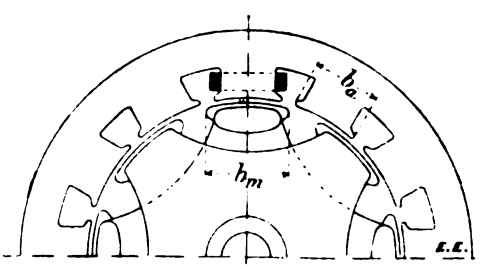

FIG 7.

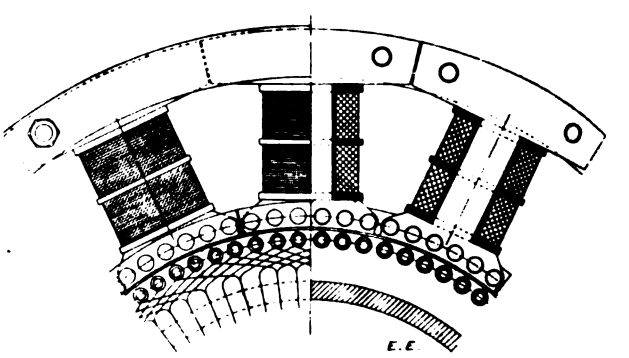

FIG. 8.

TABLE II.—Average Values of K″.

Single-phase alternating-current machines.

Armature outside and revolving central exciting coil, Fig. 1	K″ = 1·14
Alternator (Kapp), Fig. 2	K″ = 0·5 (?)
Armature outside, revolving central coil, Fig. 7, multiphase machines	K″ = 1·44
Winding fixed, Fig. 6	K″ = 1·1

(To be continued.)

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DOUGLAS.

REPORT OF THE COMMITTEE ON ELECTRIC TRACTION.

(Concluded from page 568.)

The disadvantages and objections usually urged against the overhead system are: (1) the unsightly and objectionable appearance of the poles and wires; (2) the danger of overhead telephone wires, etc., breaking and falling on the highly charged trolley wires; (3) the danger of the highly charged trolley wires breaking, and coming into contact with persons passing near them; (4) the danger of the electrolysis of gas and water mains owing to the return current being taken by the rails; (5) the danger likely to arise from sparking at the wheels owing to the return current being taken by the rails.

With regard to the unsightly and objectionable appearance of the poles and wires, the deputation candidly acknowledge that, while admitting their utility, public sentiment generally is against their adoption and use in thoroughfares which, like the Douglas promenades, are places of public resort and public recreation. At the same time it cannot be denied that much of the objection which is taken on the ground of appearance arises from misconception and want of knowledge. Such adverse criticism as has from time to time been made upon the use of elevated wires and the erection of poles for the purposes of electric tramway service has to a very considerable extent arisen from carelessnes in erection and without regard to appearances. In the primitive days of electric traction this adverse criticism also no doubt arose from the fact that the various accessories were still in an experimental stage, and unsightly apparatus of a most objectionable character was constructed and erected on the spur of the moment to meet pressing exigencies as they arose. The first electric lines were certainly constructed without the slightest regard to either appearance or ornament, and æsthetic considerations were not taken into account, the result being that the poles and their appurtenances, the clumsy cobwebs of wires, which were erected by the pioneers of electric traction were objectionable and unsightly in the extreme. With the rapid and enormous increase in the development and extension of tramway business it speedily became worth while from a business standpoint for many expert mechanics to devote themselves and their hours of study and natural ability to the elaboration of details and to the perfection of the apparatus required in their manufacture. Special poles, insulators, suspension devices, and all the numerous appliances required for crossings, branches, terminals, etc., have consequently been developed and have greatly added to the thoroughness and efficiency of equipment, and also to ease and simplicity in erection and in workmanlike appearance. Approved apparatus such as is used in the construction of various British and Continental lines is compact, strong, and not likely at a height of 21ft. in the air to be unduly conspicuous. Prof. Silvanus Thompson says that of all overhead wires the trolley is the least unsightly and has the best excuse for its existence. Dr. Fleming, in advising the Plymouth Corporation in regard to the application of electric traction to the borough tramways, after discussing the conduit system, the accumulator system, and the overhead system, says there is little room for doubt that the only practical system of electric tramcar traction at the present moment is the overhead system. If this is carried out with all the precautions and knowledge now available, Dr. Fleming does not consider that the overhead system is at all objectionable. The light iron posts, he points out, which carry the trolley wires can be made available as supports for arc or incandescent lamps in the streets in which they exist, and with proper regard to the construction of this overhead work, he sees no reason to believe that it would in any way interfere with other traffic or be a cause of complaint by its appearance. Prof. Kennedy, in advising the deputation, says that if the Corporation decides to adopt electric traction at present, the Corporation must decide also to adopt overhead wires as conductors. The deputation, therefore, after what they have seen and the information they have acquired, cannot admit that there is any reasonable cause to fear anything from the unsightliness of either the trolley wires or the sustaining poles. It seems to be a certainty that the poles need not disfigure the thoroughfares if constructed of a light and ornamental character, any more than do the lamp-posts, more especially when, as is pointed out elsewhere, and is strongly emphasised by professional and lay opinion, the poles can be adapted to and most advantageously used for electric lighting purposes. The telegraph and telephone lines have familiarised people so long with such street ornamentation as to preclude the possibility of much shock being experienced to their taste. The poles for overhead wires cannot under any circumstances be rendered more hideous in their unsightliness or more objectionable than the abominable telegraph poles which are such a disfigurement on the raised footpath on the Central and in the centre of the grass plot on the Queen's Promenades, and in respect of which repeated protests were made to the authorities at St. Martin's-le-Grand, but without avail. Moreover, it is more than doubtful whether the trolley wire and its supports are sufficiently objectionable or unsightly to compensate for the great expense and manifold disadvantages necessarily attendant upon reconstruction of roadway and interference with existing sub-surface sewers, gas and water pipes and mains. The deputation, from their own careful personal observation, have come to the conclusion that very little objection can be taken to the use of poles and overhead conductors from an æsthetic point of view. Independent evidence available shows that in several places where at first the people entertained strong objections to the overhead system on account of the alleged unsightliness of the wires, poles, etc, they speedily became reconciled to the appearance of the streets, and now have no objection to the apparatus. In some of the places visited—Versailles, Dresden, Berlin—the poles were ornamental rather than otherwise, and the deputation found as a matter of fact that the suggested unsightliness of its appearance was much less on the spot than had been anticipated. This is not merely the opinion of the deputation, but careful and persistent enquiries made from the officials and heads of departments of the various municipalities—who, it may be presumed, represent public opinion to some little extent—as well as from the managers and engineers of the tramway companies, corroborate the deputation, and prove that the opinion expressed by them is general, and that public prejudice is gradually being overcome, and that the overhead wire is likely to be the standard system. It seems at the same time to be generally recognised that electricity is a motor which is in a state of constant flux, its efficiency increasing and its cost decreasing in inverse ratio as knowledge of its adaptability and its usefulness extends.

It is maintained that the danger of falling telephone wires can be completely guarded against by the exercise of due precautions and the use of good and proper appliances. Where telephone or telegraph wires cross over they have to be protected by fixing to them wooden covering pieces carried on little brackets or pillars soldered to the top of the wires. On the bay route of tramways there are only one or two places where precautions of this description would be necessary—at the junction of Church-road with Marina-road and the Promenade, and again at the junction of the Queen's and Strathallan Promenades and Summer-hill, and probably at Little Switzerland. It is, however, worthy of note to remark here that the town clerk has been officially informed that the National Telephone Company contemplate making application to the Corporation to lay their wires underground.

The question of accidents is, of course, a most important question, affecting as it does the interests of the general public. A reference to the descriptive report will show that at Versailles the public have realised that there is no danger to be apprehended from the trolley wires, and the public has absolute confidence in the system. From Frankfort information was obtained that accidents were most frequently the result of contributory negligence on the part of the public. In Dresden accidents have not been numerous, and such as have occurred have been due to carelessness, and could not be attributed to the system. Testimony was also obtained in Berlin that the greatest liability to accident was in the conduit system, subject to certain qualifications. Accidents have happened twice in Hamburg—twice in four years—but the precautions taken beforehand assured the wires falling dead. Some time ago some telephone wires were blown down in Brussels, and falling across the trolley wires came in contact with a two-horse van being driven across the street; the driver, it is stated, sustained severe shocks, and both horses were killed. The manager of the tramway company, writing to the town clerk, states that the troublesome consequences of the regrettable accident were attributable to a concourse of peculiarly unfavourable circumstances. On the occasion referred to the telephone wire fell on the lines on a part isolated by the protecting switch on creosote wood. As it is made black it is not perceived immediately, and the line rests in contact a certain time with the equipment or attendance machinery without any inconvenience. The horses of a truck which circulates on the company's lines became so embarrassed in the telephonic wire by the efforts which they made to disengage themselves, and thereby forced the protecting switch in such a fashion that the telephonic wire came into complete contact with the trolley wire, and the accident was thus occasioned. At Bristol no accidents of any kind have happened which could be attributed to the system.

With regard to the danger from trolley wires breaking, the testimony given in the descriptive report under this head ought to be conclusive, as in practice it has been found there need be no apprehension on this point. The deputation, however, think it right to again give prominence to the opinion expressed by Prof. Kennedy when asked his views on this matter. He states that the Corporation may consider that there is practically no danger to be apprehended from the overhead wires if they are well put up in the first instance, and properly inspected. The danger which it is frequently urged attaches to the overhead system, and which has been largely exaggerated, appears upon close investigation to have been accentuated and to have arisen almost entirely from primitive

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and careless erection, and insufficient maintenance. The feeder wires also were carried above ground on poles along the side of the track, and these being very heavy insulated cables, were very noticeable. The form of construction now in vogue of putting the feeder wires underground has reduced the overhead work to a minimum, and adds much to the sightliness of the installation. The provision of good material and the best appliances, combined with excellent workmanship and attention to detail in execution, is all-important. For a separation of a line into sections, so that an accident upon one portion may not interfere with the whole line, and also for protection against lightning, etc., ingenious apparatus of a perfectly reliable character has been developed. It has been strongly urged as an argument against the adoption of electric traction in any form that a considerable amount of trouble has been caused by electrical disturbance in the towns where the earlier lines were laid, and especially with the overhead system, where the return current is by the rails. To secure an easy path for the return current is a matter of great importance, and on the earlier lines of track, which largely trusted to the earth as a return, very serious difficulties were encountered. Heavy currents of electricity circulating through the metallic pipes and conduits along the line of the route caused their rapid corrosion. At first enormous falls of potentials were permitted, but in England the practice is governed by the rules of the Board of Trade, which specify that the fall must not exceed seven volts. A perusal of the regulations made by the Board of Trade in relation to this matter and for regulating the construction of the electrical portions of the tramways practically render it impossible for electrical disturbance to be felt. It has been said that these rules appear to some extent permissive in their application, and even if they are complied with in the first instance, there is no certainty that compliance will not become increasingly difficult, and perhaps impossible, as time goes on and deterioration sets in in the underground and inaccessible parts of the return circuit. Rules without observance are worse than useless, and so much the greater responsibility will devolve upon the corporation neglecting to enforce its powers, and in the event of any accident or damage arising through such neglect the corporation in default must be held responsible and liable. An improved method of bonding the rails is, however, now generally adopted, it having been definitely ascertained that heavy copper joints between the ends of the rails should always be employed, and the rails relied upon for the return to the extent of their current-carrying capacity. When that is exceeded, insulated return circuit feeders are run back to the power-house. With the use of the latest and most approved form of the "Chicago" rail bond, and the adoption of proper precautions, it is highly probable that trouble of the nature indicated can be altogether prevented. Some consider that the sparking at the wheels gives rise to complaint and in many instances is a cause of great objection. Under the climatic conditions existing in Douglas along the line of the Douglas Bay route, it is not anticipated that there will be any trouble from this source.

The deputation do not by any means deny the premises that the conduit system in one or other of its many ramifications may be the ideal system, or that in theory, according to some, it has attained the very acme of perfection, but they are inclined to prefer the practical and feasible before even the highest ideal. The conduit system may possibly possess all the ideal qualities with which it is credited by those advocating its adoption, but it is no more effective than the overhead system, while it is more costly to lay down, more difficult to remedy in case of defect, and is less cleanly than the overhead wire. Every feature of the conditions thus combines to free the choice from difficulty. The overhead system possesses well nigh every advantage that can be asked from an ideal system of traction. The deputation do not close their eyes to the fact that strong objections will probably be made to the alleged disfigurement of the streets in relation to the one great objectionable feature of the overhead wire. The deputation, however, all things considered, are of opinion that this drawback is so comparatively small as to be of little moment compared with the numerous manifest advantages which the system possesses over every other system.

The deputation has to report, in conclusion, that at a meeting held on Friday, August 27, 1897, at which the following members were present: Alderman J. Hall (as chairman), S. Webb, Councillors R. H. Cubbon, R. Clucas, J. Barron, and E. Chadwick (Mr. Councillor Carr also being present), it was resolved on motion of Mr. Councillor Chadwick, seconded by Mr. Councillor Barron, "That the draft report as prepared and submitted by the town clerk be and the same is hereby approved and adopted by the deputation, and ordered to be submitted to the Council in due course." Mr. Councillor Clucas voted against the resolution, explaining that whilst he raised no objection thereto, he desired to keep himself absolutely free for the consideration of details.

Although in the event of the general principle of the substitution of overhead electric traction for horse traction being considered and agreed to by the Council the question of financial considerations will be more fully considered at a later stage, the deputation, as an instance of the financial advantages likely to be derived to some extent at least from a similar substitution in Douglas, would again cite the case of Bristol, where, with a 7½ minutes' service, the cost per car mile run is now 5½d. as against 9d. with horses, whilst the passenger receipts have doubled. Similar advantages financially are anticipated in Liverpool, where the present cost of haulage by horses exceeds 7d. per car mile run, and the Corporation confidently anticipate that electric haulage, besides reducing the cost of traction to 3d. per car mile run for larger cars, will be really considerably more economical than appears by this comparison, since 50 per cent. more passengers could be carried for the 3d. than for the 7d.

ELECTRIC LIGHTING AT KENSAL TOWN.

Mr. T. W. E. Higgens, the surveyor to the Vestry, has made the following report to the Vestry of the parish of Chelsea:

Preliminary.—In accordance with your instructions, I beg to submit a digest of the information obtained from various districts as to electric lighting installations. I have in all cases tried to obtain figures which show the results of actual working; estimates of what is going to take place, or results of a few months' working, have been avoided as of no use except generally to mislead.

Particulars Available.—Information as to electrical installations is rather difficult to obtain. The Board of Trade publish results of the working of gas undertakings, but though they have the information as regards electric light companies, they do not publish it. The information submitted, when not directly obtained from the engineer to the district, has been compiled from reports and returns published in the electrical papers, and from the statements of costs of working found in various publications. The accompanying tabulated statement gives the most important particulars regarding the various installations. There are, however, no particulars available as to the length of streets in which mains are laid; in some cases only a small portion of the district has been provided with the necessary mains. In Chelsea, for instance, probably more than half the home district has yet to be wired, so that the total outlay in mains is a very long way from representing what will be the total outlay in wiring any of the districts completely. In considering the table, there are particulars about some of the installations which are worthy of note. They are as follows:

St. Pancras.—These accounts are interesting because that district possesses two generating stations—the Regent's Park and the King's-road stations. At the latter a dust destructor assists in providing heat, and out of the £19,688 expended for sites, £4,847 is in respect of land whereon the destructor is placed. The fuel bills for the two stations do not, however, show much advantage from the presence of the destructor. The fuel bill for the station without the destructor shows that the cost of fuel is ·760 of a penny per unit generated, whereas that for the station with the destructor amounts to 1·338d. per unit generated.

Islington.—The revenue per lamp at Islington is exceedingly high. It is, I understand, accounted for by the fact that the supply is given to a number of shops in the main roads, which keep open for long hours. The total number of lamps on the circuit at the end of the year was only 12,000 8-c.p., and it is probable that when the area served is much increased, the revenue per lamp will show a considerable increase.

Hampstead.—The vestry clerk, in presenting the accounts to the Vestry, calls attention to the fact that the period to which they refer includes three heavy quarters, so that the accounts for future years may not be so favourable.

Leyton.—The engines for this installation are worked by a "Dowson" gas plant. The accounts are only for the period between September 8, 1896, and March 31, 1897.

Chelsea.—In the foregoing table I have included the whole population, ratable value, and area, but for the present purpose it is advisable to divide Chelsea and Kensal Town. The figures, therefore, are:

	Population.	Ratable value.	Area (acres).
Chelsea home district	75,196	£710,386	650
Kensal Town district	21,450	69,310	144
Total	96,646	£779,696	794

I have included the Chelsea Electricity Supply Company's accounts in this statement for purposes of comparison. We all know Chelsea and its special circumstances, whereas our information (if we have any) concerning other places is, as a rule, much more superficial. The revenue per lamp obtained in Chelsea is less than in any other metropolitan district. This is accounted for by the fact that in the north-eastern portion of the parish, where most of the company's consumers live, very little current is required for six months in the year. The shops

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TABLE OF INFORMATION AS TO ELECTRIC LIGHT INSTALLATIONS.

The systems in operation are as follow. St. Pancras: Three-wire and five-wire distribution. Pressure to consumers at 220 volts. Islington: Alternating high-tension, with transformer sub-stations in streets. Pressure to consumers at 100 and 200 volts. Hampstead: Alternating high-tension, with transformer sub-stations. Pressure, 105 volts. Leyton: Continuous-current. Three-wire. Ealing: High-pressure alternating-current. Chelsea: Continuous-current, with accumulators and motor-transformers in sub-stations. Pressure, 100 and 200 volts. Brighton: Three-wire system, with batteries, combined with high-tension alternating-current and transformer stations. Halifax: Alternating high-tension current. Cardiff: Alternating high-tension current, with transformer sub-stations in streets, and low-tension distribution. Bradford: Three-wire continuous-current at 460 and 230 volts. Wolverhampton: Continuous-current two-wire system. Transformed from 2,000-volt direct-current. Nottingham: Low-pressure continuous-current, three-wire. Pressure to consumers at 200 volts.

Name.	St. Pancras.	Islington.	Hampstead	Leyton	Ealing	Chelsea	Brighton.	Halifax	Cardiff.	Bradford.	Wolverhampton.	Nottingham.
Population	240,764	336,000	75,449	80,000	30,000	96 646	120,499	94,775	160,690	228,809	86 532	229,775
Ratable value	1,648.134	1,771,420	786,908	217 750	200,000	779,696	760,623	378,933	1,018,000	1,097,661	277,000	900,181
Area (acres)	2,672	3,109	2 248	2 564	3,200	794	2,620	8,209	8,408	10,776	3,525	10,935
Supply commenced	Nov., 1891.	Jan., 1896	Oct., 1894.	Sept, 1896	Oct., 1894.	Sept., 1889	Sept., 1891.	Dec., 1894	Dec., 1894.	Sept., 1889	Jan., 1895.	Sept., 1894
Expended on Site £	19,688	14,291	1,160	—	1,000	26,654‡	7,001	5,541	—	3,141	1,927	10,824
Expended on Buildings £	23,487	30,756	15,821	3,186	9 103	19 179	25,207	11,911	—	17,805	8,011	14,436
Expended on Boilers and machinery £	51,074	20,548	16,968	3,504	10,885	90,632	37,063	12,495	—	29,675	15,405	17,455
Expended on Mains £	74,689	26,776	41,559	8,071	15,668	56,860§	80,075	12 567	—	41 878	8,396	18,946
Total capital expended £	187.136*	102,101*	83,331†	17,038	¶	214,612	178,632	46,229	49,532	108,336	38,216	67,762
Amount borrowed £	153,000	89 150	59,400	15,600	—	210,712	153,614	45,334	32,500	86,202	32,469	72,265
Total cost (working expenses only) per unit sold	3·60d.	4 58d.	3·30d	4·25d.	—	3·08d.	2 04d.	3·57d.	3 06d.	1·81d.	2·71d.	2·17d.
Average price per unit obtained for private lighting	5·34d.	6·42d.	5·60d.	3·74d.	—	5·88d.	4·70d.	5 65d.	5·43d.	4·66d.	5 99d.	5·69d.
Number of consumers	672	—	—	—	—	972	1,366	235	—	—	154	334
Revenue per lamp	9s. 4d.	17s. 3d.	7s. 6d.	—	—	5s. 10d.	8s. 9d.	6s. 9d.	8s. 10d.	7s. 2d.	9s. 10d.	7s. 2d.
Surplus on last year's working £	—	—	1,832	—	—	6,050	5,830	—	—	1,948	—	2,284
Deficit on last year's working £	801	1,836	—	445	—	—	—	801	1,403	—	226	—

* To December 31, 1896. † To March 25, 1897, and accounts are for 15 months. ‡ This includes freehold buildings. § The purchase of the Cadogan Electric Light Company cost £10,238. ¶ As the Ealing accounts are still in the press, the above figures have not been verified.

in Sloane-street mostly close early, and a number of large house in Cadogan-square and neighbourhood are shut up for months before and after the London season. It is probable that as the consumers increase throughout the centre portion of the parish and along King's-road, the revenue per lamp will be increased.

Brighton.—The town of Brighton is known as the pioneer of a new system of charging for electricity, introduced by its engineer, Mr. Wright. By this system the average charge for electricity depends upon the length of time the lamps are used throughout each of the half-years. The average price per unit for early-closing shops, and rooms only used occasionally, amounts to 7d. per unit; but for sitting-rooms, basements, and late-closing shops, to only about 2¾d. per unit. This method of charging is arrived at by an indicator, invented by Mr. Wright, which indicates the maximum number of lamps the consumer has ever had alight simultaneously during the period for which he is charged. The system gives a great advantage to the regular consumer, rather than the consumer who requires a large quantity at odd times.

Bradford.—It is interesting to compare the last year's accounts of the Bradford Corporation with those of the Chelsea Electricity Supply Company. In both places a low-tension system is used, both obtained their order in 1886, and both commenced to supply in 1889. Bradford sold 813,623 units; Chelsea, 813,764. Bradford gross profits were £10,052; Chelsea, £10,351. Both paid £2,301 as interest on loans. After so much in common their differences are instructive. Bradford revenue, £16,195; Chelsea, £20,816. Bradford total costs, £6,143; Chelsea, £10,465. Bradford sets aside for depreciation and reserve £5,803; Chelsea, £2,000. As regards this latter item, I understand that the Chelsea Electricity Supply Company consider it cheaper to maintain their plant to the highest point of efficiency, and therefore allow very little for depreciation.

Kensal Town Electric Lighting.—I have presented the above details in accordance with the directions of the Works Committee, but I am bound to say I do not see that they are of much value as regards Kensal Town. But as the committee are considering whether it would be advisable to undertake the electric lighting of Kensal Town instead of allowing the London and Brush Provincial Electric Lighting Company to obtain an order, I desire to lay before them information which I think may be of some value in considering the question. I do this also because it was understood that I should report upon the question of electric lighting both at Kensal Town and the home district, but as Kensal Town is now before the committee, it might be well to deal with that portion of the district at once, and not discuss the subject twice over.

Information Required.—In dealing with the electric lighting of any district, to enable you to judge whether it is advisable to incur the expenditure of laying down an installation, it is important to know (*a*) the number of lamp connections which will be required within a reasonable time by persons in the district; (*b*) the number of motors which will require to be driven by electricity; (*c*) the estimated amount of the electricity bills which the consumers will pay.

Conditions at Kensal Town.—Now, the above information is very difficult to obtain. Kensal Town contains about 3,000 houses, the majority of which lie north of the canal, on the Queen's Park Estate. Would a large number of persons on this estate use electric light, even if their landlord, the Artizans' and Labourers' Dwellings Company, or some other persons were to undertake to do the wiring free of cost to the tenant? I hardly think so. At any rate, the number would be very small. For we must remember that persons with small incomes greatly appreciate the heat from gas in the winter, and find that it saves firing. A regards shops, which in some districts are good customers to electric lighting companies, we have in Harrow-road about 100, many of them very small. There is also the public library, a church, a chapel, and a public hall. Kilburn-lane also possesses a few shops, but we would only light one side of the road. South of the canal there are the baths and public offices in Kensal-road, but otherwise the demand for current is not likely to be great. A few factories have been erected in this neighbourhood; it is questionable whether they would require power for motors.

Future Conditions if Electricity Supplied.—Of course in estimating the requirements of the district in this manner we are bound to take the condition of affairs as we now find it. In time to come public opinion may go round, or perhaps I should say will go round, and electricity will be used much more than it is. I do not doubt that if the Vestry were to go to the expense of laying mains in every street at Kensal Town, lighting the street lamps by electricity, and supplying what few consumers they could get, and were content to work the installation at a very great loss for many years, they would eventually find that it would pay working expenses, and perhaps interest on the cost of mains, provided that no cheap primary battery is meanwhile invented. But it would take years to accomplish this, and it is questionable whether the sinking of so much capital would be justified under the circumstances.

Partial Installation.—There is, however, an alternative. The Vestry might acquire a site large enough to eventually supply the whole of the district, commence laying mains in a few streets, and wait for the demand to arise before they extended, but in many cases the demand does not arise till the householder finds the mains laid past his door. There are districts where the demand is continually increasing, owing to houses

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being rebuilt, and the character of the neighbourhood altering; but Kensal Town is not one of these districts. The portion north of the canal looks settled for many years.

Local Information to be Obtained.—In order, therefore, to get any reliable figures as to the number of lamp connections and motors, it would be necessary to first ascertain from residents in the district whether they are desirous of using electricity, and, if so, to what extent? whether they would be prepared to have their premises wired should the mains be brought past their doors; and what number of gas-burners are used in the portion of the premises to be lighted by electricity. If this information was only obtained approximately, some basis for calculating the chances of success would exist. At present there is none. It is easy to guess that 10, 20, 50, or 100 premises would require electricity, guess how many lamps they would require, and calculate accordingly; but such estimates are not worth much, though they are often made. Paragraph under "Cost of working and probable return" contains one.

Different Systems.—If, however, the Vestry were to obtain a provisional order, and lay mains throughout the whole of the Kensal Town district, they would have to decide upon the system to be employed. There are high-pressure systems and low-pressure systems, but the first object of any system is to lead the current from the dynamo terminals to the consumers' lamps with the greatest efficiency and the smallest capital expenditure.

High Pressure.—In a high-pressure system it is always necessary to fix a transformer, either in the consumer's house or in a sub-station, to reduce the voltage from high to low pressure. And in this system losses in transformers form a large percentage of the total waste, for the transformers are most efficient at the highest load. An objection to the system is the dangerous nature of the currents employed. A high-pressure system is always most suitable when the electrical energy has to be carried for a long distance.

Low Pressure.—With a low-pressure system the waste is in the conductors, which must be large enough to take the heaviest winter load, but which, when taking that load, are causing the greatest percentage of waste of electrical energy by their resistance to the current. Thus with a low-pressure system the loss at high loads is great, but at low loads is small. This system is quite safe, and most suitable when the district to be served is a small one.

"Three-Wire" System.—The most suitable low-pressure system would be the "three-wire" system, by means of which a great saving in copper is effected, as compared to the simple parallel system, and efficient regulation of the pressure by means of feeders is possible in a district of the size of Kensal Town, without the use of transformers or motor-generators.

Capital Expenditure.—The very lowest cost of such an installation would be:

Site	£3,500
Buildings	6,000
Boilers, machinery, and electrical apparatus	10,000
Mains and feeders laid complete	12,000
Provisional order, fees, instruments, and incidental expenses	4,500
	£36,000

Cost of Working and Probable Return.—The annual cost of working such a station, when it is in thorough working order, with a fair load, should not exceed 4·5d. per unit sold, that is, of course, making no allowance for repayment of capital. After some years' working, the number of units sold annually might possibly be:

	Units.
Public lamps having two 16-c.p. incandescent lamps in place of existing gas-burners	90,000
Public buildings	8 500
Shops, 20 at 480 units	9,600
Private houses, 60 at 120 units	7,200
Various buildings	4,700
	120,000

98,500 units to public lamps and buildings at cost of production, say, 4½d. per unit	£1,846	17	6
21,500 units to consumers at 6d.	537	10	0
	£2,384	7	6
Cost of production of 120,000 units at 4½d.	2,250	0	0
Profit on working	£134	7	6

There is, however, nothing allowed for interest on capital; and as regards the public street lamps, the substitution of two 16-c.p. incandescent lamps for the existing gas-burners causes an increase in the annual expenditure of £1,150, the cost of electric current (apart from lamp renewals) being £1,688, against £530 now paid for gas. This in itself is a serious annual addition to the Vestry's lighting bill. The number of units from shops and private houses seems small, but I think they would be for some years. Probably at first the shop window and a few lights in the shop would be installed more to attract customers than from any seeming advantage by their use; but in time lights would increase, and new demand for current would arise.

Which Suitable at Kensal Town.—Kensal Town is a small district. With a generating station alongside the canal, no lamp would be more than 900 yards away from it. The people to be served are mostly a working-class population, and cannot afford to have more lamps burning at one time than is absolutely necessary; the proportion of lamps burning at one time to those installed might, therefore, be very small, and consequently low loads would often prevail. On account of the smallness of the area, and the nature of the demand, I am of opinion that a low-pressure system would be most economical in working, especially if the Vestry were to lay mains throughout the entire district.

Brush Company's Offer.—It will be noticed that the company applying for the provisional order are proposing to supply current at a much less cost than I have estimated. This is accounted for by the fact that they are proposing to distribute the energy from their existing generating station, and, therefore, the additional annual expenditure would be small, and the capital outlay principally confined to mains.

Objections to Partial Scheme.—As regards a smaller scheme, I do not see what could be done with any satisfactory results. It would not be worth obtaining a provisional order to light the baths, public offices, and Harrow-road only; but directly you get north of Harrow-road, there seems no reason why one street should not be wired as much as another. In Chelsea we have streets with large houses lying near streets with small houses; the electric lighting company wire the former, and let the latter remain untouched until some prospect of demand for current arises; but at Kensal Town the houses are all small, and there is no reason for picking and choosing. If mains are laid in A street, there seems no reason why we should not follow the alphabet through Queen's Park Estate till we come to P street. In designing your generating plant and station, it is much more satisfactory to have your station large enough to accommodate the whole of your plant when the installation is quite complete. It does not pay to put down a small plant and have to take it out and put in a larger one as the load increases. For these and other reasons it does not seem advisable to commence supplying in a very small district if the Vestry really intend to extend their operations over the whole district. If they intend to do so, it had better be all done at the same time.

Dust Destructor.—It seems now impossible for any report on an electric lighting installation to leave out the mention of a dust destructor. An idea was started some years ago that electric light could be produced for nothing by means of this appliance, and many people believed it. From that time the destructor is generally included in the reports of electric lighting installations, though not often in the installations. I have before alluded to St. Pancras destructor and its assistance to the electric installation; there is, however, another destructor to which attention has been lately called—namely, Shoreditch. The speciality, however, is not the destructor, but the "thermal storage," which is no part of a destructor, but might be used with coal if desired. It has, however, only lately been started, and is being watched with interest, but the results of the working cannot be available for a few months and of the maintenance of the thermal storage apparatus for a year or two. At present, however, it is net well to be too sanguine. As regards the ordinary destructor, it is not in favour at electric lighting stations. The best coal, the best engines, and the best stokers are found to be the most economical in the end. Refuse is notoriously uncertain in character, and when, at times of full load, the engines are expected to do their best, a few loads of badly-burning refuse might lead to unsteadiness in the light, and good stokers have no liking for burning refuse instead of coal. Of course, the Kensal Town dust would not be enough to keep the installation going if the whole district was to be lighted. Ordinary furnaces would have to be used to work independently of refuse. I do not, therefore, think that it would be an advantage to include a dust destructor in any scheme for electric lighting, especially where local feeling is said to be so strongly adverse to it. A dust destructor is an excellent appliance for the destruction of refuse in a sanitary manner, but where steam raising is put first and refuse destruction second it is not being used for the purpose for which it was intended.

Procedure with regard to Application and Order.—As regards the application of the London and Brush Provincial Electric Lighting Company now before the committee, this company ask the Vestry to give their consent to their application for a provisional order. If they give their consent a resolution to that effect must be passed at a special meeting held after one month's notice of the same. If they object, they must do so before January 15. Their consent is not absolutely necessary to an order, but if they object, the company will have to apply to the Board of Trade to overrule the Vestry's objection. If the Vestry desire to obtain a provisional order themselves, they will, in order to successfully oppose the company's application, have to show the Board of Trade that they intend to make application for a provisional order during the next session.

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CONTRACTS FOR ELECTRICAL SUPPLIES

CONTRACTS OPEN.

Ploesti (Roumania).—Tenders are invited for lease of lighting the town by electricity for a period of 40 years, also for power transmission purposes. Particulars may be obtained on application to the Municipal Authorities at Ploesti. Tenders by Nov. 27.

Ayr.—The Corporation invite tenders from firms willing to undertake the free wiring of premises in the streets of the burgh. For full particulars as to districts in which the mains are laid, apply to Mr. Arthur J. Fuller, burgh electrical engineer. Tenders, with full description of scheme and terms, must reach Mr. A G. Young, town clerk, by November 11.

Melbourne (Victoria).—The Agent-General for Victoria, 15, Victoria-street, Westminster, invites tenders for the supply of electric light cables and fittings, for the Railway Department of the Colony. The specifications and conditions of contract can be obtained at above address, where tenders must be delivered by November 10, addressed to the Victorian Railways Commissioner, accompanied by a preliminary deposit of £20 enclosed in a separate envelope addressed to the Agent-General. The tenders will be opened at Melbourne on December 20.

Burnley.—The Corporation invite tenders for the supply and delivery at their electric lighting station of lead-sheathed, armoured underground cables. Specification, schedule of quantities, and form of tender may be obtained on application to Mr. W. R. Wright, borough electrical engineer, on payment of a deposit of £1. 1s., which will be returned on receipt of a bona fide tender. Sealed tenders, endorsed "Tenders for Cables," and addressed to the Chairman of the Electric Lighting Sub-Committee, Town Hall, Burnley, must be delivered by November 17.

Singapore.—The Municipal Commissioners of the town of Singapore, Straits Settlement, invite proposals for the lighting of the public street lamps for five years from January 1, 1899. Tenderers may submit proposals for lighting by gas or oil, or partly with one illuminant and partly with the other. Further particulars may be obtained on application to Mr. C C. Lindsay, M.I.C.E., 167, St. Vincent-street, Glasgow, or to Mr. J. Polglase, secretary to the Municipal Commissioners of Singapore, Singapore. Tenders may be sent either to Mr. Lindsay, up to November 30 next, or to the Secretary up to December 31.

Queensland (Australia).—The Municipal Council of Ipswich, Queensland, is inviting tenders for the supply and erection of the following electric lighting plant, etc.: tubular boilers, pipes, pumps and heaters, alternators and exciters, switchboard, high and low tension mains, junction boxes, transformers, etc. Specifications and all particulars as to conditions, etc., may be obtained from Messrs. Gordon and Gotch, St. Bride-street, Ludgate-circus, London, E.C., and tenders have to be forwarded to the town clerk (Mr. Albion Hayne), Council Chambers, Ipswich, Queensland. Tenders by November 15.

Hull.—The Corporation are advertising for tenders for the electrical equipment of their tramways, to the extent of about nine miles double track and half mile single track. It will be open to contractors to submit tenders for various systems, and the contract, which will not be divided, will include engines and generators, switchboards, feeders, poles, brackets, trolley wire, rail bonding, and all accessories, also the first instalment of cars (15 motorcars and five trailers). Copies of specification, etc., may be obtained from Mr. A. E. White, city engineer Town Hall, Hull, by persons proposing to tender, upon payment of a deposit of £10, which will be refunded upon receipt of a bona fide tender and return of the papers and plans supplied. Cheques to be made payable to Mr. Thos. G Milner, city treasurer. Tenders, endorsed "Tender for Tramway Equipment," are to be addressed to the Chairman of the Works Committee, and delivered at the Town Clerk's Office, Hull, before noon to-day.

Blackpool.—The Corporation are prepared to receive tenders for the following works required in the conversion of their present system of electric traction: (Section A) steel columns, brackets, and straining posts; (B) trolleys, trolley wire, and insulators; (C) controllers, motors, and gearing; (D) main and section fuses. Tenders will be received for one or more sections, but not for part of a section. Specification, general conditions, and form of tender may be had on application to Mr. Robt. C. Quin, borough electrical and tramway engineer, Corporation Electricity Works, Blackpool, on prepayment of £2. 2s. which will be returned on receipt of a bona fide tender upon the prescribed form, and within the stated time. Drawings and plan of route may be inspected at the office of the Borough Electrical Engineer during the usual office hours. Sealed tenders, addressed to the Chairman of the Electric Lighting and Tramways Committee, and endorsed "Tender for Traction Material, Section —," to be delivered to the Borough Electrical Engineer by 10 a.m. on November 22.

Madras.—Tenders are invited for the utilisation of water flowing from the Periyár Lake for purposes other than irrigation and not incompatible with the use of the water for drinking. The irrigating season extends over nine to ten months, during which time the discharge is likely to be from 1,100 to about 500 cubic feet a second, according to the demands for irrigation and the available quantity in the lake. Subject to the risk of interruption by accident or drought, supply can be given throughout the irrigation season. No supply can be guaranteed at other times, but, so long as water is available, the Government will be prepared to issue it in such daily quantities as may seem to it advisable with reference to the time which is likely to elapse before the supply is replenished by the setting in of the rains. The fall from the tunnel to the foot of the hills is approximately 900ft., and the distance measured along the course of the stream about 6,800ft. One cubic foot per second falling 900ft. is estimated to produce over 60 effective horse-power. Intending lessees should state the quantity of water required in cubic feet per second and the annual rent offered for each cubic foot per second. No rent will be charged for the first year from the date of the concession; for the second year the charge will be one-fifth, and an additional charge of one fifth will be made every year until the full rent is reached. The whole or part of the concession may be surrendered on a year's notice being given. Lessees will construct at their own expense, on plans to be approved by Government, all the weirs and other works required to divert the water from the river below the tunnel. For further information, application may be made to the Chief Engineer for Irrigation, Madras, by whom tenders will be received up to July 1, 1898.

RESULTS OF TENDERS.

Llandudno.—The Urban District Council have accepted the following tenders for work in connection with their electric lighting and dust destructor station:

Babcock and Willcox, water-tube boilers	£2,504	10	0
Sunderland Forge Company, condensing plant, steam plant, etc.	1,536	10	0
India Rubber and Gutta Percha Company, steam-engines and dynamos	3,235	0	0
White and Co., switchboard	635	0	0
Pritchett, battery	856	0	0
Sunderland Forge Company, travelling crane	75	0	0
Henley, underground mains	5,123	1	0
Crompton, arc lamps, posts, etc.	1,229	18	0

BUSINESS NOTES.

Stourbridge.—The Urban District Council have decided to take steps to purchase a suitable site for the erection of a refuse destructor.

Torquay.—Mr. Storey has been elected engineer in charge of the electric lighting works of the Town Council, upon the recommendation of Prof. Ayrton.

Montrose.—The Council have decided to transfer their provisional order to Messrs. Edmondson. The deed of transfer will be advertised shortly.

Cuba Submarine Telegraph Company.—For the month of July the receipts were £2 926, as against £4,766 for the corresponding period of 1896.

Dewsbury.—At the final meeting of this Council for the official year the Council decided to place electric arc lamps in New Bridge and other thoroughfares.

Branch Office.—The British Thomson-Houston Company, Limited, have opened a branch office at 63A, St. Vincent-street, Glasgow, in charge of Mr. M. H. Bennett.

West India and Panama Telegraph Company.—For the two weeks ended October 31 the receipts were £2,028, as against £2,394 for the corresponding period of 1896.

Removal.—The Tudor Accumulator Company, Limited, have removed their offices to 16, Victoria street, London, S.W. Their works will be, as heretofore, at Dukinfield, near Manchester.

Paisley.—The first sod of the new electric light works at Blackhall was cut last week. It is intended that the work should be finished by next winter. The estimate is between £40,000 and £50,000.

Cannock.—A special meeting of the Urban District Council will be held this month to discuss the question as to whether the Council should obtain a provisional order for lighting the district with gas or electricity.

City and Guilds Technical College.—A special course of six lectures on electric traction, by Mr. Philip Dawson, M.I.E.E., A.M.I.C.E., etc., will commence on the 11th inst. at the College, Leonard-street, City-road, E.C.

Agency.—We are informed that Messrs. Ludgate and Co., Manchester, have been appointed sole agents for Lancashire and Yorkshire for Riley and Winstanley's patent automatic constant level sight-feed lubricator for gas and oil engines.

Brussels International Exhibition.—We note that a gold medal has been awarded to the Horsfall Furnace Syndicate for patent refuse destructors, and a bronze medal for a patent smoke-consuming boiler furnace, both patented by that firm.

Lytham.—On the morning of the 26th ult, at the height of the tide, an electric barge, which has been built at the yard of the Lytham Shipbuilding Company, was successfully launched. The barge is built for Messrs. Lever Bros., of Port Sunlight.

Gateshead.—The Committee's recommendation that the Council approve the action of the Visiting Committee in arranging for the electric light in the Winterton annexe of the asylum, at a cost of £2,780. 16s. 6d., was agreed to at the last meeting of the Town Council.

Waterloo.—With regard to the electric lighting of the streets, on the 2nd inst. the attention of the District Council was called to the desirability of lighting some of the principal streets of the district by electricity. It was resolved that tenders be obtained for five lights.

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Western and Brazilian Telegraph Company.—The receipts for the past week were £3,048. The directors recommend a dividend at the rate of 2 per cent. per annum, tax free, for the six months ended June 30.

Bromley.—As no objection was raised at the meeting of the Urban Council to the proposed electric lighting last week, and the official month having expired, it is presumed that the agreement has now been submitted to the Board of Trade, and that no obstacles will be presented.

Reigate.—An Exchange says: "As the Town Council of Godalming has decided to proceed with a scheme for lighting the borough with electricity, the borough of Reigate is now the only municipality in Surrey which has neither introduced the electric light nor completed arrangements for doing so."

Newington.—Considerable discussion took place at the last meeting of the Vestry upon the comments made by certain newspapers with reference to the Newington Electric Lighting Committee's visit to Brighton and Portsmouth. Ultimately, a report from the town clerk, in which the expense incurred was explained, was received.

Harrogate.—In connection with the application of the Corporation to borrow the sum of £17 500 for the purpose of extending the electric lighting scheme, Major-General H. D. Crozier, R E., Local Government Board inspector, held an enquiry into the matter in the Council Chamber, at the Municipal Offices, on Wednesday last.

Saint George's (Hanover-square).—A report will be presented to the Vestry to-day from the Works Committee stating that they have received notices from the Westminster Electric Supply Corporation, Limited, and from the London Electric Supply Corporation, Limited, of the corporations' intention to lay mains in various streets, as per plans submitted, and have offered no objection to the work.

St. Marylebone.—At the last meeting of the Vestry it was unanimously decided to give formal intimation to the Board of Trade and the Metropolitan Electric Supply Company, Limited, who already supply some of the private houses in the district, of the Vestry's intention to apply for a provisional order for supplying electric energy for public and private purposes in the parish of Marylebone.

Personal.—Mr. Wm. Ernest Brandreth, of Preston, at present assistant engineer at the St. Luke and Clerkenwell stations of the County of London Electric Lighting Company, has been appointed shift engineer at the Hammersmith Vestry electricity works.—Mr. L. G. Trundle, at present employed at the public infirmary, Mansfield, Notts, has been engaged by the Llandudno Council as clerk of works at the electric light and destructor buildings.

Wolverhampton.—At a special meeting of the Town Council held last Friday, a letter was read by the Town Clerk from the Midland Electric Lighting Corporation, Limited, notifying to the Council their intention to apply to the Board of Trade during the next session of Parliament for power to supply electric energy within the borough. The Town Clerk added that he had acknowledged the receipt of the letter, and taken instructions to watch the proceedings.

Cork.—The Corporation unanimously adopted the report of the city engineer and of the Committee on Electric Lighting at their meeting on the 3rd inst. The report provides, in addition to 32 glow lamps, for 96 arc lamps, to be placed in the main streets. On each of the latter, two 32-c.p. lamps are fixed, which will be turned on after midnight. The current is to be supplied by the Cork Electric Tramways and Lighting Company at an inclusive cost of 2½d. per unit.

St. Mary, Islington.—The notice paper for the Vestry meeting of November 5 contains a report from the Electric Lighting Committee stating that it has considered a reference from the Works South-Eastern District Sub-Committee suggesting the advisability of substituting electric light for gas on the refuge in St. Thomas's-road, opposite the postal sorting office, and recommending that an arc lamp be fixed at the position mentioned at an estimated cost of £103. 6s. 8d.

Lancaster.—The minutes of the Electricity Committee state that from the comparative statement presented by the engineer it appeared that consumption of electricity had increased 30 per cent. compared with the corresponding period in 1896, and there had also been a similar increase compared with the previous year. Therefore, the committee were quite justified in asking the Council to make the extension that they did a short time ago. The minutes were confirmed by the Town Council.

Coventry.—At a recent meeting of the Town Council the Corporate seal was affixed to a conveyance to the Coventry Electric Tramways Company of a piece of land near Priestly's Bridge, Stoney Stanton-road; purchase money, £800. In reply to a question, it was stated that the work being carried on by the Electric Light Committee was contracted for. It had proceeded slowly, but a letter from the contractors stated that the delay was due to the non-delivery of some of the troughs, which were now on the way.

Greenwich.—The committee have reported to the District Board of Works that, in connection with the reference to them of the question whether it was desirable or otherwise (so far as Greenwich was concerned) for the Board to retain powers for the supply of electricity in their own hands, they had engaged the services of Mr. A. H. Preece, A.M.I.C.E., and had received from him a report on the subject of establishing an electric supply station in Greenwich. The report was referred to the District Committee for consideration.

Limehouse.—The report of the committee who recently visited the Shoreditch dust destructor works has been referred to the Works Committee, and the clerk has been requested to write to the Shoreditch Vestry asking what were the working expenses, and also thanking the Vestry for the permission accorded the Limehouse members to inspect the works, and to the engineer for the courteous manner in which he received the visitors and explained the various operations.

Aston.—The Highways and Buildings Committee of the Aston District Council report that they have retained the services of Mr. Vaudrey, electrical expert, to advise them in regard to the electric lighting of the town, and that, acting in accordance with the regulations of the Board of Trade, which require the Council to select and advertise the streets or roads they propose to electrically light within the next two years, an inspection of the district has been made, and the streets or roads they have selected to electrically light are as follows: Aston-road, Lichfield-road, High street, Birchfield-road, Lozells-road, and Victoria-road.

Rawmarsh.—A special meeting of the Urban District Council was held at the Council Offices, Rawmarsh-hill, for the purpose of receiving a recommendation of an Electric Lighting Sub committee. The following resolution was carried: "That the Electric Sub-Committee have authority to instruct Mr. W. M. Gichard to prepare the necessary notices, memorials, etc., and to apply to the Board of Trade for powers to supply electricity for lighting and other purposes within the parish of Rawmarsh, if the reply from his parliamentary agent is favourable."

Kent.—Two companies have recently been registered, one under the title of the Folkestone District Electric Railways Company, Limited, with the object to construct, lease or otherwise acquire, equip, maintain, and work with electrical or other power, any light railways or tramways at Folkestone or elsewhere in Kent; and another as the Rochester, Chatham, Gillingham, and District Electric Railways Company, Limited, with the object to construct, lease or otherwise acquire, equip, maintain, and work by electrical or other power any light railways or tramways in the county of Kent or elsewhere.

Lincoln.—At the last meeting of the Town Council it was stated that Mr. C. S. Vesey Brown (electrical engineer) explained three different schemes for lighting certain parts of the city with electricity, and the Council was recommended to agree to the lighting of the portions of streets comprised in scheme No. 1—viz., 27 arc lamps, High street from The Strait to Portland-street, Guildhall-street, and Newland to opposite Park-street, Silver-street from High-street to Broad-gate. The subject was referred to the Lighting, Building, and Improvement Committee.

Middleton.—The last meeting for the municipal year of the Town Council was held on the 27th ult., and a recommendation of the Gas and Electric Lighting Committee for borrowing powers to the amount of £18,500 for important additions to the works was passed. A letter was read from the British Electric Tramway Company announcing that it was their intention, under the Light Railways Act, to apply for powers to erect an electric tramway from Castleton to Middleton and Rhodes, and from Middleton to Oldham. The tramways would be on the overhead-wire system. A committee was appointed to consider the matter.

Commissioners of Sewers.—At this week's meeting the solicitor reported that he had accepted a writ on behalf of the Commissioners issued for the City of London Electric Lighting Company to recover in the Queen's Bench Division of the High Court of Justice the sum of £6,473. 11s. 8d. The Chairman said the suggestion before the Court was practically that the solicitor should be instructed to defend the action. He added that the company had refused to accept the offer of the balance, the only amount in dispute being £1,142 It was in reality a very simple matter; it was not a dispute over the whole amount. After some discussion, the Court resolved to leave the matter in the hands of the solicitor.

Dover.—The Surveyor has presented a further report to the Town Council on the testing of the electric light. He pointed out that other towns do not test the candle-power, relying on the requisite amount of energy being supplied to the best form of lamp known. Mr. Dibden, with whom he had been in communication, had presented a report on the subject to the London County Council and it showed, as the result of tests, that the efficiency of lamps was not up to what was specified. The cost of one test with a radial photometer would be £10 10s. and travelling expenses, and the cost of the appliances to purchase would be £90. It was agreed that a test be made before the Council decided to purchase an apparatus.

Leatherhead.—On the recommendation of the General Purposes Committee, the clerk has been directed by the Urban District Council to insert in the draft advertisement *re* electric light—Bridge-street, Church-street, High-street, Epsom-road, North-street, Station-road, Kingston-road (part), and the road between the two railway stations only—as roads in which electric lines should be laid down within a specified time. It has been decided to write to the National Telephone Company informing them that they could not erect posts without the consent of the Council. The estimates for the half year ending Lady Day contain the following items: electric light, £100; lighting, £335; salaries, £155; allotments, £12 10s.; working balance, £200.

The City of London Electric Lighting Company, Limited.—The revenue return of this Company for the quarter ended September 30, 1897, gives the gross revenue from sale of current for public lighting as £3,146, compared with corresponding quarter last year, £3,158; the revenue from sale of current for private lighting, etc., £21,978 (£17,274); the revenue from other sources (estimated), £1,000 (£750); making a total of £26,124

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(£21,182), which shows an increase of £4,942. The equivalent of 8-c.p. lamps connected on September 29, 1897, was 278,162, which is an increase during the quarter of 7,264; the equivalent of 8-c.p. lamps connected on September 30, 1896, was 228,740, an increase during corresponding quarter last year of 13,181.

Shoreditch.—The Board of Guardians reported at their last meeting that the House Committee, having gone thoroughly into the question of electric lighting with Mr. Doughty, the Vestry's electrical engineer, the cost of electricity as an illuminant, apart from the first cost of the installation, was estimated at £1,087, and it would probably exceed the cost of gas by about 10 per cent. At the present stage of public supply, the committee were of opinion that it was undesirable to proceed with the project, and recommended that the question be deferred for the present. This was agreed to after discussion, during which a statement was made that the chairman of the Vestry had said that they hadn't an ounce of refuse to burn at the destructor and they were burning all coal.

Tipton.—The Council have held a special meeting to consider the advisability of applying for a provisional order for electric lighting. The Clerk read a report of a joint conference of local authorities on the subject, and a lengthy letter from the Board's solicitor describing the procedure of obtaining a provisional order. It was also stated that two companies had given notice of their intention to apply for powers to supply electricity in the Tipton district. In the course of a brief discussion the opinion was freely expressed that it would be the Council's duty to see that no private company obtained over the local authority powers to provide electric lighting, and it was decided that the Council should oppose the application of the private companies to obtain a provisional order, and to grant an interview to the representatives of the company.

Bolton.—A special meeting of this Council was held last week, at which it was decided to promote a parliamentary Bill for a very wide extension of the borough boundaries, which will involve annexation of eight townships and add 40,000 to the population of the town, making Bolton the third town in Lancashire. The scheme also includes the introduction of electric trams and other improvements.—Owing to a fire caused by the fusing of the wires at the electricity works on the 2nd inst., the town, so far as the electric lighting was concerned, was placed in darkness, the whole supply being cut off. The result proved very inconvenient, the streets, public buildings, hotels, tradesmen's establishments, and the clubs being practically unlighted. No serious damage resulted from the fire, but considerable confusion was caused in the town.

Cheddleton.—At the last meeting of the Staffordshire County Council the County Lunacy Committee submitted a report regarding the Cheddleton Asylum, the Council being recommended to approve the acceptance of the tender of Messrs. Mavor and Coulson, Limited, for supplying electric generating and storage plant, and to provide a sum not exceeding £6,940 to include engineer's fees, etc., and the tender of the Walsall Electrical Company, Limited, for supplying electric wiring and fitting and to provide a sum not exceeding £3,430 to include engineer's fees, etc. It transpired the tenders had been accepted by the committee on the advice of the engineer. It was moved that the recommendations be referred back and the tenders advertised for; and the committee withdrew the recommendations after the amendment had been withdrawn.

West India and Panama Telegraph Company, Limited.—The report for the half-year ended June 30 states that the amount to credit of revenue is £38,209, against £42,317 for the corresponding half-year of 1896, and the expenses have been £21,426, against £22,280, leaving a balance of £16,763, which, with £646 brought from last account, makes a total of £17,429. The directors propose a dividend on the ordinary shares of 1s. per share, tax free, leaving a balance of £1,243 to be carried forward. The traffic receipts for the six months show a decrease of £3,124 as compared with the corresponding period, which is chiefly due to the tariff reductions the directors were compelled to make to retain the traffic over this company's system. The expenses of repairing cables during the half-year amounted to £8,764, being practically the same as those for the corresponding period.

Camberwell.—The report of the Electric Lighting Committee, submitted to the Vestry yesterday, stated that the committee has received statutory notice from the London Electric Supply Corporation that after the expiration of one month it intends to lay high and low tension distributing mains in the Camberwell-road. The Vestry in November, 1893, applied to the Board of Trade to revoke the order granted to this corporation, as it had failed to lay mains within the compulsory area during the prescribed two years. The Board of Trade, however, did not comply with this request. The committee has referred this matter for consideration to a sub-committee, and recommends that the Board of Trade be asked to stay any action being taken by the London Electric Supply Corporation pending the Vestry's further consideration with regard to the revocation of the order.

Worthing.—At the meeting of the Electric Lighting Committee a letter was read from Prof. Kennedy saying that since his report to the Corporation of November 4, 1894, an important improvement in the manufacture of incandescent electric lamps has been made; and having, in accordance with the committee's request, reconsidered his estimate for the proposed works in the borough, and the cost at which they could be carried out on the system which had now become possible, he finds that a saving exceeding £4,000 may be effected, and a further sum of over £400 per annum at the commencement in the annual cost. It was resolved, before submitting any recommendation, to ascertain as far as practicable what number of the inhabitants resident within the compulsory area were prepared to take the electric light at or below the terms stated in the Council's order.

Brierley Hill.—At the last meeting of the Brierley Hill District Council, a report was presented showing that the Tramways Committee of the Council had met two representatives of the British Electric Traction Company, and the resolution of the Council insisting upon the company taking their electric current from the Council was thoroughly discussed. It was pointed out to the committee that if it was insisted upon it would probably result in the abandonment of the scheme for the electrical equipment of the local tramways, and if the Council would withdraw the resolution the company would erect a power-house for generating electricity in the Council's district. The committee recommended the Council to rescind their resolution. The committee's recommendation was adopted, and the Council instructed the clerk to attend the enquiry at Dudley to support the company in their application for powers.

Direct West India Cable Company.—The Direct West India Cable Company, Limited, has, the prospectus states, been established to take over and carry out an agreement entered into between the British Government and the Halifax and Bermudas Cable Company, Limited, for the laying and working of a submarine cable from Bermuda to Jamaica, *vid* Turk's Island, for which her Majesty's Government undertakes to give a subsidy of £8,000 a year for 20 years. The Company's authorised share capital is £120,000. The Jamaica Legislative Council have, it is stated, adopted the report of a select committee in favour of that colony granting an annual subsidy of £2,000, and the Company will apply for its being carried into legal effect. A contract for construction and laying has been entered into, and the directors believe that a profitable business will be at once obtained.

St. Mary Abbotts, Kensington.—The report of the Works and Sanitary Committee, submitted to the Vestry yesterday, states that notices and plans have been received from the undermentioned electric lighting companies relative to extensions of their mains in this parish—viz: Notting Hill Electric Lighting Company—Ladbroke-grove by Cornwall-road, Clanricarde-gardens, Brunswick-gardens, and Ladbroke-grove by Hanover-terrace; House-to-House Electric Light Supply Company—Cromwell-road, Fulham-road, and Cheniston-gardens. Also an application from the National Telephone Company applying for permission to place telephone wires underground in certain streets as shown on plan submitted, and pointing out that the object of the application was that practically all routes of overhead wires might be removed, and only the necessary overhead distributing stations maintained. The committee recommended that permission be given for the works to be proceeded with subject to the usual conditions.

Llangefni.—At the last meeting of the Anglesey County Council the Clerk, in reply to a question whether he had any communication from Mr. Theophilus Rowland with regard to the proposed electric tramway, said that all he knew was from what he saw in the papers as to the railway. A member stated that he met Mr. Rowland and discussed the matter. The promoters had lodged an application with the Commissioners. The application would be considered in November, and doubtless the department would open an enquiry, and to such enquiry they would have to go if the proposed railway was not satisfactory to them. They intended proceeding with the line to Beaumaris in five months. The Chairman said the electric tramway people made applications for powers to go from Valley to Amlwch and to Pentraeth. Should they not go to them and tell them they could not take it in sections, but proceed with the whole scheme? The members at this point commenced to leave, and no decision was come to.

Appointment Vacant.—The Glasgow Corporation invite applications for the position of chief resident engineer of their electricity department. Applicants, besides possessing practical experience in all matters relating to electricity, must be specially qualified to prepare designs and specifications for, and to carry out the construction of, generating stations and the laying down of mains and all other works necessary for the production and distribution of current for lighting and motive power, and to take the entire general management of the department. The salary will not be less than £800 per annum, but the successful candidate will require to devote his whole time to the duties of the office. Applications, stating age and experience, accompanied by 20 printed copies of not more than six testimonials of recent date, to be lodged with Mr. J. D. Marwick, town clerk, City Chambers, Glasgow, marked "Electrical Engineer," by 9th inst. Canvassing will disqualify applicants.

Glasgow.—Joint sub-committees representing the tramway, the watching and lighting, and the electricity departments of the Glasgow Corporation met recently to discuss the lighting on the new electric tramway route between Mitchell-street and Springburn. The meeting decided to recommend the parent committees to adopt three different systems of lighting—that of spanning the street with cross-wires affixed to the buildings, poles on either side of the street, and poles in the centre with overhanging arms.—The Sub-Committee of the Corporation on electric traction agreed to recommend, at a meeting held on the 2nd inst., the acceptance of the tender by the Westinghouse Electric Company, an American firm, for fitting up the new electric tramway route between Mitchell-street and Springburn. The offer amounts to £19,657, and includes the electric plant for the route, the supply of engines, dynamos, wires, etc. There were seven offers altogether, all by American firms, and the one accepted is the lowest.

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Hackney.—A special meeting of the Hackney Vestry was held on Wednesday last to rescind the resolution dated October 12, 1892, which was "That, having carefully considered the subject of the reference made to them, they are of opinion that it is very desirable that the electric lighting of the district should not pass into the hands of private persons." The rescinding was ruled to be necessary in order that Mr. H. Hulland could move "That the joint committee of the Public Health Committee and Electric Lighting Committee be empowered to submit a proposal for the transfer of the Hackney electric lighting order." After a lengthy debate it was agreed to modify the last resolution to read that the joint committee mentioned above should be instructed to draw up a report on the electric lighting and dust destruction in the parish, showing the advisability of the various alternatives open to the Vestry in dealing with the above subjects. The Chairman then ruled that the rescinding of the old resolution was unnecessary.

Belfast.—The bi-monthly meeting of the Harbour Commissioners Board was held on the 3rd inst The minutes of the general meeting, which were read by the secretary, contained a resolution recommending the confirmation of a scheme for the electric lighting of the harbour, and that, in accordance with the recommendations of the engineer and the electrical engineer, tenders for a portion of the plant in connection with the scheme be accepted, provided these tenders were lower than the estimate. These minutes were confirmed. The expense, it was estimated, will be about £11,000, and, with maintenance, would entail a charge upon the estate of about £1,250 a year more than they were paying for gas lighting. For the extra expenses, however, 165,000 c.p. light will be obtained, instead of 11,200. The result will be to give the electric light to the York and Dufferin Docks and to the Albert and Alexandra Quays, a facility which must certainly prove for the advantage and benefit of the trade of the port.

Blackburn.—The Town Council, at its last meeting, approved the scheme and estimate of the electrical engineer for the lighting of Preston New-road and Witton tramway routes with the electric light from the posts carrying the overhead line of the electric tramways. A communication was received from the New Mutual Telephone Company, Limited, Manchester, asking the Corporation to pass a resolution urging the Post Office authorities to allow competition in the telephone service, and intimating that the company would be prepared to extend its operations to Blackburn. The matter was referred to a sub-committee. Complaints having been made of the inefficiency of the telephone trunk line service, the town clerk was directed to call the attention of the Postmaster-General to its inadequacy and press for improvement. On the report of the Finance Committee, it was decided to raise £7,343 for street improvements, £7,978 for main sewers and storm overflow works, and £6,800 for the provision of gas-meters, by the issue of nominal debentures bearing interest not exceeding £3 per cent. per annum.

Catalogues.—We have received from Messrs. Robert Stephenson and Co., Limited, engineers and shipbuilders, Newcastle-on-Tyne, a catalogue of their "Rocket" oil-engines, containing various information, referring to trials, applicability, etc. Amongst its chief advantages are stated that it is easily started, has a small oil consumption, and that all parts are accessible and interchangeable. The manufacturers claim that the "Rocket" (Kaseloveky's patent) oil-engine is specially suitable for electric lighting, and that they can undertake to supply the complete plant, consisting of engine, dynamo, measuring instruments, wiring and lamps, switches, etc., suitable for country mansions, shops, or business premises.—Messrs. Howard B. Little and Co, Shaftesbury-avenue, send a list of radiographic apparatus, accessories, and parts. Having carefully modified the designs of their various apparatus, and being more royal than the king, the firm guarantee every apparatus to give a longer continuous spark than quoted by them as its maximum. Inventors wishing for technical advice, or requiring models made, are invited to apply to Mr. Little, who states that, assisted by experienced draughtsmen and skilled mechanics, he is in a position to further their aims in all such matters.

Light Railways.—Notices have been given of intention to apply for powers, etc., to construct light railways between the Metropolitan Railway station, Finchley-road, Hampstead, and the adjoining suburbs of Finchley and Hendon, by the Finchley District Electric Traction Company, and from the tramway terminus at Acton-hill, through Ealing, and terminating at Hanwell-broadway, by the British Electric Traction Company, Limited.—The Light Railway Commissioners held an enquiry at Helston last week respecting an application for powers to make a light railway from Helston to the Lizard.—A scheme has been set on foot for securing the sanction of the Light Railway Commissioners for the formation by private enterprise of light railways along the London-road and Lewes-road valleys of Brighton, and from the top of North-street along Dyke-road. The scheme has not yet been before the Town Council.—The Denbighshire County Council have decided to apply to the Light Railway Commissioners, under the provisions of the Light Railways Act, 1896, for an order authorising the Council to advance £3,000 to the Tanat Valley Railway Company. In reply to a question it was said that the Montgomeryshire County Council had agreed to subscribe £2,500 to the company.

Fulham.—The report of the Lighting, Electric Lighting, and Dust Destructor Committee of the Vestry, referred to in our last issue, states: "Having carefully considered the reports of the deputation appointed by the Vestry to visit and report upon the destructors in operation at Oldham, Warrington, Cambridge, and Southampton, we have accepted and approved of the majority report. Before coming to a definite decision, we concur in the opinion expressed in the majority report of the deputation that it is advisable to obtain designs, specifications, and prices for carrying out their proposal, and we have therefore instructed the surveyor to write to the Horefall Refuse Furnace Company, Messrs. Beaman and Deas, Messrs. Meldrum, Messrs. Manlove, Alliott, and Co., and Messrs. Goddard, Massey, and Warner, for designs, specifications, and prices for the erection of a dust destructor, chimney shaft, buildings, etc., on the Town Mead-road site capable of dealing with 60 tons of house refuse per day, together with boilers to produce steam for a disinfecting apparatus and for driving such engines and machinery as would be necessary for depôt purposes, provision being made for the future erection of additional cells and seating of boilers should the Vestry eventually decide to destroy all the refuse at the one destructor, or undertake a combined scheme of electric lighting and dust destruction."

Huddersfield.—At the last meeting of the Huddersfield Chamber of Commerce attention was drawn to the inefficient telephone service from which the town and district occasionally suffers, the defects in the service being attributed to disturbance caused by the electric lighting cables of the Huddersfield Corporation. To get rid of the existing inconvenience the laying of underground telephone wires is the chief thing called for, and the sanction of the Corporation has been duly sought in order that this desirable change may be introduced. So far, nothing has been done by the Corporation in the matter. The National Telephone Company are, however, not only proposing to place all their wires underground, but also to abolish their district exchanges, so as to afford their subscribers direct communication with the central office. No question of the non-repairs of the streets is involved, it is said, in the company's application to the Corporation, since the former are willing that the municipal authority shall put down all the wires, and charge upon them the cost of the work. Already the company have a few double metallic circuits at work in Huddersfield, certain customers paying extra fees for the advantages derivable, and the results have been found much more satisfactory than under the single-wire system. An expenditure of no less than from £30,000 to £40,000 is involved in the proposed changes, and it is stated that, following upon the sanction given by the Corporation, 18 months or two years would be sufficient for their completion.

Roller-Bearings.—The ordinary general meeting of this Company was held recently at the Westminster Palace Hotel, under the presidency of Major-General Hutchinson, who said that the accounts were for 15 months, from July 2, 1896, to September 30 last. The cost of bearings had been considerably reduced from what was the case in the first instance. For railway work considerable progress had been made during the last 12 months with the railway companies, both in this country and on the Continent. With regard to electrical railways, the City and South London (King William-street to Stockwell) had fitted trains with them, and the directors were glad to announce that they had secured the contract for the whole of the rolling-stock for the Waterloo and City Railway, and the whole of the carriages on the Liverpool Overhead Railway were being gradually fitted with their bearings. The "Mono-rail" lightning express train at the Brussels Exhibition was fitted throughout with these bearings, and the directors had reason to believe that the results were satisfactory. The Company was awarded a silver medal diploma at the exhibition for its exhibits. With respect to tramway works, the bearings had been supplied to gas traction and electrically-worked cars for Blackpool, for cable cars at Edinburgh, and for horse tramways at Burnley, Worcester, Deptford, and Northampton. For motorcar work the bearings had already been supplied to Scarborough and Queensland, and bearings for shafting, furnace cars, trolleys, cranes, and ventilating fans for machinery had also been supplied by the Company, and negotiations were now in progress for fitting up electrical cabs, omnibuses, and other vehicles.

Bradford.—Major-General H. D. Crozier, R.E., an inspector of the Local Government Board, held an enquiry recently into the proposal by the Bradford Corporation to borrow £50,000 for the purpose of meeting growing demands by providing additional machinery and plant. The Town Clerk said extensions of mains would absorb £32,493; meters, £4,000; motors for hire, £2,000; boilers, £1,500; machinery, etc., £1,900. The inspector ordered certain detailed estimates to be furnished. The Gas and Electricity Supply Committee report: All consumers of electricity are now supplied at a pressure of 230 volts. The balancing on the three-wire system at 460 and 230 volts is completed. The chief advantage of this change consists in being able to supply twice the number of lamps from the same mains with no further loss of pressure. The other advantages of this important change of pressure are: (1) the area of direct supply is increased from 1½ square miles to nine square miles; and (2) the voltage is suitable for the supply of electricity for tramcar traction if required. A free supply of incandescent lamps to all consumers of electricity for incandescent lighting from the Corporation supply mains has been introduced, and is now in successful operation. In order to encourage a demand for electricity in the daytime, it has been arranged that a certain class of electrical apparatus shall be let out on hire. This arrangement has only been in operation nine months, and 39 motors and 62 arc lamps have been already applied for. These motors have proved an excellent advertisement in themselves, and are rapidly increasing the day load at the works. The price of electricity for motors has been reduced from 3½d. to 2½d. per unit. Twenty-one miles of cables have been laid during the year, being equal to seven miles of one side of a street. The public arc lamps have been increased from five to eight.

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Perth.—We have at various times drawn attention to the discussions which took place at the Town Council of Perth, referring to the question of applying to the Board of Trade for a provisional order to enable them to introduce the electric light into the city. A special committee appointed to deal with the subject met on October 18, and resumed consideration of the threatened application by the Imperial Electric Light and Power Company, Limited, for a provisional order to supply electricity within the burgh. After considerable discussion, in which the committee were unanimous in agreeing that an application for a provisional order should be made this session either by or on behalf of the town, it was moved that the Council be recommended to enter into an agreement with Edmundson's Electricity Corporation, Limited, to apply in name of the town for a provisional order, in terms of the proposed agreement to be afterwards arranged, but an amendment that the Council be recommended to apply for an order in their own name was carried. On the same evening the Council took into consideration the recommendation of the Special Committee on Electric Lighting that the Town Council should apply this session in their own name for a provisional order for electric lighting within the burgh. Several propositions were discussed and withdrawn, and it was finally decided to take all necessary steps to obtain a provisional order from the Board of Trade for the supply of electricity within the boundaries of the burgh for public and private purposes, and to instruct the town clerk, with the assistance of the town's parliamentary agents, to give the necessary parliamentary notice of the proposed application; it was resolved, further, to meet on Monday, December 6 next, to determine as to forwarding the application.

Kennington.—The report of the General Purposes Committee submitted to the Vestry last week contained the following items: As the crossings on the north side of Lower Kennington-lane have been disturbed by the electric lighting company in laying their mains, the present time seems to be favourable for relaying them, especially as they were not relaid when the road was done in the spring of 1895, and are now in a bad condition. The surveyor estimates that the cost of relaying the crossings in Jarrah will amount to £82. 10s.; but from this sum must be deducted the amount which would be received from the electric lighting company if the old crossings were simply replaced—namely. £14—and which, of course, must still be paid by the company if the Vestry decides to relay with new wood.—The Charing Cross Electric Company give notice of their intention to complete their system of mains in Commercial-road by adding some cables at the side of those already existing. Instead, however, of laying the cables as proposed, on the same side of the road, they laid them for a short distance along the other side of the road. Negotiations have been entered into with the company with regard to this, and their solicitors now state that the company will be willing to pay an extra rent of £15 per annum if the Vestry will allow the mains to remain in their present position. The committee are of opinion that this is an adequate offer, and recommend that it should be accepted, and that a short supplemental agreement embodying the arrangement should be prepared by the clerk; the company to agree to remove the part of the mains in question if required by the Vestry, the additional rent in that case to cease.—Notice has been received from the South London Electric Supply Corporation, Limited, of their intention to lay mains to certain roads in Brixton, Clapham, Stockwell, Herne Hill, and Norwood. The committee have directed the surveyor to see that the mains are laid to his satisfaction.

Lambeth.—At the last meeting of the Vestry the General Purposes Committee reported upon applications from the South London Electric Supply Corporation, intimating their intention to lay mains in certain roads in Brixton, Clapham, Stockwell. Herne Hill, and Norwood; and another from the London Hydraulic Power Company, notifying that they intended constructing an extension from their main existing in York-road for a short distance in Sutton-street and Manners-street to the premises of Messrs. H. and G. Simonds, Limited. In each instance the committee directed the surveyor to see that the mains were laid satisfactorily. The Charing Cross Electric Company, the committee also reported, had laid their cables on the wrong side of Commercial-road, contrary to their agreement with the Vestry. Negotiations had been entered into with the Company with regard to this, and their solicitors now stated that the company would be willing to pay an extra rent of £15 per annum if the Vestry would allow the mains to remain in their present position. The committee were of opinion that this was an adequate offer, and recommended that it should be accepted, the company to agree to remove the part of the mains in question if required by the Vestry. The Vestry approved of this course. The Committee reported that an application had been received from the National Telephone Company for permission to lay tubes along certain roads in the inner and outer wards. The committee recommended that the application be approved on the conditions which were laid down when the company's former application was assented to—namely, that the entire expense of taking up and relaying the roads, both original and consequential, should be borne by the company, and that the company should pay to the Vestry a yearly rent of £2. 2s. for every mile or part of a mile of tubes laid down. An amendment was proposed to the effect that the recommendation be referred back, and "further, that the company be required to provide an improved service at a reduced cost, in accordance with the evidence given by the City Commissioners of Sewers before the Select Committee in 1895." He pointed out that the company now enjoyed a monopoly in telephone service, the inefficiency and expensiveness of which had become a standing disgrace to London. They were charged £20 a year for a bad and slow service, as compared with £10 in Glasgow and £6 in Manchester. In view of the present scandalous state of affairs, he held that local authorities should bring what pressure they could to bear upon the company, which was now seeking favours from them. The amendment was agreed to *nem. con.*, and, as a substantive motion, also adopted.

Leeds.—The two main thoroughfares of Leeds will be lighted with electricity, probably before the end of this month. For this purpose the Corporation some time ago ordered 40 electric lamps, each to be of the nominal illuminating power of 2,000 candles. These are to be placed on the top of the central poles and side brackets used in connection with the electric tramway, and the current required for the illuminating power is to be supplied from the Corporation electrical generating station at Crown Point. Mr. W. Wharam, electrical engineer, of Rockingham-street, who has received the contract, reported to the Lamp Committee last week that he had only been able to get a dozen of the particular kind of lamp desired by the committee, hence he had not been able to complete the work by October 1, as originally arranged. With the assistance of the lamp-makers, however, he expected to have the work completed in a month. The *Yorkshire Post* says that a scheme is being promoted for connecting the tramway systems of Leeds and Bradford by means of a light railway, upon which cars are to be propelled by electricity. The undertaking is not intended to compete with or be a rival of either the Leeds or Bradford tramway systems. On the other hand, it is claimed that it will act as a feeder to both by placing the intermediate districts in closer touch with both centres. After leaving the termination of the existing tramway of the Bradford Tramways and Omnibus Company, Limited, at Thornbury the proposed line will pass along Leeds-road in an easterly direction to its junction with Woodhall-road and Bradford-road, thence along Bradford-road over the Idle and Shipley branch of the Great Northern Railway, thence along Bradford-road aforesaid to Farsley, whence it will run along Town-street, Farsley, to the junction of that street with Stanningley-road, along Stanningley-road to its junction with Lower Town-street, Bramley, and on Stanningley-road to its junction with Branch-road and Armley-road, to the terminus of the line in Armley-road. Advocates of the enterprise say that if the Light Railway Commissioners grant leave to make the line, both it and the generating plant and rolling-stock are to be of most modern type. Preliminary designs indicate that the trolley arrangement, with overhead wires, is to be adopted. For almost the whole length of road to be traversed there is said to be room for a double line of rails. Unfortunately, the gauge of the Bradford tramways is only 4ft., while the Leeds tramways have the usual gauge of 4ft. 8½in. Hence, it is quite impossible to make a junction with the Bradford tramways, or to run through cars. We understand, however, that the Bradford Tramway Company's lease will expire shortly, and the tramways will come under the control of the Corporation, who may reconstruct them for the purpose of electric traction. If that is so, an excellent opportunity occurs for that reconstruction to take place on the wider gauge, and thus ensure a through communication between the two cities and the populous intermediate villages and townships. Dr. Hopkins, who devised the electric traction system at work in Leeds, and Mr. F. Beaniand, of Westminster, are the engineers, and Messrs. Addyman and Evans, of Leeds, solicitors to the promoters.

TRAFFIC RECEIPTS.

Bristol Tramways.—The traffic returns for the week ending October 29 were £2,570. 12s. 7d., compared with £1,883. 4s. 5d. for the corresponding period of last year, being an increase of £689. 8s. 2d.

Birmingham Tramways.—The traffic receipts for the week ending October 30 were £3 590. 4s. 1d., as compared with £3,192. 9s. 3d. in the corresponding week in 1896, being an increase of £397. 14s. 10d.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended October 31 amounted to £1,364, as compared with £1,112 in the corresponding week of the previous year, being an increase of £252.

City and South London Railway.—The returns for the week ended October 31 were £1,018, compared with £1,016 for the corresponding period of last year, being an increase of £2. The total receipts for the half-year 1897 amounted to £16,538, compared with £16,711 for the corresponding period last year, being a decrease of £173.

South Staffordshire Tramways.—The traffic returns for the week ending October 29 were £628. 1s. 5d., as compared with £588. 6s. 7d. in the corresponding week of the previous year. The aggregate receipts so far this year were £27,476 9s. 5d., as compared with £26,639. 11s. 9d. in the corresponding period in 1896.

S.D. Tramways, Dublin.—The traffic receipts for the week ending October 29 were £476. 17s. 0d., as compared with £413. 8s. 9d. in the corresponding week in the previous year, being an increase of £63. 8s. 3d. The number of passengers carried was 75,988 in 1897 and 61,997 in 1896. The aggregate returns up to date are £12,267. 3s. 1d., as compared with £12,874. 2s. 7d. last year, being a decrease of £606. 19s. 6d. The mileage open is the same as last year—viz., eight miles. There were 289 cars running, against 178 in 1896; the number of miles travelled being 23,725 (18,071 in the same period of 1896).

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PROVISIONAL PATENTS, 1897.

OCTOBER 25.

24665. Improvements in anodes and in the electro-deposition of nickel and other metals. Henry Wiggin and Co., Limited, and Gustav Adolph Boeddicker, 7, Staple-inn, London.

24699. Improvements in electric bells or gongs. Charles McCann, 163, Queen Victoria street, London.

OCTOBER 26.

24715. The improved universal electric lamp for cycles and other vehicles, military and other field work. Phineas Henry Emanuel, Melrose, St. Andrew's-road, Southsea.

24723. Pneumatic electric system of communication between railway passengers and guard or other railway servants. William Graham Kidd, 6, James-place, Leith, N.B.

24754. Improvements in electricity meters. George Hookham, 18, Southampton-buildings, Chancery-lane, London.

24782. Improvements in and connected with electric arc lamps. Stephens, Smith, and Co., Limited, and John Stephens, jun., 1, Cuba-street, Millwall, London.

24792. Telegraphic transmitter for ocean cables. David Lynch, 36, Chancery-lane, London.

24829. Improvements in coin-freed mechanism applicable to gas, electricity, and like meters. Stephen Simpson, 28, Victoria-street, London.

24833. Improvements in and relating to electricity meters. Joseph Routin and Charles Eugen Lancelot Brown, 46, Lincoln's-inn-fields, London.

OCTOBER 27.

24854. Improvements in electric arc lamp and other mechanisms. Henry John Spencer and William Fennell, 27, Bower-road, Victoria Park, London.

24884. Improvements in electro-deposition apparatus. Albert Frederick Harris, 12, Cherry-street, Birmingham.

24913. Improvements in connection with electric traction systems. Henry John Spencer, 52, Dunsmure-road, Stamford-hill, London.

24925. Improvements in primary batteries. Edgar Giglio, 6, Lord-street, Liverpool.

OCTOBER 28.

24950. Improvements in circuit arrangements for wireless telegraphy. Alfred Charles Brown, 129, Algernon-road, Lewisham, London.

24958. Improvements in electric tramway and electric transmission of power systems. Charles William Godson Little, Herrick House, Lewisham, London.

OCTOBER 29.

25061. Improvements in switches for motors. Henry Herbert Turner, Albert Turner, Arnold Turner, and George Shaw Aveyard, 55, Market street, Manchester.

25076. Improvements in and connected with the electric propulsion of barges and boats on canals and rivers. Henry William Handcock and Alfred Herbert Dykes, 5, Victoria-street, London.

25141. A decorative reflector for incandescent electric lamps. Fritz Deimel, Jacques Lehmann, and Alfred Sylten, 4, South street, Finsbury, London.

25151. An improved system of automatic telephone exchange. Max Margowski, 53, Chancery lane, London. (Gustave Seligmann-Lui, France.)

OCTOBER 30.

25183. Improvements in and relating to brackets, chandeliers, electroliers, and the like. Charles Darrah and Thomas Gibson, 70, Market-street, Manchester.

25205. Improvements in coin-freed electric shock machines. Graydon Poore, 70, Chancery-lane, London. (Complete specification.)

25210. Improvements in the method of and means for transmitting electric currents in tramways. Max Röhser, Penny Bank-chambers, Halifax. (Complete specification.)

25212. Improvements in grapples for submarine cables. John Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (La Société Industrielle des Téléphones, France.)

25235. A roller-bearing locking or under carriage applicable especially to electrical and other motor vehicles. The Honourable Reginald Thomas Dudley Brougham, 24, Southampton-buildings, Chancery-lane, London.

25243. Improvements in controlling the supply of electric energy and in apparatus therefor applicable more especially for varying the power or brilliancy of electric lamps. Norman Staniland and Oliver Prescott Macfarlane, 45, Southampton-buildings, Chancery-lane, London.

25244. An improved arc lamp. Paul Mersch, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Section 103, October 11, 1897, being date of application in France.)

25245. An improved method of varying the speed of electric motors or the electromotive force of dynamo-electric machines. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Eugenio Cantono, Italy.)

25246. A process for the electrolytic separation of metals. Henrich von der Linde, 45, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1896.

19558. Printing telegraph instruments. André.

19593. Writing telegraphs. Cerebotani and Bernstein.

22360. Automatic telephonic exchange system. Berditschewsky-Apostoloff.

23399. Electric switches. Kleinschmidt.

25896. Electric insulators. Sax.

26249. Electrical heating apparatus. Dowsing.

26275. Boxes for electric conduit wiring. Russell.

26303. Dynamo-electric machines. Wise. (Aktiebolaget de Lavals Angturbin.)

26427. Electrical switches. Brymer and Todd.

26627. Alternating-current systems of distribution and regulation. Belfield. (Lamme and Mershon.)

26774. Conduit pipes for electric conducters. Edmunds.

26965. Means or apparatus for use in electrically lighting incandescent and other gas burners. Boardman.

27446. Electrical resistances. Crompton.

1897.

5131. Electrical resistances. Bowles.

5136. Electric tan-bark bath and apparatus therefor. Stanger.

15491. Electric heating apparatus. Fraley.

17479. Automatic transformer-switch apparatus. Schlatter.

20496. Surface contact electric railway systems and apparatus for use therewith. The British Thomson-Houston Company, Limited. (Potter.)

20502. Surface contact railway systems and apparatus for use therewith. The British Thomson-Houston Company, Limited. (Potter.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	11-11½
Brush Company, Ordinary	3	1½-1⅝
—— Non. Cum., 6 per cent. Pref.	2	1⅝-2⅛
—— 4½ per cent. Debenture Stock	100	107-111
—— 4½ per cent. 2nd Debenture Stock	100	98-102
Callender's Cable Company, Debentures	100	108-113
—— Ordinary	5	7-8 xd
Central London Railway, Ordinary	10	9⅞-10¼
——	6	5⅞-6
Charing Cross and Strand	5	12-13
Chelsea Electricity Company	5	10-10½
—— 4½ per cent. Debentures	100	110-113
City of London, Ordinary	10	25-26
—— 6 per cent. Cumulative Pref.	10	17-18
—— 5 per cent. Debenture Stock	100	131-136
City and South London Railway, Consolidated Ordinary	100	69-71
—— 4 per cent. Debenture Stock	100	137-139 xd
—— 5 per cent. Pref. Shares	10	15½-15⅝
County of London and Brush Provincial Co., Ordinary	10	12⅝-13⅛
—— 6 per cent. Cum. Pref.	10	15½-15⅝
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1⅝-2
—— 5 per cent. Debentures	—	89-94
Edison and Swan United Ordinary	3	2⅛-2⅜
—— 5 per cent. Debentures	5	4-5
Electric Construction, Limited	2	2-2⅛
—— 7 per cent. Cumulative Pref.	2	3⅛-3⅜
Elmore's Copper Depositing	1	1⅛-1⅜
Elmore's Wire Company	2	2-2⅛
W. T. Henley's Telegraph Works, Ordinary	10	19⅛-20⅛
—— 7 per cent. Preference	10	18⅛-19⅛
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	9-9⅛
—— 7 per cent. Preference	5	10⅜-11⅛
India Rubber and Gutta Percha Works	10	21-22
—— 4½ per cent. Debentures	100	103-107
Kensington and Knightsbridge Ordinary	5	13⅛-14⅛
—— 6 per cent. Pref.	5	8-8⅛
London Electric Supply, Ordinary	5	2-2⅛
Metropolitan Electric Supply	10	17⅛-18⅛
—— 4½ per cent. First Mortgage Debenture Stock	100	119-123
National Telephone, Ordinary	5	6⅛-6⅜
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	14-16
—— 5 per cent. Non. Cum. Third Pref.	5	6-6⅛
—— 3½ per cent. Deb. Stock	100	104-109
Notting Hill Company	10	15-16
Oriental, Limited, £1 shares	1	1⅛-2
—— £5 Shares	5	8⅛-8⅜
—— £4½ shares	4½	7⅛-7⅜
Oriental Telephone and Electric Company	1	9/16-11/16 xd
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	103-105
South London Electric Supply, Ordinary	2	1⅜-2⅛
St. James's and Pall Mall, Ordinary	5	16-17
—— 7 per cent. Pref.	5	9⅛-10⅛
Telegraph Construction and Maintenance	12	36-39
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	8	12⅜-13⅛
Westminster Electric Supply, Ordinary	5	14⅜-15⅛
Yorkshire House-to-House	5	8-8⅛

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NOTES.

The Workmen's Compensation Act, 1897.—We have received a copy of a useful little treatise on this important Act of Parliament which deserves to be widely read. The author is Mr. M. Roberts-Jones, and the book is published by the Western Mail, Limited, at Cardiff, and at 82, Fleet-street, E.C.

Electric Traction in Buenos Ayres.—The Buenos Ayres and Belgrano Tramways Company has received cable advice of the authorisation of the substitution of electric for horse traction over its entire system, extending from Plaza Victoria, the centre of the city of Buenos Ayres, to the suburb of Belgrano, the duration of the permit being 99 years.

Light.—We have received a copy of a book, entitled "Light: Visible and Invisible," being a series of lectures delivered at the Royal Institution at Christmas, 1896, by Prof. Silvanus Thompson, D.Sc., F.R.S., M.R.I., principal of, and professor of physics in, the City and Guilds Technical College, Finsbury. The book is published by Macmillan and Co., at 6s. net.

"The Dynamo."—This is the title of a handy little book by Mr. S. R. Bottone, and describes how the dynamo is made and used. We gauge its success by the fact that it is already in its tenth edition, and we note that each edition is an improvement on its predecessor as regards being up-to-date. The book is published by Messrs. Swan, Sonnenschein, and Co., Limited.

Electricity in Africa.—At last the Bulawayo Railway is opened, and on the same day the town of Bulawayo was lighted throughout by the electric light for the first time. The opening of the railway did not pass off without mishap. The electric light dynamo van of the Johannesburg-Eastern Province special train to Bulawayo caught fire at Gaberones. The van was totally destroyed, and the electrician and his assistants were severely burned. None of the passengers, however, were injured.

Falcon Works' Engineering Society. — The inaugural meeting of the fourth session of this society, which is formed of the staff and employés of the Brush Electrical Engineering Company, was held at the works at Loughborough, Leicestershire, on Thursday, the 4th inst., when Mr. Percy Sellon delivered an address reviewing the history of the society and of the Falcon Works, and explaining the extensions which the company are carrying out and have in contemplation at the works.

Human Traction.—In England many people think it is cruelty to use horses for tramcar and 'bus work, but in Mozambique the people are free from the trammels of societies for the protection of mammalia of various kinds. According to the report of a United States consul, there is only one street railway in the entire province of Mozambique; it is about two miles in length, is built on a 24in. gauge, and its entire rolling-stock consists of one flat hand car capable of seating four people. The motive power is from two to four stout Kaffirs!

A Long Ride.—The network of trolleys with which New England is now covered makes it possible for anyone to ride for 124 miles on trolley roads. This is probably the longest trolley line in the world. Of course, the trip would have to be made in a number of cars. From the residence of Mr. Henry H. Rogers, vice-president of the Standard Oil Company, at Fort Phœnix, in Fairhaven, to Nashua, New Hampshire, the route is as follows: New Bedford, Fall River, Taunton, Bridgewater, Brockton, Braintree, Quincy, Boston, Malden, Melrose, Wakefield, Reading, Wilmington, Billerica, Lowell, and Dracus, to Nashua.

German Trade.—According to the returns of German foreign trade for the first three quarters of the current year, the amount of goods, precious metals excluded, imported, was, in units of a thousand tons, 29,237 as against 20,082 for the first nine months of 1896, the difference comprising an increase in corn and other agricultural products of 281,000 tons, in iron of 137,000 tons, in wood 517,000 tons, and cotton 27,000 tons, while wool showed a decrease of 11,138 tons. In the case of iron exported a marked decrease, representing 18,000,000 marks, took place.

Opening of the Bristol Tramways.—One day last week Major Cardew, R.E. (the Board of Trade inspector), went to Bristol and made the usual tests of the Staple-hill electric tramway extension, in company with the engineers and officials of the tramways company and the representatives of the local authorities. He expressed himself as exceedingly pleased with the manner in which the lines had been carried out. The company had all the cars in readiness, and immediately the inspector passed the line the working of the cars was extended to Staple-hill. Large numbers of the residents patronised the cars during the afternoon and evening and also on the subsequent days.

Disinterestedness.—In England we should call it grandmotherly interference, and we should not tolerate it. The following extract from *Indian Engineering* will be read with curiosity, at least in England: "The Master of the Punjab Trades' Association reports that as the houses of business in Simla are so concentrated, it is useless to expect that any scheme of telephonic communication would receive support. The Director-General of Telegraphs is therefore to be informed in reply to his enquiry that, in the opinion of the Municipal Committee, it would not be desirable, in the interests of the mercantile or private communities, to grant a license to the Bengal Telephone Company to open an exchange in Simla." If the Bengal Telephone Company choose to take the risk, what business is it of the Punjab Trades' Association?

Production of Steel in Spain in 1896.—The *Engineering and Mining Journal* states that the production of steel in Spain in 1896 amounted to 104,557 tons, an increase of 55 per cent. on the out-turn of the previous year. There are now two large Spanish steelworks producing Bessemer steel, and two others producing open-hearth steel. The Altos Hornos Works at Bilbao possesses two 10-ton Bessemer converters, an 11-ton open-hearth furnace, and 14 puddling furnaces. The Viscaya Works at Bilbao possesses three five-ton Robert converters and four open-hearth furnaces, two acid and two basic, of 12 tons capacity each, together with four puddling furnaces. The Duro Company, Asturias, has three open-hearth furnaces and 20 puddling furnaces, and the Mieres Works has one large open-hearth furnace.

The Proximity of Substances and Voltaic Action.—Mr. George Gore, in a paper read before the Chemical Society, an abstract of which is published in their *Journal*, discusses the influence of proximity of substances on voltaic action. On a previous occasion he showed that the difference of pressure due to gravity at the upper and lower ends of a vertical column of an electrolyte about three metres high, on two perfectly similar electrodes of the same metal at the upper and lower ends of the column, produced a very feeble current. If gravity, by producing pressure, exerts an extremely minute influence on chemical and voltaic action, similar effects, although excessively minute ones, must be produced by the gravitative action of a large mass of metal or other

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substance on a voltaic electrode at the end of a horizontal column of electrolyte presented to it. Experiments confirming this view are described in the paper.

Society of Arts.—The Society of Arts will commence its session (the one hundred and forty-fourth from its foundation in 1754) on the 17th inst. with an address on "The Colonies: their Arts, Manufactures, and Commerce," by Major-General Sir Owen Tudor Burne, G.C.I.E., K.C.S.I., the chairman of the society's council. There will be four meetings on successive Wednesdays before Christmas, at which papers will be read by Prof. James Douglas, on "The Progress of Metallurgy and Metal Mining in America during the Last Half Century"; by Prof. Leonard Waldo, D.Sc., on "The American Bicycle—the Theory and Practice of its Making"; by Bennett H. Brough, on "The Stockholm Exhibition of 1897"; by Samuel Rideal, D.Sc., on "The Purification of Sewage by Bacteria." The first course of Cantor lectures will consist of three lectures, to be given on Monday evenings, commencing on the 29th inst., by Dr. Eugene F. A. Obach, F.C.S., on "Guttapercha."

The Conductivity of Electrolytes.—A paper has been contributed to the Chemical Society by Mr. Theodore Richards and Mr. John Trowbridge on the effect of great current strength on the conductivity of electrolytes. As the authors' method of determining resistance by measuring its damping effect on electric oscillations applies to electrolytes, provided that the resistance to be measured is less than 20 ohms, experiments were made to ascertain whether the intense current involved in the discharge of a large condenser is capable of causing any change in the condition of an electrolyte. It was found that the resistance of concentrated copper sulphate and zinc sulphate solutions is not essentially altered by great alterations in the strength of the current. That the strong instantaneous current, which alters so much the resistance of gases, has so little effect on solutions, is no doubt due to the great mass and specific heat of the material, which must be warmed in the latter case.

Is it Original?—A weekly publication rejoicing in the name of *New York Town Topics* relates a little story about Lord Kelvin which we believe we have heard in connection with another noble personage. However, it is not a bad yarn; and besides, who can tell what effect the presence of a great scientist like Lord Kelvin might have upon a negro mind? The paragraph is as follows: "Lord and Lady Kelvin have found time to visit Philadelphia. Sunday night Frank Thomson gave a handsome dinner for them at Corker-hill, Merion, and invited half the country to meet them informally afterward. Through some mistake the distinguished guests did not arrive at 7.30, the hour set for the dinner, and as the moments sped the guests assembled in the drawing-room began to experience slight sensations of uneasiness. Suddenly the draperies before the doorway were thrust aside and in the opening beamed the butler, an ebony relic of ante-bellum days, who at once announced: 'Mistah Thomsing, de Lawd am come!'"

Electric Railway Current for Private Power Purposes.—In America the fire underwriters will not allow electric railroad circuits to be tapped for power purposes, on the assumption that current from a railroad circuit is more dangerous for fire than current from a 500-volt power circuit. Mr. Charles Buell, writing in the *Electrical Engineer* of New York, says that before the fire underwriters forbade the use of railroad current he had installed a number of electric motors on railroad circuits, but never had any trouble save once, that might not occur on a metallic circuit. If he were to have a motor of 25 h.p. installed, he would rather have the current from a circuit using the ground for one leg than one using a metallic circuit, all other things being equal and voltage not over 600. The underwriters argue that the grounded circuit is more apt to give a person a shock when standing on the ground or a wet place, but Mr. Buell says he has never found any trouble in getting a shock from a 500-volt power circuit by standing on the wet ground and touching either side of the live circuit.

The Indian Telegraph Department.—The *Bombay Gazette* says: "The report of the Indian Telegraph Department for the year 1896-7 shows continued increase in the numbers of messages carried for the public. The net revenue, after payment of all expenses, is slightly less than last year owing to increased expenditure on providing greater facilities to the public in the form of additional offices and longer hours during which they have been kept open; also to the increased appreciation by the public of the utility of deferred messages. The result, nevertheless, shows the very satisfactory revenue of 2·37 per cent. on the capital outlay, or 4·54 per cent. if *pro forma* revenue and collections on State messages be included. The report makes special mention of valuable services rendered to the Department, and adds that Mr. W. C. Nigel-Jones, superintendent in charge of the Central Telegraph Office, Bombay, deserves special mention for the manner in which he carried on his very important duties during the trying time of plague, when panic largely prevailed amongst the native community, and people were leaving Bombay in thousands daily."

Institution of Engineers and Shipbuilders in Scotland.—At the opening meeting of the forty-first session of this institution at Glasgow, papers on "The Proell-Corliss Engine and the Proell Valve Diagram," and "Water-Tube Boilers," were read by Messrs. Hermann Kuhne and F. J. Rowan respectively, and the meeting closed with the presentation of a marine engineering gold medal to Mr Robert Caird for a paper on "Propeller Diagrams," and premiums of books to Messrs. Robert Simpson, B.Sc., J. G. Stewart, B.Sc., and John Inglis, past-president of the institution, for papers on "Tunnelling in Soft Material, with special reference to the Glasgow District Subway," "The Manufacture of Welded Iron and Steel Pipes," and "Rates of Speed and Rates of Freight" respectively. Mr. George Russell, the president, stated in his inaugural address that the object of the association, according to its constitution, was to encourage and advance engineering science and practice in Scotland, to facilitate the exchange of information and ideas amongst its members, and to place on record the results of their experiments and discussions.

Bleach.—We are informed by the Electro-Chemical Company that the statements made by the promoters of the Rhodin process, whatever that may be, that no bleaching powder has hitherto been made of over 32 per cent. by electrolysis is altogether incorrect. A sample has been sent us by the Electro-Chemical Company, working the Richardson and Holland patent, which is claimed to have a strength of 38 per cent. We have not analysed the sample, but take it for granted the statement of promoters of a new company is more likely to err in depreciating what is done already than to give the higher figures of the best productions. So far as we can ascertain, the illustrated articles which have appeared in various papers about the Rhodin process have too great a similarity for originality. They seem all to have been cast in one mould—with electros supplied. The Liverpool *Journal of Commerce* states that the question raised as to the validity of the Rhodin patents in this country will be tested forthwith, in the form of an action for infringement by the

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Castner-Kellner Company against the Commercial Development Corporation.

The Cost of Knowledge.—There have recently been discussions in one or two town councils in connection with the payment of deputations in search of information as to municipal electric lighting. No doubt the agitation at this season of the year is mostly prompted by electioneering considerations, but, nevertheless, it loses none of its absurdity. To say—as one councillor said—that, after they had spent all that money, the committee were as ignorant as they were before, is an imputation of imbecility which makes us wonder what body of voters could fail to detect it. As regards the principle of the thing, if one does not intend to profit by one's neighbours' experience and mistakes, then by all means do away with deputations. But when business men try to conduct municipal affairs without detriment to their private business, it is childish to suggest that they select Saturday for visiting other towns on purpose to have a week-end at the seaside. The experience which they undoubtedly gain is used for the benefit of their town, and is remarkably cheap at the price which is usually paid for it—namely, bare travelling and out-of-pocket expenses.

The Trans-African Telegraph.—The construction of the African Trans-Continental telegraph line from Blantyre northwards was (says the *British Central Africa Gazette*) commenced in April, 1896, and had on July 20, 1897, reached a point 85 miles beyond Fort Johnson, at the southern end of Lake Nyassa. There are at present seven white men working on the construction, in addition to which there are two survey parties, each consisting of a surveyor and one other white man in front. One of these has just completed the survey to Kotakota; the other has commenced from there to Bandawe. The two survey parties will pass and repass each other until they arrive at Karonga. Another party of six white men was to leave Blantyre about August 5 to commence work from Karonga towards Tanganyika. Two hundred tons of material, representing 150 miles, arrived in Chinde at the end of July, and another 450 miles is one month behind it; this will complete to the south end of Tanganyika. Arrangements have been made by Major Forbes for the transport of material from Chinde and for its distribution along Lake Nyassa, so that there should be no delay in any way; and Major Forbes is of opinion that by March next, or April at latest, the line will be complete to Abercorn at the south end of Tanganyika. From there it will be pushed forward as quickly as possible by the west side of Tanganyika and across to Uganda.

The Engineering Strike.—At last there are prospects of peace once more in the labour world. The Board of Trade have been in correspondence with the secretaries of the Federated, Engineering, and Shipbuilding Employers on the one hand, and the general secretary of the Amalgamated Society of Engineers on the other, and the result is that the proposal to hold a conference has at length found mutual acceptance. It is expected that the conference will be held to-day at the Westminster Palace Hotel, Victoria-street. Both the Employers' Federation and the officials of the Amalgamated Society of Engineers have unreservedly given Mr. Ritchie the necessary authority to arrange the initial stages, and the Board of Trade decided to lose no time in bringing the representatives of both sides together. At the preliminary conference the principal point for discussion will be the question of chairman, and Mr. Barnes, the general secretary of the Amalgamated Society of Engineers, stated that the officials were determined to do all in their power to secure the appointment of a neutral chairman. On the other hand, the Employers' Federation will, it is stated, absolutely refuse to modify their demand to the effect that each side should have its own chairman and that the parties should confer through the chairmen. There is authority for stating that the Amalgamated Society of Engineers would submit to the representatives of the Employers' Federation the names of Lord Rosebery and Lord James of Hereford for the post of chairman.

Storage Batteries on the Continent.—The application of storage batteries to the street-railway lines of Zürich and Remscheid was recently described by Ludwig Schröder in a paper before the Elektrotechnischer Verein. The author says that the experiment of connecting the storage battery directly across the terminals of the dynamo without using an automatic cell was tried with success. The current and voltage curves show that the current output of the generators only varies between 72 and 102 amperes in the dynamo circuit, while the line fluctuates from 20 to 210 amperes. The voltage on the line circuit is quite constant, the maximum variation being between 535 and 560. The battery has been in service 2½ years, and for nine months has been connected directly to the dynamo terminals. The coal consumption has decreased to 3·9lb. per car mile. On the Remscheid lines there are some heavy gradients, and in a total length of 6·8 miles there is only 180ft. on level road bed. Motors in 40 manufacturing establishments are also connected to the line circuit. The power station equipment consists of three boilers working at 120lb. pressure, four McIntosh-Seymour 160-h.p. engines, and four 100-kw. generators. To meet the increased demand for power for factories, a storage battery has been installed consisting of 250 Hagen cells having a capacity of 648 ampere-hours, with a rate of discharge of 216 amperes. The four compounded dynamos were connected as shunt machines in parallel with the battery, and a booster designed to give 600 amperes at 100 volts was placed in series with it. The author says the battery has effected a wonderful saving.

Railway Traction.—In his presidential address before the Institution of Junior Engineers last Friday night, Mr. John A. F. Aspinall dealt with the question of steam as against electric traction for railways. He took the figures for six months of the Liverpool Overhead Railway worked with electric power, which came out at 3·67d. per train mile for locomotive expenses, the speed being 12¼ miles per hour. To compare with this result he had data carefully taken between two points 20 miles apart, with a number of the stopping places, where the conditions were not dissimilar to those at Liverpool. The journey speed was 37 miles per hour for fast trains and 15½ miles for stopping trains. The maximum weight of train of 10 to 12 coaches was 148 tons at the busy parts of the day, and 117 tons at other periods; while the locomotives weighed 56 tons. On the Liverpool line the total weight of train was 38 tons. The train mileage per day was about the same — 1,787 miles. As compared with the 3·67d. per train mile for Liverpool, the steam locomotive expenses were 5·87d. per train mile; but Mr. Aspinall pointed out that the train mileage is an unfair basis for comparison in view of the difference in the number of coaches and weight of train. Assuming that two cars always made up the complete train in Liverpool, the ton mileage became 12,213,846 for six months, and was equal to 9·67d. per 100 ton-miles for locomotive power, while upon the steam locomotive railway the cost was 4·89d. per 100 ton-miles. This difference, Mr. Aspinall showed, would be still greater if the cost for renewal of boilers and machinery for generating current was included. He was

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therefore inclined to the view that we have not yet solved the problem of moving heavy loads at high speed by electric power with sufficient economy to warrant the immediate replacement of steam locomotives, but was prepared to see great advances made.

Dielectric Constant and Electrical Absorption. Mr. Paul Drude has written a paper describing two methods for the measurement of the dielectric constant and electrical absorption with rapid vibrations, and an interesting abstract of the paper is printed in the *Journal* of the Chemical Society. The method first described consists of the determination of the ratio of the wave-length in air and in the liquid examined. An ordinary form of Hertzian oscillator is employed, and the position of the nodes determined (1) when the wires are in air, (2) when they pass through a trough of the liquid. For non-absorbing liquids, the dielectric constant is given by the square of this ratio, in the case of absorbing liquids by $r^2(1-a^2)$, where a is the absorption coefficient. For conductors, the absorption coefficient can be calculated from the conductivity, but in the case of liquids showing anomalous absorption—that is, which absorb, but do not conduct—the absorption was determined by the preparation of aqueous solutions of equal absorbing power, as shown by the number of nodes observable. In the second method, condensers filled with (1) air, (2) the compound required, were, by means of an adjustable length of wire, brought into resonance with the oscillator and their capacities, and in this way the dielectric constant was determined. This method could also be employed for solids, and is well adapted for finding the temperature coefficient, and for rare liquids. The results of the author for varying mixtures of methylic alcohol and water give a perfect, unbroken line, and thus differ from those obtained by Thwing, which exhibited many breaks. Unbroken or regular curves in close agreement with the numbers calculated by the mixture rule were obtained also for propionic acid and water, acetone and benzene, and acetone and water. A large number of liquids and solids were examined, and tables are given, but the results are frequently not in accord with those of other observers. This, however, is in many cases probably due to the difference in the wave-length, as experiments with acetaldehyde, benzaldehyde, acetone, and diethyl ketone show the variability of the dielectric constant with the wave-length, that is, measure the electric dispersion. The connection between the anomalous dispersion and chemical constitution is also discussed, the effect being apparently indicative of hydroxyl groups.

Diagram Accounts for Engineering Work.—A valuable paper was read at the meeting of the Institution of Mechanical Engineers by Mr. John Jameson on "Diagram Accounts for Engineering Work" The author recognises that in engineering establishments few things are of more importance than a ready and accurate system of prime cost accounts. In the first place, he says costs should always be posted closely up to date; and in the second place the system should be one of balance. Thirdly, it should indicate at a glance probability of error, if error exists, and much may be done in this way in regard both to labour and to store issues. The ability to detect errors is of far more value than the mere correction of an individual error as it occurs. Fourthly, a charge should be included for the use of every machine employed. Work which involves the use of costly machinery should not be simply compared with other work involving perhaps equal labour but not requiring the same use of machinery. The capital value of the machine, its depreciation, the power required to drive it, and the space it occupies in the shop are all elements of cost, which should be apportioned with careful consideration of their incidence. Moreover, machine time-boards present the further advantage of showing whether the machinery has been kept fairly employed while there was work suited for it to do. It can also be seen what class of machines may be deficient in number, as compared with other classes. The machinery employment diagram shows the percentage of the actual earnings of each class of machines compared with their possible earnings. Here the author has hit upon a very excellent idea, and one which might be carried out to great advantage, but it is doubtful whether his system as applied to indicating manufacturing and commercial trading will not be too complicated for successful and even economical working. He says that "from the several lines of an account diagram adequately filled up may be deduced a closely approximate single line pointing directly to a graduated scale of greater or less profit or loss. Waiting till the close of the year for a balance-sheet, produced too late for practical effect, is by no means a satisfactory course; the balance of profit or loss at the year's end is merely an aggregate of items arising day by day. If the exact tendency of this aggregation is displayed day by day or at short intervals, for the guidance of the management, a most important advance is realised." This hardly appears to us to be a necessary part of the system, but we agree that in many cases it would doubtless be found advantageous to construct diagrams of departments so as to show what each department is doing. This system of diagrams appears to us on the whole to be one well worthy of consideration.

The All-British Cable.—The *Times* has published a special article giving a few facts relating to the proposition laid before her Majesty's Government in respect of a new cable route from England to Australia. We referred to this proposition a few weeks ago in these columns. The first part of the project is to lay cables from Porthcurnow, in Cornwall, to Gibraltar (1,198 knots), Gibraltar to Sierra Leone (2,379) or Bathurst, thence to Ascension (1,168), on to St. Helena (810), and from there to Cape Town (1,910). This will afford a triplicate route to South Africa largely clear of existing cables, and not likely to be affected by causes producing interruption of the present lines, such as earthquakes or, in the case of cables on the coast, river floods. All experience shows that duplicate cables, even when separated by such a continent as Africa, do not afford sufficient security against interruption of communication, and the new route referred to will, if laid, be welcomed by all connected with South Africa as diminishing the risk of communication being cut off. The second part of the scheme is to lay a cable from Natal to Mauritius (1,818 knots). This, in conjunction with the present Zanzibar-Seychelles-Mauritius line, will also have the effect of providing an alternative to the following sections should they at any time be interrupted: Zanzibar-Mozambique (already duplicated), Mozambique-Delagoa Bay, and Delagoa Bay-Durban. From Mauritius the route may be to Rodriguez Island (406 knots), thence to Cocos or Keeling Island (2,218), and on to Perth, Western Australia. It is proposed that these cables should be laid by the Eastern, the Eastern and South African, and the Eastern Extension, Australasia, and China Telegraph Companies. As already stated, the new cables will land only in British possessions, and will form a triplicate route to Australia, removed from the volcanic dangers of the Java Seas; while experience on both sides of Africa shows that interruptions from seismic disturbance there are not frequent. The total length of the cables will be 13,684 nautical miles. This scheme is put forward in the judgment of the companies concerned as being preferable in every way to the Pacific route to

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Australia, where a single break in the chain would interrupt communication; while in the proposed scheme, except in the case of the cables from Mauritius to Perth, if any of the sections were broken there would be two alternative lines as far as Zanzibar, and one between that place and Mauritius. Some of the depths in the Pacific are very great, while in the projected line the recorded soundings indicate no depth greater than cables are already lying in. Again, in the Cape route the distances are all practicable without making the cables too expensive, because in a section much above 2,000 miles in length the amount of copper and guttapercha insulation used would have to be largely increased to secure a good working speed.

The Application of the Storage Battery to Electric Traction.—In a very interesting paper on this subject, read before the convention of the American Street Railway Association at Niagara Falls, Mr. Charles Hewett is wise enough to leave history alone, and dismisses it with the brief sentence that "the long series of remarkable failures is no doubt familiar to all." He also remarks incidentally that the cause of past failures has been due quite as much to errors in instalment and in manipulation as in manufacture. He deals with the question under three heads: (1) the application of the battery direct to car or locomotive; (2) the application of the battery at points on the line distant from the generating station; and (3) the application of the battery in the power-house. With regard to the first point, he is led to consider it, not account of its successes, but rather on account of its conspicuous failures, and having investigated it he can see nothing to commend it except for certain local conditions peculiar to the large cities in Europe. The first cost is greater than the overhead system, and the expense of operation is considerably greater. The battery car requires considerably more power to operate than an ordinary trolley car, and also requires a larger investment in generating machinery. Bad as all this is, he can hold out no hopes of improvement in this line. Every battery has what may be termed a critical rate of discharge. From zero up to the critical rate the working E.M.F. remains practically constant, but above the critical rate it decreases as the rate of discharge increases. On the other hand, the E.M F. increases with the rate of charge and the length of charge. The battery must have a large output for its weight and bulk, and the result is that the battery plates become mechanically weak. The conditions seem to prevent the making of plates large enough to prevent exceeding the critical discharge rate, and at the same time light enough and small enough to be carried on a car. He does not discuss special forms of battery locomotives such as the Heilmann, but he refers to the experiment on the New York elevated railway, in which the battery is connected in multiple with the line, and charges or discharges according to the demands of the trains. He does not expect much from these experiments. As regards the application of storage batteries on the ends of long lines, the author says that here the conditions are entirely different, because the battery in this case acts essentially as a pressure regulator. He does not think this method can be considered economical *per se*, but under certain conditions there is no question as to the economy in favour of the battery. He feels confident that as the advantages of the application of the battery to the power-house become better known, the practice will become more general. In this case it becomes distinctly a load regulator, and therefore it is necessary that the capacity of the battery should bear a larger ratio to the output of the station than is necessary for potential regulation. In potential regulation a comparatively small battery is necessary, since by charging the potential of booster from time to time during the day the charge and discharge can be kept very low. The author quotes an instance where a battery rated at 120 amperes has successfully regulated a total output of 1,400 amperes. For load regulation, however, the battery should have a capacity equal to one-third the maximum output of station. The average load of the station may then be made the maximum load of the engines, the battery taking care of the fluctuations. There are no physical limitations to be placed on the size of the plates, and the charge and discharge may be kept well within the normal rate. Under such conditions the efficiency of the battery is high—85 to 90 per cent.—and the deterioration very low, and in most cases no additional labour will be required.

Electric Traction on Underground Railways.—With the view of showing that electric traction on the Metropolitan Railway is not beyond the range of practical suggestion and commercial success, the *Railway News* published in its last issue a long and interesting article giving particulars of three important railway enterprises worked by electricity in the United States, and equipped by the General Electric Company. On the Baltimore and Ohio Railway there are tunnellings under the city of Baltimore extending for some miles, and an experimental electric locomotive proved so successful that preparations are now being made to operate all trains, both freight and passenger, by electric locomotives. It was shown that not only could the guaranteed speed of 30 miles an hour be obtained, but speeds of 35 or 40 miles, with 500-ton trains, were possible. The New York, New Haven, and Hartford Company commenced in July, 1895, working by electricity a seven-mile section of road, running from Nantasket Junction to Pemberton along Nantasket Beach, in the State of Massachussetts. This section was equipped with overhead conductors, and an additional 3½ miles of track, fitted with the third-rail system, was opened a year later. The company's engineer reports strongly in favour of the third-rail system, and says that although there have been no mechanical troubles of importance with the overhead construction, and the pole lines and wire are to-day in practically as good condition as when first installed, the difficulties of passing the heavy currents, frequently called for by the cars, through the trolley wheels to the motor circuits are most serious, and burnouts of trolley wheels are not infrequent, while there is doubtless a considerable waste of power in arcing at the wheels. The results of experiments made at Nantasket Beach and upon the company's street railway properties at Stamford and Meriden, have been embodied in the equipment, just completed, of two lines, one running from Hartford to New Britain and the other from New Britain to Berlin, both of which lines are now in regular operation. The distance from Hartford to Berlin *vid* New Britain is 12·3 miles, and the two lines are operated by a single power station at the Berlin end. The Metropolitan West Side Railway of Chicago is worked by the Thomson-Houston system. This road consists of 36 miles of 90lb. T-rails. The 36 miles are made up of double, triple, and quadruple track. The road is operated by electricity, with a third rail weighing 48lb. per yard, used as a current conductor, this rail being laid on the outside of track rail at a distance of about 18in. The top of the third rail is 6½in. above the level of the track rails. At cross-overs and switches the third rail is placed on both sides of the track, or at which ever side was found most convenient, all motorcars having contact shoes on both sides. The rolling-stock consists of 55 motorcars and 125 trailer cars, the motorcars being designed and powerful enough to handle six loaded trailers. Each motorcar, complete with electrical equipment, weighs 24 tons.

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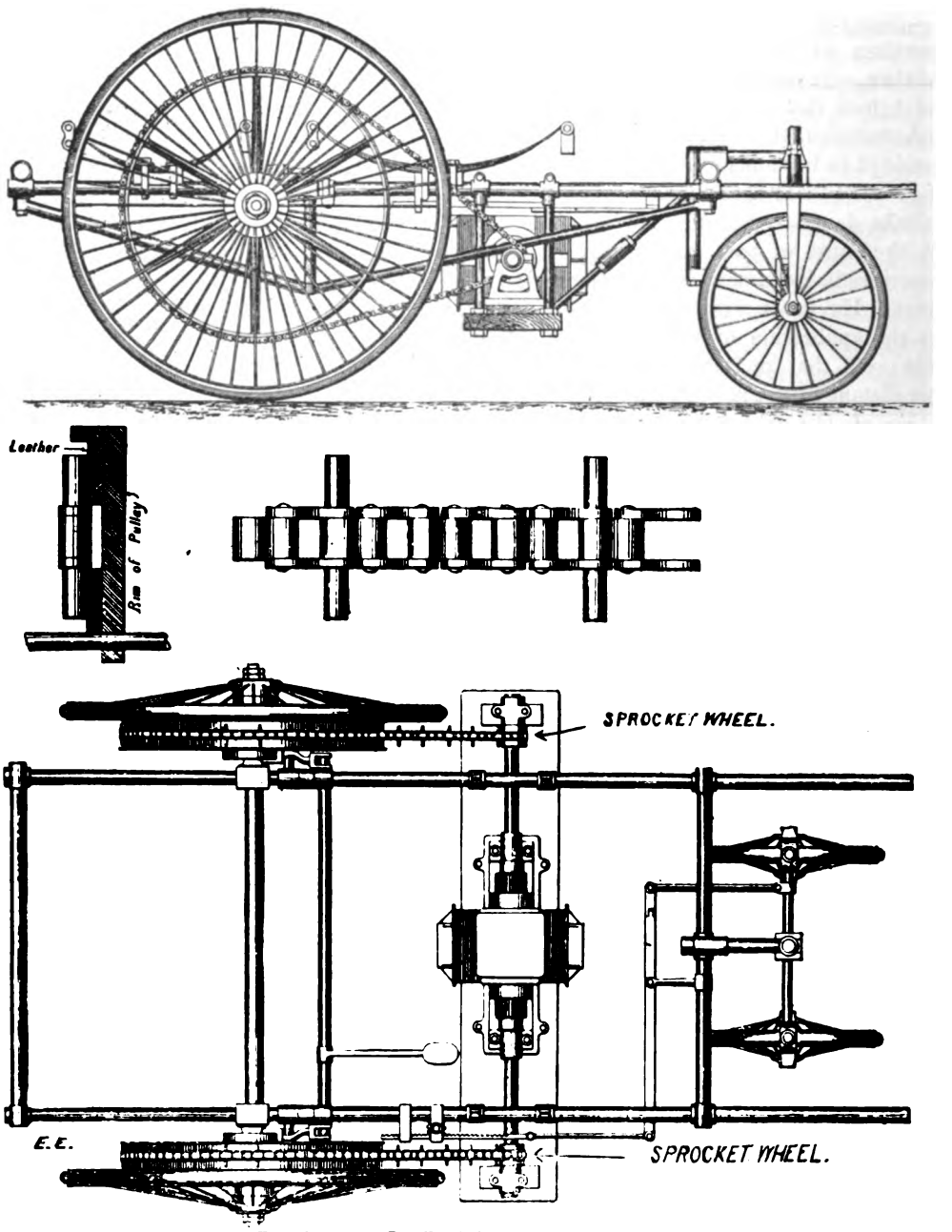
THE ELIESON ELECTRIC MOTORCAR.

One of these cars having now been running for some months past, a few details will doubtless be of interest. For the general design of the car we refer our readers to the accompanying illustrations. The frame (Figs. 1 and 2) is composed of Manessmann steel tubes. Thus not only are great strength and rigidity obtained, but also lightness is secured. These frames are built by Mr. John Warrick, of Reading, maker of the "Monarch" delivery cycle. The motor is suspended underneath the car from the tubular frame, and two chain gears are used to transmit the motion of the motor to the driving wheels of the car. This chain gears with the teeth of a sprocket wheel on the motor spindle, but one of the rivets in every third link of the chain is lengthened and stands out about an inch on either side of the chain. Round the periphery of the driving pulleys (fixed one on each hind wheel of the car) two bands of leather are fastened. These bands are spaced the width of the chain apart, so that the chain runs between these two bands, while the extended pins grip on the leather. A most absolute grip is obtained by the pins on the leather. The makers claim that this gearing secures what no other gearing has ever before obtained—that is, the combination of a positive driving with the advantage hitherto peculiar to belt driving alone—namely, that in turning corners it permits slip to take place on one side, for when turning a corner, while one wheel is checked, the other revolves at its normal speed, and the chain slips on the former, but as soon as it is required revolves it by friction like the other. It may be thought that a slip will take place when not required, such as when ascending steep hills. This matter has been fully tested by ascending Haverstock-hill at a very good speed. The steepest gradient in this hill is 1 in 15, others being 1 in 18, 1 in 25, 1 in 29, 1 in 34, length 3,750ft. Our views of the case do not agree with the above, as if the gear is sufficiently positive to ascend a grade of 1 in 15 without slip, the braking force in turning a corner is not likely to cause the pins to slip on the leather to any large extent. We think it more probable that beyond the slight slip found in all belt gearing, the necessary difference in speed of the two wheels at sharp corners is obtained by a slip between the tyres of the wheel and the road. Still, the makers by using this arrangement do without any differential gear, thus reducing the number of working parts. Further, it is a remarkably silent form of gear. The inventor's chief aim has been to simplify and reduce the working parts of a motorcar. There are five fixed rates of speed in the controlling gear.



FIGS. 1 AND 2.—Details of the Elieson Motor Truck.

The special type of car illustrated in Fig. 3 is intended for city use. Take, for instance, a man living five or ten miles out of the city. He drives into the city in the morning, and whilst engaged in business his car is being charged. This charge is sufficient to carry him home

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and into the city again the next day. Thus the owner of the car need not have a supply of electricity at his house. He can get it when in the city. The company is proceeding with the construction of vehicles of other descriptions, but anticipate a very large demand for these little cars, and even a greater demand for their small vans for the delivery of parcels. Energy is supplied to the motor from a battery of Lamina accumulators. The plate of a "Lamina" cell is of the Planté type, and is composed of sheets of perforated and corrugated lead. The sheets are so arranged that the corrugation run alternately vertically and horizontally. Thus great surface is obtained, and also a good circulation of the acid. The plates are contained in ebonite boxes. The following are the weights and efficiencies guaranteed by the makers for one of the traction cells containing seven plates and weighing complete 27lb.: charge rate, 15 to 25 amperes; discharge rate, 20 amperes. The capacity at 20 amperes discharge is 100 ampere-hours, or a capacity of 120 ampere-hours if discharged at 10 amperes.

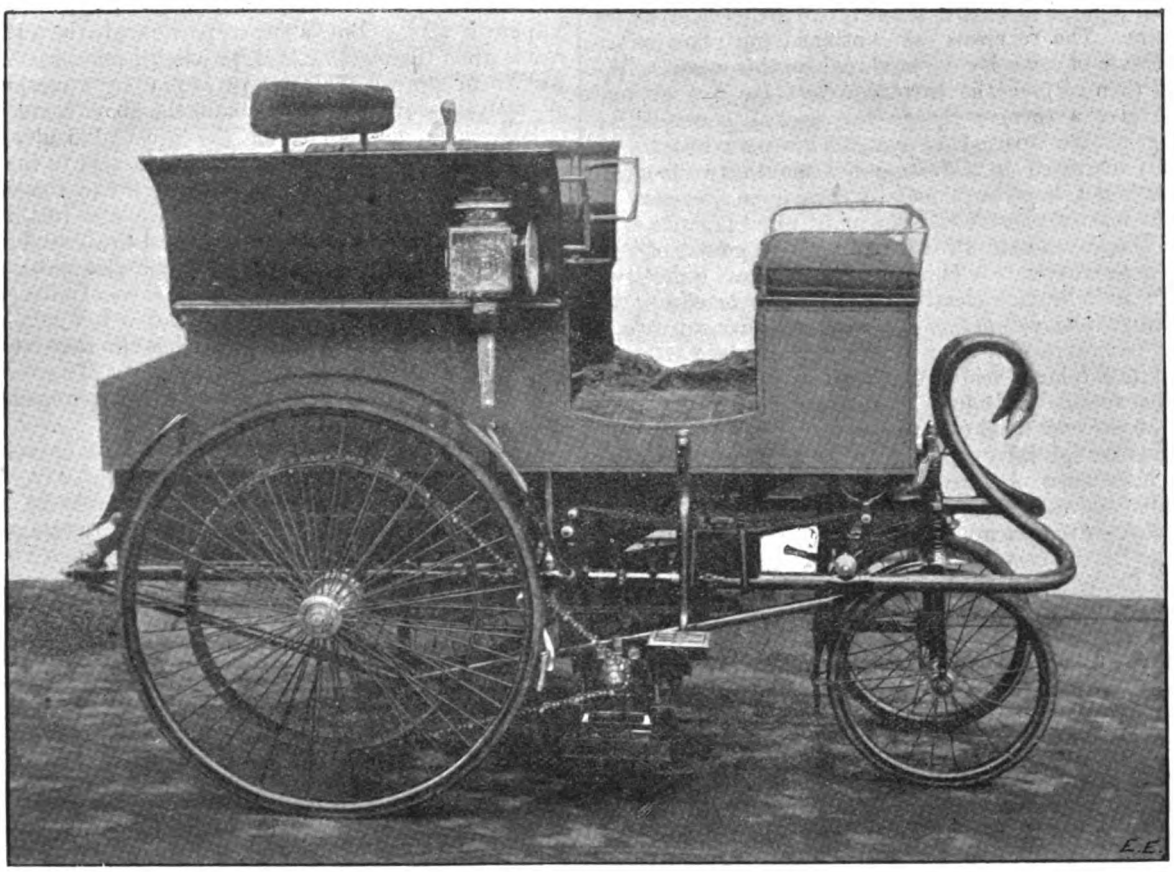

FIG. 3.—View of the Elieson Electric Accumulator Carriage.

NOTES ON ACCUMULATOR CONSTRUCTION.

BY DESMOND G. FITZ-GERALD.

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XXIV.

Those who are desirous of investigating the questions connected with the presence of oxidants in electrolysed sulphuric acid—and all persons interested in accumulators ought to belong to this category—will, I think, be grateful for a more satisfactory method of testing, in the present case, than that afforded by the "iodised starch test" (XIV.). The latter, which is not applicable in the case of alkaline solutions (it answers with alkaline bicarbonates, but not with alkaline carbonates), is also troublesome, and often actually misleading to any but a practised eye, in the case of strong acid solutions. It is true that in the case of a sulphuric acid electrolyte—say of specific gravity 1·3—containing no oxidant we do not obtain the characteristic *blue* coloration; but we do obtain a dark coloration, with brown, yellow, or red tint, which may be mistaken as indicating the presence of an oxidant, or that the sample of iodide of potassium used is not free from iodate. And thus an inexperienced observer, having to test a dozen samples of electrolyte of which only six contained $H_2S_2O_8$ or H_2O_2, whilst the others were free from these or any other oxidants, may—as has sometimes happened in my own laboratory—arrive at the conclusion that they all contained an oxidising agent. And when an oxidant is actually present, the brown coloration—resulting from the joint action of iodine and sulphuric acid upon the starch—may render the test uncertain.

The method of testing which I suggest is the following: (*a*) prepare a very weak solution of ferrous sulphate ($FeSO_4,7H_2O$), which need not be quite free from the ferric salt (Fe_23SO_4), or, to be more accurate, make a centinormal $\left(\frac{N}{100}\right)$ solution of a ferrous salt;* (*b*) prepare a very weak solution of red prussiate of potash, ferricyanide of potassium [$K_3(C_6N_6Fe)$], or, more accurately, make a (dyad) centinormal solution of the salt, by dissolving it in the proportion of 2·19 grammes to the litre of water. Then, with the point of a glass stirrer, place one drop of the ferrous solution on a "spot-plate" or white saucer. Add to this a few drops of acid of the same specific gravity as that to be tested, but free from oxidant. Then add a drop of the ferricyanide solution: a very distinct and brilliant blue coloration will be produced—Turnbull's blue [$Fe_3(C_6N_6Fe)_2$]. Now take a drop of the ferrous solution as before, and add to it a few drops of the acid to be tested. Add a drop of the ferricyanide solution. If the acid contain an oxidant in sufficient proportion to convert the ferrous into ferric sulphate, no coloration will

* In chlorimetry and oxymetry, as in thermo-chemistry, it has been usual and most convenient to take the *monad* gramme equivalent, or the old equivalent weight in grammes, in lieu of the atomic weight, as the basis of the system. Thus the normal (N) solution of dyad or ferrous iron would contain 28 (not 56) grammes of iron to the litre, in a solution made up for the volumetric determination of *iron*. But when the solution is made up for the determination of the weight of *oxygen* absorbed in the conversion of a ferrous into a ferric salt ($2FeSO_4+H_2SO_4+O=Fe_23SO_4+H_2O$) two monad gramme equivalents, or 56 grammes of iron are contained in the litre of N solution.

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be produced. If but a slight coloration be obtained, this may disappear if the experiment be repeated, using more of the acid to be tested.

By using larger and accurately measured quantities of the ferrous solution and of the acid to be tested, the process may be developed into a volumetric determination of the proportion of oxidant contained in the electrolyte.

XXV.

The Planté process of formation has, certainly with some reason, been regarded as insufferably tedious, and wasteful of electrical energy. Planté himself recommends that on the first day of formation the battery should be charged six or eight times alternately in different directions, a discharge being taken prior to each reversal, and the duration of the charge being gradually increased from 15 minutes to one hour. It is then left in a charged condition all night, and next day a reverse charge is given for two hours. The reversals are continued until no appreciable increase of capacity is produced by this means. We are told then to give the battery a rest for a week, and then to give a reverse charge for several hours before allowing another period of rest. This period is to be gradually increased to a fortnight, a month, two months, etc.* It is not, however, generally considered necessary to carry the formation so far. The most usual practice is to give 33 charges in each direction, allowing a period of rest before each reversal. This operation takes quite two months; and although electrical energy may be cheap, the expenditure in this direction is a matter for consideration. It may be interesting to note that Planté used 10 per cent. dilute sulphuric acid (specific gravity 1·07) as electrolyte; the specific resistance of this acid being 1·87 times that of 30 per cent. acid (specific gravity 1·22).

Tedious though this process may be, some very striking results have been obtained by it, notably in the case of the Tudor cell. Possibly, however, some modifications of the process, in the nature of trade secrets, may have been adopted. By the use of the perforating mechanism devised by Mr. Beaumont (XXII.) still better results may be obtained in this direction. It is doubtful whether, even now, any of the means which have been suggested with a view of obviating the expenditure of time and energy in the Planté process can be safely adopted, more especially in the case of the peroxide element.

XXVI.

Leaving now the Planté process, and harking back to Section IX., one of the means just above referred to, and the one which has been most extensively adopted, has now to be considered. This is the production of a porous layer on the surface of a lead plate by the action of dilute nitric acid. The acid used should be very weak, about 1 per cent. (specific gravity at 60deg. F. from 1·005 to 1·006). There should be about one quart of the fluid to every square foot of lead surface; and the temperature should be raised to boiling point (in a vessel, such as one of salt-glazed stoneware, which will not be attacked by the acid) for a period of 10 or 12 hours in the first place, and for a second shorter period after the plates have been exposed to the air. The plates should then be washed with hot water and afterwards in very dilute sulphuric acid. Fresh dilute sulphuric acid of specific gravity under 1·2 must be used for the operation of forming; and it is advisable to discard this acid also—unless the presence in it of oxides of nitrogen is negatived by tests—and to replace it with acid of the same or lower density when the battery is to be used.

Even when the above-mentioned precautions have been observed, it is stated that the presence of (regenerated) nitric acid is sometimes indicated by a shedding of active material due to the corrosion of the underlying metal. The deleterious change which the battery seems to undergo has been ascribed to the *air* of certain localities†, but it might with greater probability be attributed to the *water* of such localities, since this might contain nitrates or nitrites.

Let us endeavour to trace what takes place during the treatment of the lead plates in weak nitric acid. Normal lead nitrate [$Pb(NO_3)_2$] may be formed in the initial stage of the process, but this is for the most part decomposed by the boiling, with the production of basic compounds of lead. These must be basic nitrates, not nitrites, for the latter are yellow or red in colour, whereas the deposit formed on the lead and in the containing vessel are white or whitish. Crystals are also deposited; these are soluble in hot water and are deposited as the solution cools; these appear to be dibasic [$Pb(NO_3)_2PbO$]. The amorphous deposit is in the first instance tribasic, but by absorption of oxygen—the nitric radical acting as a carrier—it ultimately becomes hexabasic, obtaining the same composition as the hexanitrate of Berzelius: [$2Pb(NO_3)_2(PbO)_5,3H_2O$].

The porous layer on the plate is thus an insoluble substance mainly composed of oxide of lead, but containing also the nitrate of the metal. When this is brought into contact with sulphuric acid, some sulphate of lead is formed, and some nitric acid finds its way into the sulphuric acid. But another portion of the nitric acid reacts upon the metallic lead, reconstituting a basic nitrate, which, in presence of oxygen from an atmospheric or electrolytic source, tends to obtain the above composition.

We can thus understand the great difficulty that is experienced in getting rid of the nitric acid in the plates. But the same difficulty occurs with regard to the sulphuric acid used for washing and forming the plates (if this is not to be wasted), and, indeed, with regard to all sulphuric acid to be used as the electrolyte in accumulators—since this should not contain any trace of the oxides of nitrogen used in the manufacture of sulphuric acid. I would suggest that the remedy which is efficacious in the latter case might be efficacious also in the former. The remedy in question is to decompose the oxides of nitrogen by the agencies of ammonia and heat.

When, by the protosulphate of iron test or otherwise, the presence of an oxide of nitrogen—say, nitrous anhydride (N_2O_3)—is detected; the acid may be purified by adding to it sulphate of ammonia and heating until it fumes strongly and ceases to give off any gas. The oxide of nitrogen is thus decomposed, and its nitrogen evolved, according to the following equation:

$$N_2O_3 + (NH_4)_2SO_4 = H_2SO_4 + 3H_2O + 4N.$$

In the same manner nitric acid is completely eliminated—

$$2HNO_3 + 2(NH_4)_2SO_4 = 2H_2SO_4 + 7H_2O + 6N,$$

and this equation is applicable to the following suggested process for getting rid of the nitric acid in plates treated by nitric acid as described at the commencement of this section—viz., saturate the plates with a weak solution of sulphate of ammonia and heat to 600deg. F. The fusing point of lead is higher than this—viz., 618·8deg. F.

* Planté, "Recherches sur l'Electricité," p. 54.

† See report of the meeting of the Epstein Electric Accumulator Company at the Board of Trade offices in September last.

SWISS TRANSMISSION OF POWER PLANTS.

BY WILFRID L. SPENCE, A.M.I.C.E.

The following are some superficial notes by the author on some Swiss power transmission plants, which were principally polyphase ones, and also a comparison between rival systems. The paper in question was read before the Owens College Engineering Society on Tuesday last, and has been awarded a silver medal by this society, which is open to past students at Owens:

The combination of such excellent opportunities for observing Swiss practice in electrical transmission as were afforded by the exhibition at Geneva, and by the general opening of manufacturing and other works to engineers attending the electrical congress there in the early part of August last year, was one which the author deemed unlikely to again recur, at any rate for some considerable period, and one of which advantage should therefore be taken. Domestic arrangements made it impracticable to get away during the time of the congress, but shortly after an offer on the part of the secretary of the Association of Students of the Institution of Electrical Engineers to accompany his party was gladly embraced, and this short paper is based on some of the notes then collected and subsequently embodied, in a condensed form, in a private report made to the Electric Construction Company, Limited, of Wolverhampton.

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At the outset, the author thinks it desirable to state that the subject is approached from the point of view of a follower—afar off—but still with an open mind, of a past-president of the Institution of Electrical Engineers, whose faith in the general applicability of the continuous current is well known; that the practical side of the question only is considered; that no claim is made to originality or particular fitness for the work; that his own personal opinions are given, and that the said opinions are not necessarily shared by any other individual known to him; and, finally, that as there was no thought of basing a paper upon the notes so made, they have been found lacking in the definiteness and precision which would appeal to a critical audience.

Knowing how Swiss inventors and manufacturers have taken a leading position in the practical development of alternating transmission plant, one was quite prepared to find this system very widely applied, and, although among the 20 or so electric stations visited direct-current equipments preponderated numerically, still it was somewhat of a surprise to find that the most striking feature was undoubtedly the very general adoption of alternating apparatus, principally, but not exclusively, polyphase ("polyphase," as used throughout this paper, includes the two-phase system). An expression of opinion, coming as this does from such able and experienced transmission engineers as the Swiss, is worthy of very careful consideration, and an attempt is here made to critically examine it in the light of a few picked examples.

The town lighting supply stations at Zürich and Neuchatel are typical cases of single-phase plant, the demand in the former place having outgrown the supply; it is eked out by a motor alternator (and not, as has been frequently stated, by a rectifier) and battery plant at the remote end of a feeder. At Neuchatel (if the author remembers aright) the alternators are specially arranged for running, if desired, at some future time as two-phase machines. Baden and Chevres (city of Geneva supply) are excellent examples of two-phase machinery, the distribution being purely two-phase alternating in the former and hybrid in the latter. Three-phase plant is exemplified on a large scale for long-distance transmission at Oerlikon and at the Zürich works of Messrs. Escher, Wyss, and Co. Single-phase transmission for power purposes is not used to any very considerable extent, and it will not be considered further, although it has been stated that the memorable experiments at Frankfort were originally intended to be with this class of machine, and only by the accident of having a three-phase generator at hand was a polyphase current employed.

Looking backward, the author believes the great impetus given to electric transmission by the brilliant success of these experiments is largely responsible for the preference shown ever since for alternate currents, not only three, but also two and single phase. It was there demonstrated that exceedingly high line pressures could be commercially used, and that the alternate current alone was adapted for the step up and step-down transformation necessary. This flexibility, of very real value in genuine long-distance work, has since acted as a fetish, if the word may be used without offence, to conjure with, and it has apparently withdrawn attention from other methods believed to be more suitable in certain cases. Along with the general adoption of two and three phase currents for transmission has come the induction motor for power distribution, and it is difficult to say whether the compactness and simplicity of the motor as a distributor, or the flexibility of the alternate current as a transmitter, has done most to forward the polyphase system, for which at different times and in various places the following advantages have been claimed.

As to the generators: Polyphase dynamos have both a greater output and a greater efficiency than single-phase machines of like size. They can be built without moving wire, and as a consequence the armature conductors are readily insulated for high voltage, armature reaction and pressure drop are slight under changes of load, so that but little regulation is necessary, and the same machines serve equally to supply current for lighting and power distribution.

As to the line: A saving of copper amounting to about 25 per cent. is effected with three-phase current transmission, as compared with a direct-current line under equal effective pressures. The E.M.F. of transmission may by the use of step-up and step-down transformers be very greatly higher than that of the machinery at each end. The self-induction of the line with three-phase current is small, and the power factor correspondingly high.

As to the motors: Polyphase induction motors have numerous advantages over any other type in being extremely simple in construction. They have neither commutators nor rubbing contacts. They can be started without resistance in the armature circuit, have good initial torque and regulating properties, and run like shunt-wound motors under similar conditions. They are small, highly efficient, require little attention, and are not liable to accidental damage.

And generally: Polyphase plant is of almost universal application, being admirably adapted for power purposes, and readily lending itself to efficient lighting from the same circuits.

These are some of the advantages which the writer had in mind and was prepared to find in the several works where polyphase plant has been installed. Now as to the extent to which they are realised in practice.

The works of the Maschinen-Fabrik Oerlikon are largely driven by electrical power obtained from Hochfelden, distant nearly 14¼ miles. Three-phase current at 50 periods is generated at 86 volts, and after transformation to 13,000 volts is transmitted over a line consisting of four wires placed symmetrically at the corners of a square of 19¾in. side at a height of about 25ft. above the ground. The four wires, of which one is spare, are carried on oil insulators; each wire is 4mm. (0·158in.) diameter, the material copper, and the resistance 31 ohms. At Oerlikon, the current, after being reduced in pressure to 190 volts, is distributed to induction motors, some of which are started by directly switching on the full pressure without resistance; other motors are furnished with slip rings, and have three-circuit starting resistance and switches to correspond. The line loss is given at 7·5 per cent. of the initial high-tension voltage with 18 amperes per phase. This apparent load of 400 kw. furnished by two of the three 200-kw. hydro-electric generators running at full load corresponds to an actual net load of 310 kw. on the low-tension secondary at Oerlikon. The efficiency of the step-down transformers is not stated, but taking into account their size and the space occupied by the insulation necessary for 13,000 volts, it will probably not exceed, say, 95 per cent., and on this assumption the power factor appears to be slightly over 87 per cent.—*i.e.*, ratio of apparent to true watts on the high-tension side at Oerlikon. This is undoubtedly a high result, and it is attained by the extensive use made of synchronous machines, there being one such motor of 170 h.p. and another of 80 h.p., and in addition a steam-driven alternator of 65 kw., over-excited, and run in parallel with the power circuits, but doing little or no other work than acting as a phase controller.

With such a long transmission line as 14 miles, it might be expected that there would be a very considerable amount of self-induction to compensate, but this does not appear to be the case. The Maschinen-Fabrik Oerlikon, to whom the author is greatly indebted for most of the hitherto unpublished details of this plant, as also for those relating to Messrs. Escher, Wyss, and Co.'s installation, state that the "effect of induction on the line is not of importance, and can be neglected"; hence it would appear that the reduced factor is entirely due to the induction motors, some of which will always be running lightly loaded. It is noteworthy that the lighting and power circuits at Oerlikon are kept distinct, the bulk of the lamps being fed with continuous current. There may be a special reason for this, as the hydro-electric power available is inadequate to run the whole works, steam auxiliary plant being regularly in use.

Just here it is interesting to make a rough calculation of what could be accomplished with a high-tension continuous current over the same 14 miles of line and using the same amount of copper. The basis of comparison, if not scientifically accurate, is an eminently practical one. The commercial transmission efficiency may be put thus: There

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are two 200-kw. generators running together fully loaded at Hochfelden, and affording a net load of 310 kw. on the secondary at Oerlikon. For direct-current transmission the three active line wires, having each a resistance of 31 ohms, will be combined into two of equal section, affording a complete circuit with a resistance of 19·4 ohms. The efficiency of two direct-current transformers to give a combined output of 310 kw. on the secondary will be 93·5 per cent., so that 331·55 kw. must be delivered as high-tension current. This leaves 68·45 kw. as the line loss, corresponding to a current of 40·69 amperes, to a primary generating pressure of 9,830 volts, to a line drop of 1,631 volts, and to a terminal E.M.F. of 8,149 volts. Present experience with high-tension commutators goes to show that these pressures, while undesirable on a single machine, would be perfectly practicable if divided over two with the neutral connection earthed. This is a remarkable result, as the direct-current primary pressure is fully 35 per cent. less than that actually used with the three-phase current.

Another instructive example of three-phase transmission was seen at the very fine and extensive Zürich works of Messrs. Escher, Wyss, and Co. The hydro-electric power-house is actuated at Zufikon Brengarton, distant about 12½ miles. There are four alternators, of 224 kw. each, driven by a 325-h.p. turbine. Three-phase, 50 periods, current is generated at 5,000 volts and distributed in several directions, some 80 h.p. each going to Oerlikon and Wohlon, 60 kw. to Sebach, about 250 h.p. to a flour mill in Zürich, and about 400 kw. to Messrs. Escher, Wyss, and Co.'s. The Zürich line consists of two three-wire feeders, each conductor being of copper 7·7mm. in diameter carried on double-shed porcelain insulators. The actual resistance of each wire is not known to the author, but it should be about 7·85 ohms. The conductors are symmetrically arranged three on each side of the post on the same number of cross-arms, the distance, both vertical and horizontal, between contiguous wires being 17¾in. The normal maximum load during the daytime is about 400 kw, and the line loss 15 per cent. The load consists entirely of induction motors, many running more or less light, hence the power factor is only 75 per cent. As at Oerlikon, a synchronous motor is run continuously to compensate for the lagging current. In this case, however, the machine is a very large one, the three-phase armature being wound for 210 volts and 500 amperes at a speed of 750 revolutions, and it runs absolutely without external load so as to secure the best regulation. The cost of this machine, with starting and synchronising gear, was ab ut £480, or only £2. 13s. per kilowatt, the speed being very high. Here also the lighting is carried out with direct currents on a three-wire system, it being considered undesirable to have lamps on the motor circuits. During the summer the direct-current lighting machines, aggregating 60 h.p., are driven by a three-phase motor, but in winter larger generators are required, and they are then run by a steam-engine.

Again comparing with a direct-current transmission. Three of the 7·7mm. wires, each 7·85 ohms resistance when combined into two, will give a circuit resistance of 10·46 ohms. Allowing a total loss of 36·25 per cent. (corresponding to 15 per cent. line drop and a 75 per cent. power factor) it is found that with a primary generating pressure of 5,000 volts a current of 173 amperes can be transmitted, giving a net power of 550 kilowatts, available on the high-tension side at Zürich. This, of course, is very largely in excess of what is now actually obtained.

Two-phase transmission is not, so far as the author is aware, used in Switzerland over any long distances.

The Baden plant, installed by Messrs. Brown, Boveri, and Co., who have very kindly revised the notes made at the time of the visit, and have also furnished additional particulars, is an excellent example of two-phase apparatus. The generators are each composed of two electrically and magnetically independent single-phase alternators of what is known in this country as the Westinghouse type. In appearance they are almost identical with the two-phase generators subsequently exhibited by that company at Chicago. Each half machine is independently regulated, and the several alternators are paralleled in the power-house. The frequency is 40 periods and the voltage only 1,000, the town feeders being barely a mile long, while Messrs. Brown, Boveri, and Co.'s feeder is only five-eighths of a mile in length. In these works power is distributed at 115 volts by two-phase induction motors driving principally short lengths of shafting. These motors, running up to 30 h.p., are started without resistance, but also without load, by means of a slack belt gear. Some smaller motors are started indifferently with or without load and without resistance, but all machines on public supply circuits must be provided either with a reducing transformer, or preferably with slip rings, and an appropriate starting resistance for the rotor circuit. The latter disposition is the better one, as motors get under weigh with full load torque without taking more than the normal full load current. The crane motors in these shops are all three-phase machines running with the very low frequency of 13 periods per second. Current for them is furnished by slip rings on a two-pole direct-current machine coupled to a two-phase induction motor, an arrangement, as will be seen, which removes from direct connection with the main circuits those motors most liable to frequent starts, stops, reversals, and variations of load. The main shop motors are, of course, run continuously during working hours. The factory lights are principally tapped through special transformers on the town feeder, only a few being fed from their own power circuit. Messrs. Brown, Boveri, and Co. wish it to be borne in mind in connection with this plant that it was designed and laid down in 1892, a fact which will account for the divergence from modern practice in several of the details.

Perhaps the finest example of hydro-electric work in Switzerland, and certainly one of the most well considered, is the station at Chevres, on the Rhone, supplying Geneva with two-phase, 45-period current at 2,500 volts. The distance is not great, being about 3¾ miles, with an underground transmission line composed of four conductors, each 0·76 square inch in section. The generators are simply two single-phase machines of an inductor type superposed on a vertical shaft. Each phase is regulated independently, and the alternators are to be paralleled in the power-house. The general arrangement of these dynamos is rather good in that a considerable flywheel effect is obtained without undue weight on the shaft, and to the extent that there is no moving wire it appears preferable to the Niagara design, which would not in any case have answered at Chevres, because current suitable for lighting is a prime necessity. In passing, it may be noted that these machines give considerably less E.M.F. than was anticipated, and the difference is made up by boosters—"survolteurs." At the receiving end in Geneva there are several systems of distribution. One, a three-wire direct-current supply at 2 × 100 volts; another, an alternating network at the same pressure; a two-phase power circuit at 500 volts, also used for street-lighting; and, fourth, the trolley system, direct current, at 500 to 550 volts. The first and last of these are fed through rotary converters, made by the Alioth Company, of Munchenstein, Bale, and it is noteworthy that, notwithstanding the independent control over each phase at Chevres, the constancy of pressure at Geneva was greatly increased when these rotaries were started up. Unfortunately, owing to the stoppage of the Chevres plant since the close of the exhibition, the experience with these converters has not been very great, but Colonel Turrettini has informed the author that the working of the 2 × 110 volt lighting machines was not attended by any sparking, and they are believed to have been entirely satisfactory. These rotary converters are really very fine specimens of their class, and appeared to be thoroughly well designed and put together. A description of one of the two types—that with a Gramme armature—has been published in this country, but the larger machines, with drum armatures, have not previously been described. This latter form is preferred by the Alioth Company, who have very kindly placed the following particulars at the author's disposal.

The machine takes current at 360 volts alternating on the slip rings from two 80-kw. transformers—one for each phase, at a speed of 338 revolutions per minute, delivers 560 volts and 268 amperes at the commutator brushes. The armature is 34¼in. diameter by 11¼in. long. There are 320 slots, and the same number of coils and commutator bars. The winding is of copper wire 2·5mm. diameter.

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The armature weighs 6,400lb., and carbon brushes are used. The magnet yoke is of cast iron, carrying 16 steel limbs and pole-pieces, and absorbing 1,150 watts for excitation. The complete machine weighs 26,000lb. It is started by a regulating transformer of only 5 kw., used, however, as a reducer, the starting current being slightly in excess of that at full load, and the requisite E.M.F. only 12 volts or so.

The study of these converters is a most interesting one from several points of view, but particularly on account of their value as compensators for self-induction in generators and transmission lines, and incidentally because, while performing this function, they can be made to compensate for resistance drop on the direct-current low-tension distribution network. It has been seen that the use of over-excited synchronous motors in the former capacity is much favoured in Switzerland at present, and if these are constructed to act as converters to direct current, it becomes practicable by variation in the strength of field to control the E.M.F. at the continuous-current brushes. A strong field causes a rise and a weak field a fall of pressure at this point. The leading and lagging currents respectively produced by these conditions may further be taken advantage of to produce a pronounced compounding effect. Mr. Steinmetz (*Electrical Engineer*, New York, January 1, 1897) has utilised this feature on a 14-mile transmission for street railway work between Oregon City and Portland in America. His arrangement is as follows : The generators are kept at constant excitation corresponding to 6,500 volts at no load, the line and transmission loss is about 10 per cent, and the converters have weak shunt excitation but a strong series field. In consequence, at light load their E.M.F. is low, and a considerable lagging current flows over the line, the E.M.F. of self-induction is 90deg. behind the current, and as the current lags behind the E.M.F. of the generator, it results that the E.M F. of self-induction is practically in opposition to the generator E.M.F., the impressed E.M.F. on the converters is reduced to that extent, and so brings down the pressure to 500 volts on the brushes of the rotary converter. Conversely, at full load the rotaries are much over-excited, and their E.M.F. rises beyond the impressed E.M.F., the alternating current is then a leading one, and the E.M.F. of self-induction, being 90deg. behind the current, is nearly in phase with the generator E.M.F., so that at full load the voltage drop between generator and converter is greatly less, resistance drop being compensated by the rise due to self-induction and leading current, and as a result the voltage at the commutator brushes actually increases from 500 at no load to 550 at full load, instead of falling from 600 at no load to less than 500 at full load, as would otherwise be the case.

The method, while evidently very efficient from the point of view of regulation, is obviously no royal road to overcoming loss on the line. Between light load with its lagging current and heavier load with its leading current there is apparently only one point where the power factor becomes unity, and then only are generators, line, and converters working individually and collectively at their best, or at what should be their best. At all other times the losses must be considerably greater than correspond to the work done. This particular method is not, so far as can be learned, in use in Switzerland at present. Any required variation on the direct-current side is there obtainable either by regulation of the static transformers, which reduce the line pressure 2,500 volts to 360 volts for the slip rings, or by boosters on the primary. Other analogous arrangements are possible, and, in the author's opinion, preferable to compounding, which, however, is simple and automatic.

Reverting now for a moment to the claims already enumerated which have been advanced for polyphase power transmission plant. At Hochfelden (Oerlikon) the three-phase dynamos comply with the claims; they are relatively small and inexpensive, are highly efficient, generate at a low pressure, which is transformed without difficulty to a very high one, and but for the inductive load would have a small pressure drop The line, for reasons stated, does not show the 23 per cent. economy in copper which the three-phase system is supposed to effect over a direct-current line. The motors at Oerlikon are doubtless quite satisfactory. Their use, however, entails a low power factor (reducing the available horse-power some 13 to 15 per cent.). This reacts on the generators, and tends to cause a pressure drop of 15 per cent. or so, which is compensated at the cost of larger machines. At Bremgarten (Escher, Wyss, and Co.'s) the same remarks apply to the generators and to the line. The motors are not quite so simple as claimed, being, in fair sizes, started with resistance in the rotor circuit. Their general use at all sorts of loads causes a very low power factor, not greater than 75 per cent. At Baden (Messrs. Brown, Boveri, and Co.'s) the two-phase alternators do not comply with any of the claims made for polyphase apparatus, but their construction does make it practicable to operate motors and lights together. The line has none of the advantages pertaining to polyphase circuits, the power and lighting feeders being distinct. The factory motors in medium sizes fulfil the claims, but are started with a slack belt gear. At Chevres (Geneva) the foregoing remarks apply to the alternators and to the transmission line.

With regard to lighting, it seems to be generally admitted that in connection with induction motors running under variable load, really good results cannot be obtained at all on the three-phase system. If lamps must be connected to the motor circuits, then a four-wire lighting distribution, supplied, if possible, by a separate feeder, should be used. With a two-phase system and single magnetic current generators the same remarks apply. A practicable result is obtained with independently controlled phases, but even then separate feeders are most desirable, and at the best one circuit—say, the lighting—is closely regulated at the expense of the other—the power circuit. In all cases where the transmission line is a long one, synchronous motors, or their equivalent, are essential at the receiving end.

It may be objected that in each of the three examples—Oerlikon, Zürich, and Baden—the plant is not of the most modern design, and that with maturer experience the generators and transformers could be constructed with a smaller drop, and the motors with smaller air-space and less magnetising current. This may or may not be valid, but it remains that those who have had most experience consider that alternators with a potential drop of 4 to 5 per cent. at the lamps and about 15 per cent. at the motors are about as good as can be made.

Having said so much about the system generally, it is due to add that from the factory manager's point of view two and three phase motors are perfectly satisfactory. Not too much need be made of starting under load and without resistance, because the same claim can be made for direct-current shunt motors, and because in neither case is this allowed on public supply circuits. The satisfaction arises more perhaps from the perfection of accessory details, It was noticed at Messrs. Brown, Boveri, and Co.'s that small motor spindles were case-hardened and ground true. The bearings, it goes without saying, are self-oiling. The worm reducing gear as turned out by the Maschinen-Fabrik Oerlikon, and, doubtless, by others since, is a most excellently arranged mechanism. Its efficiency, which is remarkably high, is partly due to the ball thrust bearings, and partly, it is claimed, to high surface speed; but however arising, the success is undoubted, and more than sufficient to cover the multitude of sins attributable to high rotative speed. This gear is in almost universal use, not alone with induction motors, but also with direct-current machines on overhead travellers, and one of the most pleasing features in all works visited was the favour with which the arrangement is regarded. It is almost unnecessary to add that any one-motor cranes were seen.

The author's conclusions with regard to polyphase plant are as follows :

(*a*) As exemplified by the two long-distance transmissions named, three-phase plant involve very much higher line pressures than would be necessary with a practical direct-current constant-potential equipment under like conditions.

(*b*) Three-phase transmission at 10,000 volts, with power distribution by inductor motors only, compares unfavourably with direct-current plant at little more than one half the voltage.

(*c*) For long-distance transmission a three-phase line has undoubted advantages over any other system, but to

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realise these it is essential that none but synchronous or non-inductive consuming devices be used—induction motors have no place in work of this character.

(*d*) The best combination for really long-distance transmission comprises three-phase generators (step-up transformers), line and step-down transformers, rotary converters excited for minimum current, a direct-current distributing network, and direct-current motors. Any regulation on the latter circuit to be arranged so as not to cause phase displacement on the primary side. This is nearly, but not quite, the Niagara-Buffalo system.

(*e*) Where a line pressure of, say, 6,000 volts will give the necessary economy, three-phase apparatus is superfluous; a direct-current plant pure and simple will be more advantageous.

(*f*) For short-distance transmission at or below 2,000 volts, the use of a two or three phase equipment is generally disadvantageous.

(*g*) English engineer-electricians are to be congratulated on having viewed with some degree of scepticism the plunge made by their Continental friends into polyphase work. This type of plant, which is undoubtedly doing good service in Switzerland, has no *raison d'être* in England. Its development is a result of really cheap water power in some cases, and of supposedly cheap water power in others.

It remains to notice another type of transmission which is peculiar to Switzerland, or, at least, to Swiss engineers—the extra high-tension, continuous, constant-current, series system developed by Mr. Thury, of Geneva. The general arrangement is well understood and will not now be detailed. The system is best suited for the transmission of power only and for its distribution in moderately large units. The machines, generators, and motors alike are unquestionably very inefficient as compared with English contant-potential dynamos of the same output; but, on the other hand, is the fact that they work direct without any transformation on circuits of 15,000 volts or so. The motors have constant torque and a wide range of speed, the switchboards are extremely simple because the connections are never opened (only short-circuited), there are no fuses, and the line is of uniform size throughout. The disadvantages are obvious. Each machine has to be mounted entirely on insulators, and can only drive through a leather belt or insulating coupling. A wide wooden platform, also on insulators, is necessary round the machine for safety, and every motor requires an independent governor to control the speed. The system is consequently practicable with main as distinguished from individual machine motors. For lighting purposes it is rather cumbrous, as low-tension current can only be produced by the combination of a dynamo direct coupled to, but insulated from, a motor as above described. The details of governors, automatic short-circuiting cut-outs, switchboards, and lightning arresters are well worked out, and seem to give good satisfaction. The system has found considerable acceptance in Italy and Switzerland in competition with polyphase apparatus, but particularly in situations where natural water powers exist but are too far separated or too inaccessible to be unified into one large scheme. These are picked up, so to speak, in series, an arrangement to which the plant readily lends itself.

In conclusion, the author wishes formally to acknowledge his indebtedness to Colonel Turrettini, president of the Administrative Council of Geneva; and to the Alioth Company, of Bale; Messrs. Brown, Boveri, and Co., of Baden; Messrs. Escher, Wyss, and Co., of Zürich; and to the Maschinen-Fabrik Oerlikon, all of whom very kindly responded to requests for information and for confirmation of his notes.

ALTERNATOR DESIGN.*

BY J. FISCHER-HINNEN.

(Continued from page 598.)

Calculation of the Drop of Voltage.

Presupposing the above, we may now proceed to apply the formulæ (5) and (7) to practical calculations. If, for instance, we want to calculate the loss of pressure of a machine for a given output at which we know the cos ϕ of the phase difference between the terminal pressure and the current, this supposition is not always quite correct, but since an approximately exact calculation is absolutely impossible without the knowledge of this quantity, we have to put in here a value which is approximately correct and not too large. We need not specially remark that it is necessary to proceed cautiously with the estimate of cos ϕ, especially in the case of large lighting installations with transformers and with several machines, for example, where during the daytime only one machine has to provide the necessary current. In such cases it may easily happen that the exciting current required by the network exceeds half the normal current of the machine; in that case, cos ϕ falls as low as 0·2 to 0·3. If not built for plenty of power, the machine then will be insufficient, and two will have to work parallel with each other, which is far from being economical.

Experience teaches that the average day value of cos ϕ for a lighting installation with transformers may easily sink below 0·5 It is advisable to make a preliminary calculation of this. Knowing the magnetising current, J_e, the hysteresis current, J_h, and the power current, J_n, we get approximately—

$$\cos\phi = \frac{J_n + J_h}{\sqrt{(J_n + J_h)^2 + J_e^2}} \quad . \quad . \quad . \quad (8)$$

where E = E.M.F.;

E_1 = the terminal potential difference;

e = the E.M.F. of self-induction = J × R;

J = the strength of the current one phase of the armature;

R = the apparent resistance of one phase.

Then, as shown by Fig. 9, the terminal potential

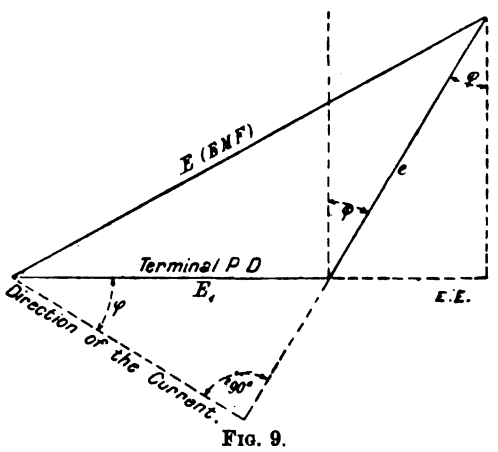

FIG. 9.

difference as a function of the E.M.F. and of cos ϕ would be

$$E_1 = \sqrt{E^2 - e^2\cos\phi} - e\sin\phi \quad . \quad . \quad . \quad (9)$$

For practical purposes a small alternation of this equation is recommended, as we may put

$$E_1 = \eta \, . \, E$$

and fix the value of the quotient, $\frac{e}{E}$, by

$$\frac{e}{E} = \sqrt{1 - \eta^2\cos^2\phi} - \eta\sqrt{1 - \cos^2\phi} = X \quad . \quad (10)$$

The meaning of the equation is clear. If a new machine has to be designed, then the loss of pressure—*i.e.*, η and cos ϕ—is predetermined. We ascertain from equation (10) the value $X = \frac{e}{E}$, and insert the same in equation (5), and so obtain the value of the ampere-turns on the magnets, or from that

$$N = \frac{X}{J}\,\frac{p \, . \, i\,m}{\sqrt{2}\left(\frac{n}{2}\right)K''q} = \frac{X}{J}\,\frac{p \, . \, 0{\cdot}8 \, . \, B \, . \, \delta\,a}{\sqrt{2}\left(\frac{n}{2}\right)K''q} \quad . \quad (11)$$

where B = the magnetic induction in the air-gap;

δ = the total length of air-gaps. In symmetrical machines this is twice the distance between the armature and polar surfaces;

* From the *Elektrotechnische Zeitschrift.*

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a = a coefficient varying from 1·3 to 2, which allows for the magnetic resistance of the iron $= \frac{\text{Total resistance}}{\text{resistance of air-gap.}}$

The coefficient, a, may vary very much, but care has to be taken when dimensioning the magnets that the total resistance agrees with the predetermined estimate. By dividing equation (11) by the number of armature teeth (which number is always a multiple of p), we get the number of turns per tooth. This number of armature-turns per tooth is constant in machines of different sizes, but of the same current output and magnetic density in the air-gap if the same drop of pressure is to be obtained.

Predetermination of Dimensions.

In order to get the dimensions of the armature we insert in equation (1) the value of N from equation (11). Also we may put

$$\Phi = \frac{D \pi \beta}{2p} \cdot l \cdot \beta,$$

where l = length of armature in centimetre,
D = diameter of armature in centimetres,
which gives

$$D \cdot l = \frac{E_1 \cdot J}{c} \frac{113 \cdot 10^6 \cdot K'' \cdot q}{\eta K \cdot a \beta X \cdot B^2 \delta} \cdot \binom{n}{a}. \quad (12)$$

J, as previously explained, represents the current in one phase, and since $\frac{n}{2} = 1$ for single-phase as well as for two-phase machines, the latter are evidently more economical as regards output for size than the former. It is to be noticed that in equation (12) the number of pairs of poles disappears. We therefore get the interesting conclusion that the dimensions of an alternating-current machine for a given output, number of periods, and drop of pressure are theoretically independent of the number of armature-turns. In other words, machines of entirely different number of turns would have the same dimensions, provided the induction remains the same. Further, a two-phase machine would only be half the size of a one-phase machine. That this is not the case in practice proves only the impossibility of putting widely varying number of turns on the same sized armature. In fact, the space required by the winding is not taken into account in equation (12). This space, however, reduces the section of iron available for the magnetic induction. From equation (11) we see that the number of turns per armature tooth is independent of the number of poles. Therefore, also, the winding space per tooth changes only slightly with the number of poles. The change tends to increase the space as the number of poles is increased.

TABLE III.

Values of $X = \sqrt{1 - \eta^2 \cos^2 \phi} - \eta \sqrt{1 - \cos^2 \phi}$.

—	Values of η =									
	0·95	0·9	0·85	0·8	0·75	0·7	0·65	0·6	0·55	0·5
cos ϕ = 1·00	0·31	0·436	0·525	0·600	0·66	0·714	0·760	0·80	0·832	0·865
0·95	0·147	0·252	0·336	0·412	0·476	0·536	0·591	0·642	0·687	0·730
0·9	0·107	0·195	0·274	0·347	0·41	0·471	0·527	0·579	0·628	0·674
0·85	0·09	0·171	0·245	0·311	0·376	0·435	0·492	0·545	0·595	0·642
0·8	0·08	0·155	0·221	0·287	0·35	0·406	0·464	0·516	0·566	0·615
0·75	0·073	0·142	0·210	0·272	0·33	0·388	0·442	0·494	0·547	0·595
0·7	0·069	0·131	0·199	0·254	0·314	0·37	0·426	0·477	0·529	0·579
0·65	0·064	0·124	0·188	0·246	0·304	0·36	0·412	0·465	0·516	0·568
0·6	0·06	0·12	0·180	0·235	0·291	0·346	0·40	0·452	0·504	0·553
0·55	0·059	0·116	0·172	0·228	0·280	0·339	0·391	0·442	0·493	0·543
0·5	0·058	0·113	0·167	0·222	0·274	0·331	0·384	0·433	0·485	0·535
0·45	0·057	0·110	0·163	0·218	0·269	0·324	0·378	0·426	0·479	0·528
0·4	0·056	0·108	0·159	0·214	0·265	0·318	0·372	0·421	0·472	0·521
0·35	0·055	0·106	0·156	0·211	0·261	0·313	0·367	0·415	0·466	0·515
0·3	0·054	0·104	0·154	0·208	0·257	0·310	0·363	0·411	0·461	0·511
0·25	0·053	0·103	0·152	0·205	0·254	0·307	0·359	0·408	0·457	0·507
0·2	0·052	0·102	0·151	0·203	0·252	0·304	0·357	0·405	0·455	0·505
0	0·05	0·1	0·15	0·2	0·25	0·3	0·35	0·4	0·45	0·5

Therefore, as the speed of the armature decreases the number of poles increases from the same frequency, and consequently the effective diameter of the armature is lessened. It is, therefore, necessary to reduce the induction, B, which, from (12), causes an increase of the product, D l. The same cause tends to diminish the apparently great advantage of the two-phase machines over the single-phase machines. In order to take this point into consideration, we may introduce a new quantity—*i.e.*, the number of ampere-hours per centimetre of the circumference of the armature. Take

$$\gamma = \frac{J N \left(\frac{n}{2}\right)}{D \pi} \quad \ldots \ldots \quad (13)$$

Table III. gives average figures between those contained in Table I. and those of Prof. Arnold's article, whereby

$$J = \frac{\text{power current}}{\cos \phi} = \frac{\text{power current}}{0{\cdot}85}.$$

TABLE IV.—Average values of γ.

Single-phase machines.	
Fig. 1, with armature outside and revolving exciting coil	38
Fig. 2, Kapp alternator	70-130
Multiphase machines.	
Fig. 6, with fixed exciting coil	40
Fig. 7, armature outside and revolving exciting coil	30

Again, B is obtained from equation (11):

$$B = \frac{N \cdot J \cdot \sqrt{2} \left(\frac{n}{2}\right) K'' q}{X \cdot p \, 0{\cdot}8 \, B \cdot \delta a},$$

and N is substituted from (13).

Also, $$\frac{c}{p} = \frac{v}{60},$$

where v = the number of revolutions.

This is inserted into equation (1), and from that D is calculated.

$$D = \sqrt[3]{\frac{1}{l}} \times \sqrt[3]{\frac{E_1 J \left(\frac{n}{2}\right) 216 \times 10^6 \cdot p \cdot \delta a X}{v \eta K \gamma^2 \beta K'' q}}. \quad (14)$$

Having calculated D from either (12) or (13) we proceed to ascertain the armature-turns from (11) or (13), and it only remains to calculate the winding of the magnet, which may be done after the well-known method of Dr. Hopkinson. An essential condition is always that the number of ampere-turns upon the magnets shall correspond with the conditions given by equation (11).

Table III. may be used to save the trouble of calculating value of X afresh each time.

First Example.

The dimensions of a single-phase alternator is to be calculated from the following particulars: Output 35 kw. with cos ϕ = 0·85—*i.e.*, 41 kilo-volt-amperes; J = 41 A; frequency, 50 ⁓ per second; 600 revolutions per minute, 10 poles (p = 5); drop of pressure = 20 per cent., η = 0·8. It is further assumed that—

$B = c a \cdot 8{,}800.$
$K'' = 1{\cdot}14$ (from Table II.).
$q = 0{\cdot}8.$
$\delta = 0{\cdot}5.$
$a = 2.$
$\beta = 0{\cdot}75.$
$X = 0{\cdot}311$ (from Table III.).
$K = 4.$
$\gamma = 38.$

Then if we take for example the length of the armature to be 20cm., we get from (12)

$$D = \frac{1}{20} \cdot \frac{41{,}000 \cdot 113 \cdot 10^6 \cdot 1{\cdot}14 \cdot 0{\cdot}8}{50 \cdot 0{\cdot}8 \cdot 4 \cdot 2 \cdot 0{\cdot}75 \cdot 0{\cdot}311 \cdot 77{\cdot}4 \cdot 10^6 \cdot 0{\cdot}5} = 73{\cdot}2\text{cm}.$$

or from (13)

$$D = \sqrt[3]{\frac{41{,}000 \cdot 216 \cdot 10^6 \cdot 5 \cdot 0{\cdot}5 \cdot 2 \cdot 0{\cdot}311}{20 \cdot 600 \cdot 0{\cdot}8 \cdot 4 \cdot 38^2 \cdot 0{\cdot}75 \cdot 1{\cdot}14 \cdot 0{\cdot}8}} = 71{\cdot}5\text{cm}.$$

The difference arises from the fact that the induction, B, is taken a little too low in the first equation. In reality, B = about 8,000 C.G.S. lines per square centimetre.

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There still remains the calculation of the number of armature-turns.

From (11)

$$N = \frac{0{\cdot}311}{41} \cdot \frac{5 \cdot 0{\cdot}8 \cdot 8{,}900 \cdot 0{\cdot}5 \cdot 2}{\sqrt{2} \cdot 1{\cdot}14 \cdot 0{\cdot}8} = 209.$$

As a check we may determine N also from (13)

$$N = \frac{D\pi}{J}\gamma = \frac{71{\cdot}5 \cdot \pi \cdot 38}{41} = 208.$$

(To be continued.)

INSTITUTION OF ELECTRICAL ENGINEERS, Nov. 11.

At the opening meeting of the new session of this Institution last night, the president, Sir Henry Mance, in the chair, the proposed list of officers for the ensuing year was read. Should anyone desire to propose additional candidates, we would remind them that the proposals, signed by 10 members and accompanied by the written consent of the person nominated, must be sent in to the secretary within seven days. The following are the names proposed by the Council:

PRESIDENT.

†Joseph W. Swan, F.R.S.

VICE-PRESIDENTS.

*Prof. S. P. Thompson, D.Sc., F.R.S.
*Prof. John Perry, D.Sc., F.R.S.
†W. E. Langdon.
†James Swinburne.

ORDINARY MEMBERS OF COUNCIL.

*S. L. Brunton.	*Dane Sinclair.
*Prof. J. A. Ewing, F.R.S.	*Herbert Taylor.
*W. P. J. Fawcus.	*Charles Henry Wordingham.
*Major R. Hippisley, R.E.	‡Henry Edmunds.
*Prof. J. A. Fleming, M.A., F.R.S.	†Robert Kaye Gray.
	†P. V. Luke, C.I.E.
*E. Manville.	†W. M. Mordey.
*John S. Raworth.	†A. A. Campbell Swinton.

ASSOCIATE MEMBERS OF COUNCIL.

*H. W. Miller.
*Sydney Morse.
†Sydney Evershed.

HONORARY AUDITORS.

‡Frederick C. Danvers.
†E. Garcke.

HONORARY TREASURER.

‡Prof. W. E. Ayrton, F.R.S. (past-president).

HONORARY SOLICITORS.

‡Messrs. Wilson, Bristows, and Carpmael.

* Remaining in office. † For election. ‡ For re-election.

The following was the paper read:

Accumulator Traction on Rails and Ordinary Roads.

BY L. EPSTEIN, MEMBER.

While electric traction on the trolley system has proved on the whole an unqualified success, both from a technical and financial point of view, traction by means of accumulators could, until quite recently, only be pronounced a failure, and all that even its most ardent advocates can plead for is the substitution of the term "qualified success." However, at the present time, signs are not wanting that promise at last success for accumulator traction. The progress made in the manufacture of secondary batteries, and the experience gained with regard to the best mode of using them, not only warrant that belief, but, what will no doubt prove more convincing, relatively good results have already been obtained. It will be remembered that ever since accumulators were produced on a commercial scale attempts were made from time to time to use them for traction purposes, but all these experiments up to a short time since—although frequently hailed with great enthusiasm—only led to disappointment, from a commercial point of view.

An investigation of the causes which militated against success might prove useful, and will show that they may be divided into two classes—viz., inherent defects in the accumulators themselves, and mistakes in the mode of their application. Dealing with the method of working first, it will be seen, on analysing the expenses, that, apart from the cost of repairs and renewals, a heavy expenditure was incurred by the handling of the batteries; and, in view of the success of trolley traction, it is natural that the remedy should suggest itself to imitate, as far as possible, the latter system—that is to say, to employ accumulators in such a manner that they require a minimum of attendance and handling. It was, as we all know, the common practice to sub-divide the battery into a number of groups, each contained in a tray, and the connection between one tray and the next, as well as at the terminals both on the cars and in the lifts for charging, was most imperfect. Sliding contacts were generally used, which were open to attack by the acid spray, necessitating almost incessant cleaning and repairs. Again, the pulling out and pushing in of these heavy trays was not always done with the requisite care, much to the detriment of the batteries, cars, and lifts. A further considerable source of waste consisted in the electrical leakage when charging, especially as many tiers of the cells were underground, and therefore out of sight, whilst they were not easily accessible, and were thoroughly saturated with acid spray. These difficulties and losses can be obviated by adopting a system which will allow of the batteries being treated as a mechanically and electrically well-connected whole, either by being placed in the cars or preferably slung to the frame, or carried on a separate car—apart from the sub-division in groups for coupling in parallel or series during discharge. Where the conditions of working render it desirable, the motor, or motors, could also be fixed in the battery car, which would then assume the character of an electric locomotive; but in any case, whether carried in the car itself or slung to the frame, or carried on separate wheels, the battery should not be sub-divided and handled in the old way, but should always be treated as an indivisible unit. The obvious advantages gained by this method are the absence of lifts or similar contrivances, good connection between cell and cell, no corroding contacts, no loss of current through leakage, less wear and tear of the batteries, and consequent easier management, and reduced expenditure. The importance of obviating the exchanging of batteries has been fully recognised on the Continent, and the methods of working in Hanover and Paris offer interesting illustrations of how this object has been attained.

In Hanover, as is well known, a combined system of trolley and accumulators is in use. The batteries are charged from the trolley *en route*, and an additional charge is given to them on their return to the car-shed. This installation is on a sufficiently large scale to render the financial results of commercial value, and it is gratifying to see from the official report that the results for the year 1896 were pronounced to be in every respect satisfactory. The cost of maintenance is said to have been accurately ascertained, and found to average per car and month 40s., which at an average mileage of 90 per car and day corresponds with ·177d. per car mile. The directors anticipate that this cost will be increased somewhat, but they are also confident that it will in no case exceed 60s. per car and month which amounts to ·266d. per car mile) even in those years when the quicker deterioration of the plates will occur. It must be understood that the cost of maintenance includes renewals of plates to keep the latter always in good condition, so that the additional depreciation is reduced to a rate not higher than that of the renewal of other parts of the machinery. Based on the actual experience gained, this rate has been fixed at 6 per cent., and with an accumulator car covering between 31,000 and 34,000 miles during the year on this mixed system, accumulator traction incurs an additional expenditure of ·4d. per car mile as compared with the trolley. Taking into account that in the absence of the accumulators the trolley system would have to be installed throughout the whole line at an outlay of £2,000 per mile of track, and further considering the maintenance of the overhead system and the saving in the wear and tear of the trolley, which is, of course, at rest while the accumulators are supplying the current, it is computed that even on the most unfavourable assumption the extra cost of the combined system compared with the overhead system alone does not in Hanover exceed ·2d. per car mile.

It may be of interest to mention here that the running expenses of the electrical system, including driver, amounted to 2·22d. per car mile. This system, although so far satisfactory, is open to certain objections, the foremost being the dead-weight of the accumulators carried on the trolley-wire section. It might be found more advantageous to place the batteries in a frame slung to the car, or in dummy cars, either of which could be picked up at the end of the trolley section, while the charging of the accumulators could still be effected in the same manner from the trolley wires, the only difference being that the charging would take place at fixed points instead of *en route*.

A different system is employed in Paris, where the Société des Moteurs have installed and are working a line about 12 miles long at the same cost, including depreciation, as horse traction. Here the plan has been adopted of charging the batteries at the stopping places, the time of charging varying ordinarily between eight and ten minutes, and the charging is effected not, as is usual, at constant current, but at constant potential, consequently very high current densities are applied at the beginning of the charge. Six feeder circuits are projected, of which three are working at present. These circuits

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are underground, and, although of different lengths, are all of uniform resistance. I am not aware that any figures showing the actual cost of working are available.

It will be seen that, however different these two systems may be in detail, they have the following points in common: (1) The batteries are dealt with as a whole. (2) The batteries are once for all installed in the cars where they are charged and discharged. (3) Each of the two systems permits the use of batteries of less weight than if the old practice had been followed of charging them either at the journey's end or at constant current.

Never losing sight of the object in view—viz., to approach in the mode of working as far as possible the overhead or conduit system—the special method to be adopted will depend upon local circumstances. While in one case the batteries may be advantageously carried in or slung to the car, in others it will be found desirable to place them in dummies, which latter might also carry the motors, as an alternative to the motors being fixed in the cars. A dummy with a battery sufficient to propel a 52-passenger car for about eight hours will weigh, complete, about three tons, the dummy itself, with axles and wheels, weighing about three-quarters of a ton. As each ton propelled under normal conditions incurs an expenditure of about ·4d., the extra weight of the dummy would increase the expense by about ·3d. per car mile. It is, however, obvious that this increase represents only a small fraction of the expenditure which is incurred when the accumulators are handled in the old manner, apart from the saving in wear and tear of the cars and of the batteries.

There are many lines on which the traffic varies considerably, not only as is usual during the different hours of the day, but perhaps in a much more marked degree, during different seasons of the year, such, for example, as tramways in market towns or seaside places. By the use of dummy cars the exigencies of a varying traffic can most effectively be dealt with, as they may be attached to one or more trailers, provided the batteries have the required qualities, and may safely be discharged at high rates. However excellent the method of using the battery may be, it will avail but little if the battery itself be lacking in the necessary qualities, and it may safely be asserted that the success or failure of accumulator traction will be decided by the merits of the accumulator. In order to lend itself satisfactorily to traction purposes, an accumulator must, in addition to all the good points possessed by a successful lighting cell, present special features of its own. Although lightness may not be the main consideration, yet it is a very important one. Again, the cell must not only be able to withstand jolting without shedding of material and high discharge rates without buckling, but, moreover, it must not decrease in capacity while in use, as this would necessitate alterations in the time table relating to the charging of the batteries, and interfere with the general arrangement. The battery, furthermore, should not require frequent overhauling, and the repairs should be neither more numerous nor more costly than those of any other part of the machinery. We all know that in the past batteries left very much to be desired. Some of the positive plates deteriorated much sooner than others, and this led first to the practice of replacing them by less damaged plates taken from other cells, and finally to that of converting part of the negative sections into positives. After some time the original array had dwindled down to a small fraction consisting of the least injured remnants, which were occasionally referred to as a proof of the long life of the type they represented. As a battery naturally consists of a large number of cells, and each cell again consists of a large number of plates, the overhauling and repairing proved a very serious item—in fact, in many cases the heaviest item of expenditure.

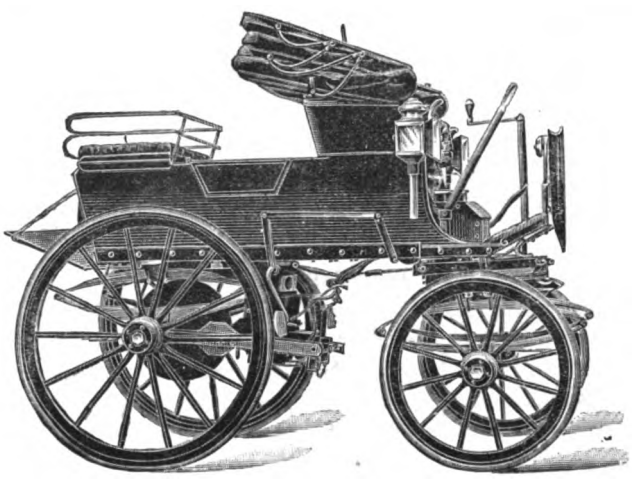
The nearest approach to an ideal cell for traction purposes will probably be one in which the positives are of the Planté type, with a large extent of surface, the layer of active material relatively thin, but in most intimate contact with the metallic lead out of which it has been formed. As is well known, while the capacity of a plate is determined by the volume of active material, the rate of charge and discharge depends upon its surface, and as it is quite feasible by means of ribs or protrusions, without unduly interfering with the mechanical strength of the plate, to extend its area to about 10 times that of the plain surface, it follows that the current densities obtainable will be increased in the same ratio. It is further essential that the acid should have free access to all parts of the active material, and such is naturally much more the case with a Planté plate offering a largely extended surface with a thin coating of peroxide than it would be in a plate with a plain surface, where the active material forms a relatively thick layer. Not only is the contact between active and conducting parts less perfect in the pasted plate, but, in addition thereto, as the acid in the pores of the active part is liable to become exhausted, especially with heavy discharge currents, while the interstices are too narrow to allow of a quick diffusion of the electrolyte, the electric action may be seriously interfered with, although there may still be a sufficient quantity of undischarged active material.

As regards good negative electrodes, positives of the above description, after having been reduced, may be employed with advantage, or lead oxides or salts may be used, as the finely reduced lead is a much better conductor than peroxide of lead; but care should be taken to secure the best possible contact between such material and its support, and so to select the materials intended to become active that they will, after full formation, produce a layer of the highest possible porosity consistent with mechanical coherence. It has been found by experiment that the exhaustion of a positive plate or section of a cell effects a gradual falling in the E.M.F., while as soon as the negative electrode is exhausted the E.M.F. falls very rapidly. For this reason, and as it is obviously advantageous to have as little variation in the E.M.F. of the battery as possible, I would suggest, for traction purposes, to use negative sections of higher capacity than that of the corresponding positive sections.

(To be continued.)

THE HEADLAND ELECTRIC CARRIAGE.

The illustration we give herewith is of the Headland electric accumulator carriage, which figured in the recent Lord Mayor's show. It was arranged by the Lord Mayor and Sheriffs' Committee that the electric carriage in question should follow the "Rocket" coach, the latter to represent 1837 and the former 1897. It is naturally an accumulator carriage, and we understand that its speed capabilities were not strained on the 9th inst.



FORTHCOMING EVENTS.

The following are some of the announcements for the forthcoming week:

TO-DAY (FRIDAY).—Physical Society, meeting, at the rooms of the Chemical Society, Burlington House, Piccadilly, 5 p.m. (Mr. J. Rose-Innes "On the Isothermals of Ether"; Mr. F. S. Spiers and Mr. F. Twyman "On the Variation in Temperature of the Electromotive Force of the H-form of Clark's Cells").—Council meeting at 4 p.m.

TUESDAY, NOVEMBER 16.—Institution of Civil Engineers, Great George-street, Westminster, ordinary meeting, 8 p.m. Paper to be discussed: "The Manchester Ship Canal," by Sir E. Leader Williams, member, with papers descriptive of "The Eastham Division," by Mr. Whately Eliot, member; "The Runcorn Division," by Sir E. Leader Williams, member; and "The Irlam Division," by Mr. W. O. E. Meade-King, member. At a subsequent meeting the following paper will be read and discussed: "Central-Station Electric Coal-Mining Plant in Pennsylvania," by Mr. W. S. Gresley, associate-member.

WEDNESDAY, NOVEMBER 17.—Institution of Electrical Engineers, students' annual general meeting for election of committee and secretary, at 28, Victoria-street, S.W., 7.30 p.m.—Society of Arts, John-street, Adelphi, opening meeting of 144th session, 8 p.m. ("The Colonies: their Arts, Manufactures, and Commerce," by Major-General Sir Owen Tudor Burne, G.C.I.E., K.C.S.I., chairman of council).—Meteorological Society, at the Institution of Civil Engineers, 7.30 p.m. ("Results of a Comparison between the Sunshine Records obtained Simultaneously from a Campbell-Stokes Burning Recorder and from a Jordan Photographic Recorder," by Richd. H. Curtis, F.R.Met.Soc.).

THURSDAY, NOVEMBER 18.—Chemical Society, Burlington House, 8 p.m.—Finsbury City and Guilds Technical College, Leonard-street, City-road, E.C., 8 p.m. (Mr. Philip Dawson on "Electric Traction").

MONDAY, NOVEMBER 22.—Imperial Institute lectures, 8.30 p.m. ("Electric Balloon Signalling applied to Scientific Exploration in Arctic and Antarctic Expeditions," by Mr. E. S. Bruce, M.A.).

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THE
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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

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BOUND VOLUMES.

Vol. XIX. of new series of "The Electrical Engineer" can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.

MANAGING ENGINEERS.

In the good old days, before patent reform, there were a considerable number of patents taken out which amongst interested parties were known as fishing patents. We are not quite sure whether the term is not equally applicable to newspaper work, and well might term many articles "fishing articles." The present one is intentionally to come within the class, inasmuch as at the present time, and with the somewhat meagre information to be obtained, any hard-and-fast conclusion is hardly possible. The subject to be discussed may be termed managing *v.* consulting engineers. The work of a consulting engineer may be fairly well defined. He is engaged to prepare designs and specifications of works to be carried out, and to supervise the carrying out of such works. The remuneration is generally a percentage on the cost of such works. In many cases the complete work is designed and carried out, in other cases the designer has to consider the completion of the work by future extensions, and to so arrange it that the part taken in hand in the first place is more or less complete in itself, yet so adapted as in the future to be merely a part of the whole. This extension at intervals is usually the course pursued in electric light and power undertakings. The original consulting engineer has then not only to consider in his designs the part of the work to be done immediately, but also to so arrange his designs that that part may without much difficulty be enlarged as business increases. If the original consulting engineer is employed to carry out the extensions, we cannot see that he has any grumbles to make; if, however, the extensions are carried out without his being employed, it is suggested with some truth that his remuneration is not proportional to the real work done. It is far easier for a new man to make extensions on a scheme partially carried out, as the whole scheme is more or less indicated, than it is to work out a scheme from the commencement. Why these remarks? There seems to be an indication on the part of some authorities to replace the consulting engineer after a part of an electrical generating or distributing scheme has been in operation, and extension is required, by what we have termed a managing engineer. This engineer is not to be in charge of the station, but to be in charge of extension works. From a purely £ s. d. point of view the authority may be a gainer by this course of procedure, in that it pays an annual salary in lieu of commission upon money expended, and *may possibly will say to the managing engineer in the course of a few years, "Your work is completed, and your services are no longer required."* We can understand that from all points of view exceptional cases may arise where one course is to be preferred above the other, but we desire at the present time to put the matter far more broadly, and to ask if it is more favourable in the long run to either of the parties concerned to prefer the managing to the consulting engineer. The contention may be wrong, but it seems in the first place that the consulting engineer's experience must be from a wider survey of

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and contact with professional work than that of the managing engineer, whose labours are confined to one locality. Hence, from this point of view alone, it would seem that to the authority the wider experience is really worth more than the limited experience. Again, is it not probable that the consulting engineer in the first instance will look at the work as a whole and insist upon a higher commission upon the part actually carried out under his supervision? Lastly, the outlook of the future of the managing engineer does not seem particularly rosy. As stated previously, our intention is not to dogmatise, but merely to bring the question before our readers—the time being ripe for its discussion.

TRACTION PRACTICE.

One object of the various engineering societies is to afford the members opportunities for discussing matters of common interest. This free expression of opinions after papers on various subjects have been read is most valuable, and tends to correct any mistaken value placed on an author's private opinions. The Mechanical Engineers practically opened the ball this season in London in this respect, and the discussion last week on Mr. Philip Dawson's paper on electric traction was sharp and to the point. It was a great pity that the paper came on so late in the evening, so that the author had no chance of replying to the points raised. The remarkable number of reconstructions of traction stations in America was perhaps the strongest point made against their traction practice, and it must also be curious to many to find that the contracting firms do not lose prestige with their frequent change of systems. The reason why repeated orders for remodelling stations are so frequently given may, perhaps, be found in the fact that the contractors control to a large extent the financial affairs of the tramway companies. The steam-engine practice came in for the most criticism, but we are afraid the theories of one speaker as to the harmful effect of a flywheel in causing shocks to the reciprocating part of an engine will act like boomerangs, and recoil on their propounder. It may be asked, indeed, if the steam pressure on admission gives, as he said, the largest possible shock to the engine, how can a flywheel which comes as a buffer between the dynamo and the reciprocating parts increase that steam pressure.

THE BEGINNING OF THE END IN TELEPHONY.

Those who have followed the signs of the times will know that many of our large towns desire to be relieved of the thraldom of the National Telephone Company. Glasgow has acted with some spirit in this matter, but London—like Brer Fox—lays low, though probably it is *the* city of the civilised world worst served telephonically. Its service is both dear and bad. The octopus hands, or more probably the lengthy purse of the National Company has hitherto managed to gain control sooner or later of all possible competitors. The end, however, seems to be foreshadowed, and probably ructions will come about when the present legal monopoly closes. We infer this because the States of Guernsey have accepted by thirty votes against two the Post Office license to construct a telephone exchange in the island, and the work thereon will be commenced immediately. The number of subscribers obtained for this exchange is already well over three hundred. The moral of the business is that a monopoly is broken, and this time it would seem for good.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

LEEDS AND BRADFORD LIGHT RAILWAY.

SIR,—In your issue of the 5th inst. you give an extract from the *Yorkshire Post* with reference to the above scheme, wherein it is stated that Dr. Hopkinson and Mr. F. Bean-land are the engineers. This is an error, as *we* are acting in that capacity. We should therefore be obliged if you will kindly make this correction in your next publication.—Yours, etc., GEORGE HOPKINS AND SONS.

30, Parliament-street, Westminster, S.W.,
November 9, 1897.

EXPERIMENTS UPON PROPELLER VENTILATING FANS.

SIR,—Having had several enquiries regarding the experiments I carried out at the recent meeting of the Institution of Mechanical Engineers, an account of which appeared in the last issue of your paper, I have pleasure in saying that the experimental apparatus may be seen in action at my office any time between 10 and 5 o'clock during the next two weeks if application is made beforehand for an inspection.—Yours, etc., W. G. WALKER.

47, Victoria-street, Westminster, S.W.,
November 11, 1897.

NEW CATALOGUE.

We have received the following letter from Messrs. Howard B. Little and Co.:

"DEAR SIR,—We beg to thank you for your notice of our radiographic list in the number of Guy Fawkes' day. We know that it has not for some years past been considered correct to look a gift horse in the mouth, yet we are ignorant on so many points that we ask your forbearance if our impertinence leads us to ask a pertinent question: When you state that we are 'more royal than the king,' may we take it that you have appreciated our modesty? for hitherto we have made no such statement.

"Our knowledge of history leads us to conclude that some one or two kings really were royal. Our knowledge of our staff here leads us to believe that one or two of them are distinctly blue, but hitherto we have not drawn their blood, so cannot be quite sure. And again, Sir, one more question—which king: the Monarch of Spain, the Emperor of Germany, the Czar of all the Russians, or Old King Cole? Lastly, Avenue might have been printed with a capital; but there—Typo. Pecavi, or would you prefer "pecavamus"? If your august selves should happen to print this, accept our worthless thanks. Be prosperous, and don't offend again.—We are, Sir, yours faithfully,

"THE AUTHORS, OR PERPETRATORS, OF THAT LITTLE LIST."

Electric Branding of Seals.—Attempts have recently been made in the Behring Sea to brand fur-bearing seals by electricity. An electrical branding apparatus was placed on the islands by Prof. Davis Starr Jordan and his staff, but all attempts were unavailing. The apparatus is said to be a complete failure, so it has been abandoned, and the seals are now being branded by hot irons.

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QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. The answers to any question should be sent within 10 days after the question has appeared. Questions may be sent at any time. In both of the questions this week the real difficulties of the subjects are only implied. We trust those who know what these difficulties are will come forward and give our readers the benefit of their experience.

QUESTIONS.

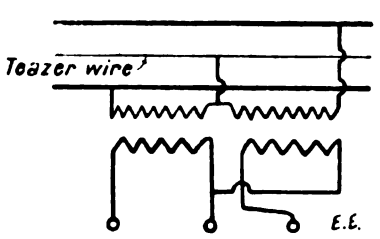
10. What are the relative advantages and disadvantages of exciters driven in the following ways: (1) direct on alternator shaft; (2) by belt from alternator shaft; (3) by independent engine?—ARTHUR C. NASH.

11. What is the best way of controlling from a central station the pressure of the supply when a number of feeders of various lengths are in use?—SARSFIELD W. MARTYN.

ANSWERS.

Question No. 5.—Where can the monocyclic system of alternating-current distribution be seen at work, and what advantages or disadvantages does it possess when compared with the triphase system?

Best Answer to No. 5 (*awarded* 10s.).—I do not know of any plant at present in this country working on the monocyclic system; this is essentially an American idea. The monocyclic generator is simply a single-phase generator which has a small winding placed midway between the main windings called a "teaser," and this teazer winding has usually one-quarter the number of turns of the main winding, and consequently this extra phase, of which it is the source, is not 120deg. from the other two, but only 90deg. from and one-quarter the magnitude of the E.M.F. of the main coils. Now, if the number of windings in this teazer were in proportion to the main windings, as $\frac{\sqrt{3}}{2} : 1$, the voltage measured between any two windings would be the same, and we should thus obtain essentially a three-phase generator. To obtain a three-phase current from the monocyclic system two transformers are used, the primaries being connected in series across the mains, and the common terminal connected to the teaser; then the secondaries are connected in opposition, or reversed relation (see sketch); we thus obtain a three-phase current,



and the teaser wire carries only a magnetising current. In this system it is not absolutely necessary to use a monocyclic generator, but two mains may be run and a three-phase induction motor running single phase utilised, and it will be found that between the impressed E.M.F. and the counter E.M.F. there exists another one, and the three will be of approximately three-phase relations. If a lead is taken from the middle terminal of the induction motor to another machine, it will not only run up to full speed, but will also start with any desired torque. We see then that for a monocyclic generator the cost of the mains is very little more than for a simple alternator; it is not necessary to have a large lead for the teaser line, or the teaser may be left out, but this involves the use of a three-phase induction motor. Another advantage, and this is an important one, is that there is no unbalancing, because all the load is on the same circuit, and this is the only one in the machine; and also that the full output may be utilised for running motors, and not only a certain number, as is the usual case with alternators. In conclusion, we have nearly all the advantages of a three-phase plant and yet do away with one main, and are enabled to run lights without any difficulty off the same mains.—E. E. TASKER.

Answer No. 5.—At the workshops of the American General Electric Company, at Schenectady, N.Y., there is a monocyclic alternator of 300 kw. capacity, which is used for lighting and power purposes. From tests made on this alternator, which is direct connected to a high-speed condensing engine, it appears that it has a commercial efficiency of over 80 per cent. at half load. As the commercial efficiency is the ratio of the electrical output to the indicated horse-power, this is an excellent result. The tests were made by Profs. Jackson and Fortenbaugh with all imaginable care, and will be found duly described in the *Transactions*, Am.I.E.E., vol. xii., p. 350. The great advantage of the monocyclic system over the triphase is the higher efficiency of the alternator in the former system and the greater ease with which it can be constructed. There are two coils in the armature in the monocyclic system. The principal winding is in the main slots, and the auxiliary or "teaser" winding is placed in smaller slots halfway between the main slots. There are three wires in both systems, but in the monocyclic one the difference of phase between the two outer mains and the middle one is about 60deg. only, and not 120deg. as in the other case.—J. C. R. (Kingston).

[We give elsewhere in this issue some recent information about the monocyclic system. The statement of "J. C. R." about the higher efficiency of the monocyclic alternator is to be received with caution.—ED. *E. E.*]

Question No. 6.—What are the relative advantages and disadvantages between the two high-pressure systems, using alternating and direct currents respectively for ordinary town supply?

Best Answer to No. 6 (*awarded* 10*s.*).—Assuming that the area of supply is too far distant from the generating station to be fed economically by a purely low-pressure system, I think the merits of the two systems—viz., single-phase alternating high-pressure and continuous-current high-pressure—should be determined chiefly by the character of the town or district to be supplied. It will be readily granted that for arc lighting continuous currents are very much superior to alternating currents, and that continuous-current motors are more efficient and satisfactory in their working than alternate-current motors. Arc lamps can be run in long series on the continuous system, whilst in alternating systems it is considered expedient to use separate arc dynamos or rectifiers. For incandescent lighting, heating, and cooking, the alternating system is just as good as the continuous. Reliable continuous-current dynamos can now be manufactured quite easily, to generate up to 2,000 volts, the difficulty in the construction of the commutator and winding of the armature having been overcome. The question of the relative cost of distribution in any particular town or district has also to be considered. For instance, a fairly-congested manufacturing or commercial town, which could be supplied efficiently by a network of low-pressure mains, and where there would in all probability be a good demand for motors and arc lighting, should most certainly adopt the high-pressure continuous-current system, on account of its greater adaptability for these purposes. But in a town that is chiefly of a residential or scattered nature, where the use of low-pressure distributors is altogether out of the question, on account of high capital cost and heavy fall of pressure, the alternating system has one paramount advantage to recommend it. I refer to the facility which it offers for the efficient and reliable transformation on the consumers' premises or in street boxes. The ease with which the alternating current can be converted appears to be the secret of its wide adoption. The alternating-current transformer, with its high efficiency and absolutely no moving parts, when contrasted with the costly, relatively inefficient motor-transformer with its revolving armature, is almost a perfect piece of apparatus. However, the motor-transformers in sub-stations can be put in and out of circuit as required by switches operated at the generating station, enabling their load factor to be increased, as well as the total efficiency of conversion. Another important advantage, especially in small stations, is that accumulators can be used in the continuous system with

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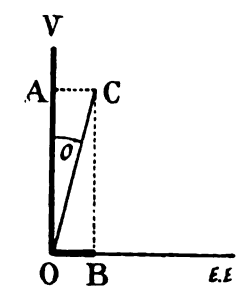
all the advantages of a low-pressure supply. Although the charging has to be done through the motor transformers, and consequently at a rather low efficiency, it is accomplished at a time when the motor-transformers are not required for their lighting load, or in parallel with the lighting work; it necessitates no extra transformers for the purpose. The battery can be discharged direct to the mains either alone or in parallel with the motor-transformers. It may be that the total efficiency of distribution in the alternate system is slightly higher than in the continuous system, but the only examples to be found in this country of the continuous system are yet comparatively small, and as the load-factor on the station and transformers increases, no doubt there will be a great improvement. However, we cannot fairly compare the efficiencies of one system with that of the other without considering their ultimate effects. For example, the loss of a certain percentage in the battery of the continuous system may enable us to dispense with one or more shifts of men in the station, whilst in the alternating system steam has to be kept up and engines run continuously. In practice continuous currents can be generated efficiently, and without the paralleling difficulties which pertain to many of the steam alternators of present manufacture. Neither do induction troubles present themselves in the distribution of continuous currents, as with alternating currents. Nothing will decide which system has most advantages to recommend it with greater certainty than the annual balance-sheets, which will be influenced largely by the general fitness of each system to the district in which it is adopted.—JOHN PILLING.

Answer No. 6.—Alternating current can be easily generated at a higher pressure than direct, because there is no commutator in an alternator. The direct-current machine must have a commutator of large diameter, in order to prevent sparking across the segments. The limit to the pressure is in practice about 2,000 volts, whereas alternating current may be generated at 10,000 volts, or even higher. In the case of the alternating current, the transformers necessary for reducing the pressure are statical—*i.e.*, they have no moving parts—but those for direct current are rotatory. These latter must be made twice the size of the former for a given output, and they have two transforming losses as against one in the statical transformers. Alternating-current transformers are more efficient at full load than those for direct current, but with the latter the system can be made more efficient at light loads, for the transformers can be cut off by special devices from the station, and so there will not be the iron losses which occur continually in statical transformers. It has not been found practicable to cut these latter off except by sending an attendant round. Motor-transformers in sub-stations can feed either directly into the mains or into batteries. This makes it necessary to have either an attendant or complicated automatic devices, or both. If it be required to start the motor-generators direct from the station, each of the machines must have a separate high-pressure feeder. If the number of feeders be reduced, an attendant is necessary to go round to the sub-stations to start the motor-transformers by hand. All this greatly increases the cost. With alternating-current transformers only one feeder is required for each sub-station. The two systems work equally well for incandescent lighting, but direct-current motors are better and more economical than alternating. Arc lighting can be run from either direct or alternating, although the latter is generally rectified when the lamps are used for street-lighting. The rectifiers are placed in the station where they may be easily supervised. It is easier to parallel direct than alternating-current machines, because there is no synchronous speed. It is more difficult to use the three-wire system with high-pressure direct current, because of the necessity for balancing apparatus, such as motor-transformers or accumulators.—T. A. LOCKE.

Answer No. 6.—The advantages of the alternating-current system over the direct-current system for high-pressure distribution greatly outweigh its disadvantages. The chief advantage of the alternating system is that an alternating current is more easily transformed to a lower voltage than a direct current. Board of Trade and Fire Office rules, besides the consideration of personal safety, forbid the use of high-pressure currents in houses, etc. To transform a direct current to a lower or higher pressure requires either a motor-dynamo or a battery of accumulators, to be charged in series and discharged in parallel, or in part series and part parallel, or *vice versâ* for higher pressure. This accumulator system is impracticable for town-lighting, whilst a motor-dynamo is a more expensive machine than an alternating-current transformer or induction coil, and requires constant attention and is not so efficient. Another advantage of the alternating system is that alternate-current generators require no commutators, and therefore the full E.M.F. can be obtained by one machine running alone when the load is light, while with direct-current machines two or more would have to be connected in series to obtain a very high E.M.F. Perhaps the chief disadvantage of the alternating system is that no energy can be stored in accumulators for use in an emergency, or when only a light load is on. Another disadvantage is that the mean E M F. of an alternating current is less than the maximum E.M.F. generated, and therefore an alternating current will not convey as much power along the line as a direct current of the same value whose E.M.F. is equal to the maximum E.M.F. of the alternating current. There is also a *loss of pressure* in the mains, with an alternating current, due to self-induction, besides that due to the resistance of the line, which latter would of course be the same with a direct current. If the frequency of an alternating current is much above 150 complete alternations or periods a second, the resistance of the line is increased by "skin" effect—that is, the current tends to flow near the surface of the conductor, thus diminishing the actual section of copper through which it flows, and thus increasing the resistance. With very high frequencies (they become higher year by year in practice), say 1,000,000 the current practically all flows along the surface and none in the centre of the conductor, thus forming a "skin" to the wire. There is often a *loss of power* with alternate currents due to the "wattless" current. Suppose O V in the figure represents the impressed volts, and O C the virtual current, lagging behind the E.M.F. by the angle θ.



The current O C may be resolved into two currents at right angles to each other—viz., O A in the same direction as O V—*i.e.*, in phase with the volts—and O B at right angles to O V, or half out of phase. It is evident that current O B has no E.M.F. behind it (it is really an imaginary current), and therefore has no power. This is called the "wattless" current. O A is the working current available, and is obviously less than O C. Until quite recently great difficulty was experienced in making an alternating-current motor self-starting, especially with a load on it, and now that there are a few in the market which are self starting (both single-phase and multiphase), they are apt to throw the alternators at the station out of phase with one another, probably owing to their self-inductive action. Most arc lamp mechanisms will also not work with alternating currents.—C. THORN.

Answer No. 6.—The following are some of the chief advantages that the high-tension direct-current system has over the high-tension alternating system: that the cost of production is somewhat lessened in the former system, there being no necessity for independent exciting plant, the machines being self-exciting. Again, for motor and traction work direct currents are superior to single-phase alternating currents—it is here assumed that the single-phase is in use in the other system—as the motors for use

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with direct currents are more readily self-starting, and give greater starting torque than alternating-current motors. Another point in favour of the direct-current system is, that in a town where electric tramways exist it is possible to utilise the electric light plant which is idle during a greater part of the day for the day tramway service, increasing thereby the load factor of the station and the whole working efficiency of the system. Again, the direct-current system is well adapted for series arc lighting. The following are some of the chief *disadvantages* of the high-tension direct-current system. In order to reduce the current pressure to that of the working pressure of incandescent lamps on parallel circuits, use has to be made of rotary transformers or motor-generators, with their attendant disadvantages, which are that they require a good deal of attention, oil for bearings, and renewal of commutators and brushes, cleaning, etc.; while with the alternating-current system stationary transformers are used, which require little or no attention. Again, it is out of the question to put rotary transformers on consumers' premises for obvious reasons; or, in other words, it is impossible to supply consumers on the distributed transformer system, but which is quite possible with the alternating-current system, as a stationary transformer can readily be placed on a consumer's premises. This means that unless a would-be consumer is near enough to the main sub-centre transformer network to be supplied from it, he will be unable to be supplied at all. The system therefore has not that flexibility which is such a good feature of the alternating-current system. As regards the efficiency of the two systems, I should consider that there is little to choose between them. There are no doubt many other points on which the two systems might be compared, but I think the chief ones have been mentioned.—A. C. NASH.

THE MONOCYCLIC SYSTEM.*

It remains still an unsolved problem to construct an alternating-current motor which may be used with a single-phase alternating current, and have the same advantages as the continuous-current motor. The synchronous motors with single-phase alternate current do not start by themselves, and require a continuous current in order to excite the field magnet. The self-exciting "Ganz" motors do not require a continuous current, because the exciting current is obtained through commutation of the alternating current, and although they have a tendency to start, they cannot do so even at no load, and much less with a load. The ordinary continuous-current dynamos may be run as motors with alternating current if the field magnet is laminated, and they do start with a load. In such machines there is a considerable lag between current and E.M.F. Moreover, on account of sparking at the commutator, this type of machine is restricted in its use to small sizes. Revolving-field motors with short-circuited armatures start with a load, but they require two or more alternating currents with different phases, and cannot therefore be connected with an existing network fed with single-phase alternating currents. As soon as a revolving-field motor with short-circuited armature is started, a single alternating current is sufficient to keep it going, the currents of different phases being required only for starting.

The problem of the use of single alternating current for the running of motors has been solved by Déri in the construction of his alternating-current-to-continuous-current transformer. The alternating current taken from an alternating circuit is transformed into a continuous current, the latter is fed into a secondary net, with which a continuous motor is connected. In this case one may use the continuous motors—which are so much preferable—instead of the alternating motors. The only drawback is that the transformer does not start by itself, but it may be started by the aid of accumulators, which will be charged by the transformer itself while it is running, and which may be used as a reserve of continuous current when the transformer is stopped. Steinmetz has, by his monocyclic system, arranged that an existing network for single-phase alternating current may easily be supplemented so that revolving-field motors may be connected to it. These motors receive at starting currents of very favourable phase differences, and they do not stop when overloaded. This system has been called a monocyclic system, because it may be used with systems arranged for single alternating current.

In order to adapt a single-phase alternate-current system of the supply of motors to start under load, one or more of the alternators at the central station are provided with a second series of armature coils so placed as to have E.M.F. induced in them differing 90deg. in phase from that in the usual coils. In Fig. 1, A B C diagrammatically represent such a machine. The coil A B is the main armature coil for single-phase current used in parallel with the other alternators. Its E.M.F. is represented by

$$\overline{A\,B} = E \sin a.$$

The coil O C, which is connected at O to the centre of A B, has fewer turns than A B in the ratio of $\frac{\sqrt{3}}{2}$ to 1. This coil has an E.M.F. induced in it represented by

$$\overline{O\,C} = \tfrac{1}{2}\sqrt{3}\,.\,E \cos a.$$

By the same method employed in "Scott's" two-phase-to-three-phase transformer we get by the suitable proportioning of the number and turns and phase differences equal

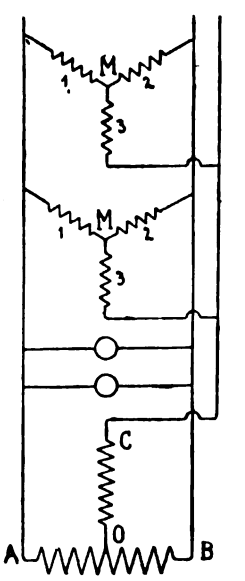

FIG. 1.

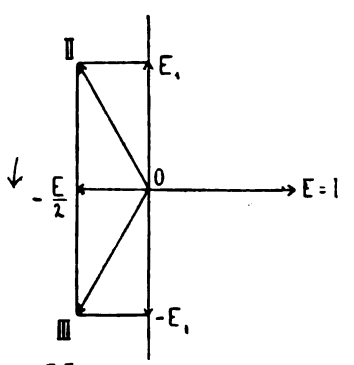

FIG. 2.

potential differences between the conductors, which potential differences are 120deg. different in phases.

$$\overline{A\,B} = E \sin a;$$

$$\overline{B\,C} = \overline{B\,O} + \overline{O\,C} = -\frac{E}{2}\sin a + \frac{E}{2}\sqrt{3}.\cos a = E \sin(a + 120);$$

$$\overline{C\,A} = \overline{C\,O} + \overline{O\,A} = \frac{E}{2}\sqrt{3}.\cos a - \frac{E}{2}\sin a = E \sin(a + 240).$$

In the polar diagram (Fig. 2)—in which the direction of rotation of the vectors is to be taken as represented as the reverse of that of the hands of a watch—vector O E = I = the voltage difference, $\overline{A\,B}$; the vector O E_1 = the voltage difference, $\overline{O\,C}$; vectors II. and III. = $\overline{B\,C}$ and $\overline{C\,A}$.

The conductors going from the terminals, A and B (Fig. 1), represent the principal conductors of the alternating-current network. The additional wires from terminal C serve the motor circuits only. The lamps are connected on to A and B, and the motors are connected to the three wires. When starting, the three circuits of the motors receive three currents each of 120deg. phase difference to the rest, so that the motors have a good starting torque. The number of turns in the motor circuit attached to the wire C are so calculated that when the motor runs synchronously, the back E.M.F. in the coil 3 is equal to the E.M.F. generated in the dynamo armature winding, $\overline{O\,C}$.

* Paper read by Dr. J. Sahulka at the Elektrotechnischer Verein, Vienna. From the *Zeitschrift für Elektrotechnik*, November 5.

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Thus at synchronism no current passes to the motor by the third wire, and the lamps and motors both are supplied by a single-phase current. The motors then run like a single-phase motor with a short-circuited armature. The phase difference of the currents diminishes in the coils 1 and 2 during the starting period, and the current in coil 3 becomes weaker. When all the motors in the system run synchronously, then the additional wire, C, as well as the dynamo coil, O C, takes no current. If a motor falls in speed in consequence of overload, or when a motor is switched on, then the dynamo at once gives out current from O C, and the motors alluded to run as three-phase motors. The coil, O C, and the wire, C, from it need not have a large sectional area, as the motor normally runs as a single-phase motor. If high-tension currents are produced by the dynamo, they may be transformed into low-tension currents at the places where they are used. If at that place lamps only are being worked, a transformer, T_1, is connected in the usual way to the wires A B. If motors are to be used as well, a second transformer, T_2 (Fig. 3), is applied. At this point, again, there are three equal voltages obtained, differing 120deg. from each other between the secondary terminals, A′ B′ C′. Also, as soon as the motors get up to the synchronous speed they require, the coil, O C, of the dynamo, the transformer, T_2, and the coil 3 of the motor take no current.

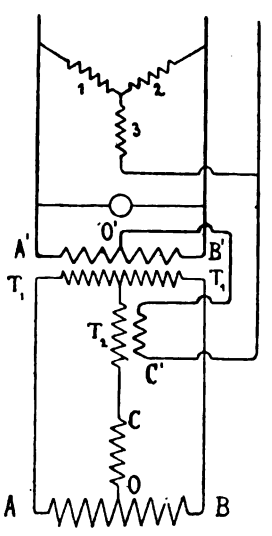

Fig. 3.

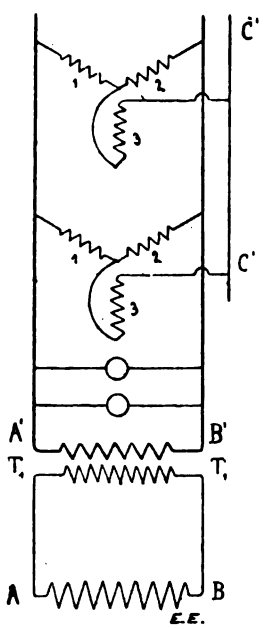

Fig. 4.

If the district in which the motors are to be run with alternating current is far from the central station, it is unnecessary to have a dynamo for two-phase current at the latter place, and no additional feeder is then required. The motors on the network can produce themselves the requisite three currents for starting, but at least one of these must be always in use. The mode of switching is shown in Fig. 4. Coils 1 and 2 are switched on to the secondary wires, A′ and B′, which come from the transformer, T_1, coils 3 on to the additional wire, C_1, but the connections are reversed from those in Figs. 1 and 3. The end of coil 3 is connected with the junction of coils 1 and 2, and the commencement of coil 3 is connected with the additional wire, C_1. The reason for this is evident; since the back E.M.F., which is created in the motor coils, 3, is opposite to the force created in the dynamo coil, O C, it is necessary to connect the coils 3 with the additional wire, C_1, in the manner illustrated in Fig. 4, so that between each pair of the three wires, A′ B′ C′, a phase difference of 120deg. may exist. As long as only one motor is running, winding 3 and the additional wire, C_1, take no current, the motor runs as a single-phase motor with short-circuited armature. When a second motor is switched on, three-phase currents are received by it from the wires A′ B′ C′, and it starts. After synchronous running has been reached, coils 3 in both motors take no current because their induced E.M.F.'s equalise each other, and both run as single-phase motors. The additional wire, C_1, may be led everywhere where motors are to be connected. If a motor lags, or when a motor is started, then the other motors change into three-phase motors and give three-phase current to the motor which lags in speed, or to the one to be started. The nearer this motor gets to synchronous running, the smaller the current in coils 3 of the other motors becomes until it disappears entirely. Two-phase motors may also be used in the monocyclic system in the same way as three-phase ones, since the transformers, T_1 T_2, give two-phase currents direct.

THE DISTRIBUTION OF ELECTRICAL ENERGY.*

BY C. H. WORDINGHAM, A.M.I.C.E., M.I.M.E., M.I.E E, CITY ELECTRICAL ENGINEER, MANCHESTER.

The nature of the problem of distributing electrical energy has, during the last few years, undergone a complete change. When the first attempts at supply were made, there was usually one or two distinct classes of demand to be met. There was either a cluster of consumers taking a fairly large amount of energy, gathered together in a small compact area, or a number of isolated consumers scattered over an extended area, with long distances intervening between them. Low-pressure supply was obviously the best in the one case, high pressure the only possible in the other. This sharp contrast between the two classes of demand led to the independent development of the two systems of supply. Each manufacturer devoted himself chiefly to one or other, and thus, unconsciously perhaps, acquired a strong bias in favour of the system he affected, since it was necessarily to his interest that it should be used. The strange spectacle was then presented of two actually hostile camps of engineers, each proclaiming that his own system, or perhaps party would not be an inappropriate word, was the best under all circumstances, and his adversaries were devoid of all understanding. The high-pressure party flattered themselves that they were the most far-seeing, while the low-pressure boasted that they alone conducted their work on commercial lines, the other party being merely enthusiastic visionaries.

It is impossible to force one unvarying system on varying conditions, and hard fact overcame, as it always must overcome, prejudice, and as time went on the high-pressure party had to admit that in small compact districts their rivals were far more successful than themselves both financially and from an engineering point of view, while they had the satisfaction of seeing the low-pressure party compelled to adopt high pressure as the area of their operations extended. It is to be feared even now this controversy is not quite defunct, but it is far less bitter, and cannot fail shortly to disappear. Improvements in consuming devices and the cheapening of supply have caused the intensity of the demand—that is to say, the quantity of energy demanded per mile of main—to become already very great, and in the near future there can be little doubt that it will be enormously increased, while at the same time the area to be supplied is increasing by leaps and bounds, hence it is clear that the problem now is not comprised in either of the two classes above referred to.

Of course, there will always be a certain number of towns in which, owing to local circumstances, there can never be a large demand for electric or any other form of energy, and in which distribution, in the sense in which the word is used of a large city, will never be required, but in towns of any pretence to large size, it seems abundantly clear that there will have to be given a supply of electrical energy in large quantities over extended areas for every variety of purpose, whether it be lighting, heating, power, or electro-chemical or other industries. This paper is not concerned with exceptional cases, it being directed to the requirements of cities and towns of considerable magnitude. Now in such towns it appears to the author indisputable that there should be a low-pressure network to which consumers can be connected directly without the necessity for any intervening apparatus on their own premises, and to which such connection can be made at all times without interfering with the supply to other consumers in any way. In his opinion it is equally essential, though he is well aware that it will by no means be universally admitted, that the current supplied to consumers should be continuous and not alternating. This opinion is based upon the fact that for all purposes of consumption continuous current is as good as alternating, with perhaps the solitary exception of some processes of electric welding, while it is undoubtedly superior to it for arc lamps, and for motors in which a variable speed is required, while for certain purposes, such as electro-plating, charging secondary batteries, and certain electro-chemical industries, it is indispensable. The superiority of continuous current for arc lamps may be challenged, but what better

* Paper read before the Northern Society of Electrical Engineers.

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evidences can be adduced than the fact that most stations giving an alternating supply either employ rectifiers for their street lamps, or run continuous-current generators for that purpose.

So far the consumers' aspect of the question only has been put forward, but considered from the point of view of economy and convenience of supply, there are equally cogent reasons in favour of continuous current. In the first place, it admits of the use of batteries, and so enables the load on the generators to be equalised over the 24 hours, and also relieves them from momentary shocks when many motors are at work, securing also better regulation of pressure. It may be argued that with alternating systems batteries can be used through the intervention of a motor-generator, but for maximum economy it is essential that they should be kept as close to the consumer as possible in the chain of transmission. And, moreover, the capital cost of batteries is already high enough without adding the cost of an equivalent capacity of motor-generators. It may indeed be argued that batteries are at present too costly to admit of their use on a sufficiently large scale, but the obvious reply is that even if this be so at present, the system should be so laid down as to admit of their use later on if, as can hardly be doubted, the cost should be reduced by improvements or discoveries. In the author's opinion, the ideal to be aimed at in central-station work is the cultivation of a long hour load from consumers, and the provision of a battery, large enough to keep a good proportion of the generating plant economically employed during the night, and to take the whole of the peak or temporary excess over the all-day load, during the afternoon and evening. Facilities for the use of batteries are not the only advantage of continuous current. By its use the choice of mains is left quite unrestricted, since the only loss in the conductors is that due to resistance, and there is no danger of causing disturbance to telephone lines. The importance of this is great, for when alternating currents are used it is usually, though not universally, considered that concentric cables are essential. Now without disputing for a moment that connection can be, and is, made to such mains with the current on, it can hardly be denied that separate cables are much more easily and safely dealt with, besides which, it surely is undesirable to cut one or two of the main conductors every time a T joint is made. That these objections are real is shown by the recent adoption by a few engineers of a cable composed of three separate ordinary cables laid up together within a lead case, though the author is not aware whether such a cable has been found to be equivalent in all respects to a concentric cable. Whether this be so or not, it is clear that with alternating current there cannot be used a system of mains which has proved to be one of the most satisfactory and durable in existence—viz., bare copper. The vibration inseparable from alternating currents gives rise to troubles from which continuous-current apparatus is free. Thus, fuse connections are apt to become loose, causing the fuse to go unnecessarily, and clamped connections of all kinds cannot be relied upon so confidently as in the case of continuous current.

There is yet a further respect in which alternating-current distribution is at a disadvantage, and this is in the question of meters. Owing to the impossibility of employing permanent magnets, it is necessary to resort to an electromagnet in order to ensure the instruments starting with small currents, and this leads to waste of energy. When inductive circuits have to be supplied, additional difficulties are met with in ensuring accurate measurements. It must be clearly understood that the author is only advocating the use of low-pressure continuous current on the distributing network. How that network is to be fed is dependent absolutely upon local conditions. It may be best if land can be obtained at a reasonable price, and if there are facilities for cheap coal and condensing water, to have several low-pressure stations, or it may be preferable to establish one low-pressure station for the densest portion of the area and one high-pressure station for the remainder. Or, again, the character of the demand may be such as to give rise to material benefit by throwing the whole load on one or two high-pressure stations. There are many considerations which enter into the question, and it would be idle to say that any particular system is best under all circumstances. The cheapest and best system to be adopted cannot be settled *à priori*; the point which it is desired to emphasise is that this is simply and solely a question of feeding the network, and that the network *qua* network can be considered by itself and on its own merits. The feeders may be low-pressure ones emanating from many low-pressure generating stations, or they may be supplied from a number of sub-stations in which continuous-current generators are driven by motors fed at high pressure with either continuous or alternating current. The author is strongly of opinion that single-phase alternating current is less suitable for this purpose than either continuous or multiphase, and he believes that it will ultimately pass out of use entirely, but as to the relative merits of multiphase and continuous currents he does not wish to offer an opinion at the present time. Assuming that it is admitted that the distributing network can be discussed on its merits, the first point to consider is: what should be the pressure of supply to consumers? and intimately connected with this the further question: should the system of mains be two-wire, three-wire, or five-wire? Now here again local considerations must to some extent enter into the question. Undoubtedly the pressure on the network should be as high as is consistent with safety, with the fulfilment of the Board of Trade regulations, and with economy to the consumers as regards lamps and apparatus. This society has already had very ably put before it the case for 200-volt supply, and every day strengthens this case by the invention of improved apparatus for use in connection with it. It may be taken that a 200-volt supply is most suited to the requirements of the majority of districts, but in streets where there are a number of small shops where two small arc lamps would be readily taken up, while four would be prohibitive in price, and where the first cost of the lamps is a material consideration, the author ventures to think that it is still advisable to supply at a pressure of 100 volts. This pressure also is undoubtedly advantageous where very small motors are required, while it possesses the further advantage that at the present time, when a large number of private plants are still in use, it greatly facilitates the changing over of the installation to the town mains.

Two-wire has apparently nothing but simplicity to recommend it in preference to multiple-wire distribution, and in point of fact it is now but little used. Into the advantages of multiple-wire it is not necessary here to enter. All persons appear agreed that three-wire is best suited for the work. The author may perhaps, however, be allowed to refer to the five-wire system. This, as all are doubtless aware, is in use in Manchester alone in the United Kingdom, hence few English engineers have had experience of it. There can be no doubt that its use requires a considerable amount of care in the balancing of consumers, but, provided that this point is attended to, it may be said, after just four years' experience, to be entirely successful, and the author is strongly of opinion that had it not been for the introduction of the 200-volt lamp, this system would have been adopted in all those towns in which a three-wire supply is given, and which have recently changed over to a declared pressure of 200 volts. It may be observed in passing that had this been done, there would have been far less difficulty in making the change. The advantages of doubling the pressure of supply are so obvious, and the readiness of all engineers to profit by the experience of others is so universal, that there can be little doubt on this point. Even now the five-wire system cannot be said to be defunct, for, as pointed out above, it is still desirable to supply in certain cases at a pressure of 100 volts, but that it will ever be adopted on a large scale, now that 200-volt lamps have been introduced, is extremely improbable, unless, indeed, the Board of Trade should be persuaded to raise the limit of low pressure to 800 or 900 volts, which it is to be devoutly hoped it will never be induced to do.

In deciding the question of the pressure to be declared, it is important to bear in mind the interests of consumers and of manufacturers. Two arc lamps can be made to burn well in series on a 100-volt circuit, and it appears extremely unfair to consumers to declare a pressure of, say, 115 volts, and condemn them to waste in useless resistance 12 or 14 per cent. of the current taken by the arc lamps. Again, manufacturers incur considerable hardship, which they naturally pass on to their customers in the form of enhanced prices, by being compelled to hold a large stock of lamps of different voltages. It should be decided once and for all what is the best pressure for general supply, and this pressure should be adopted by all towns in the kingdom. Lamps could then be standardised, and not more than three or four pressures would be required. The author would venture to suggest that the best pressures are 100 and 200 volts for lamps and small motors, and 400 volts for large motors. This question of uniformity is one of vital importance at the present time when production is so much hampered by labour disputes, and the author hopes to refer to it elsewhere more fully than could properly be done in connection with the present subject, and before a purely engineering society.

In multiple-wire distribution, the point to which most careful attention must be given to ensure successful supply is the balancing of the various consuming devices. This matter does not appear to be generally well understood. Many persons appear to think that if the current issuing from the station through the middle wire is small, the balancing is good. There could not be a greater mistake. Undoubtedly, if this current is large, the balancing is bad, but even if it be nil, the local balancing may be extremely uneven, and in consequence the pressure also. It is essential that so far as possible each street should be balanced in itself, and further than this, every consumer having a fairly large installation should have that installation split up and balanced in itself; in this way, and in this way only, can a satisfactory supply be given on the three or five wire system. In spite of all precautions, however, there must always be some want of balance, the amount and direction of which will vary from hour to hour. This may be dealt with either by having multiple-wire feeders, or by the employment of balancing motor-generators; the former method appears to

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be the more popular abroad, and the latter in England. In the author's opinion the latter is by far the most satisfactory, as being simple, less costly, and as securing better compensation for want of balance.

The next point to be settled is: should there be one network for the whole city, or should there be a number of isolated networks? The argument in favour of one network is very strong. By interconnecting all points as far as possible, and by joining up every street at both ends, there is established, as it were, a conducting sheet on each pole from which current can be drawn, and if the demand is excessive at any one point the supply can flow to that point from all directions. The importance of this is great, for it is within the experience of every supply engineer that it is impossible in laying distributing mains to avoid occasionally under-estimating the demand in a given street. If these distributors are connected at several points to the rest of the network, this is of little moment. Moreover, the area of maximum demand is constantly shifting from hour to hour, and with such a network as that advocated less copper is required to deal with this than with a number of isolated networks, each of which must be large enough for its own maximum. Again, if the position of the demand has not been accurately foreseen, and the feeding point has not been placed in exactly the right spot, the error is practically eliminated by the network. With such a system also, there is much less chance of being unable to reach a consumer in case of a fault.

Against these advantages there would be nothing to urge if one could be certain that the insulation of the mains would always continue intact, but the best of mains will fail sometimes, and it may then be urged that the consequences are much more far-reaching than if there are a number of small independent networks. In point of fact it is a question of the best means of maintaining continuity of supply. If it were feasible to arrange an automatic cut-off, whether in the form of a fuse or a mechanical circuit breaker, so as to isolate any section of mains which become faulty, there would be no question that one network is preferable, but unfortunately such a system of cut-outs is practically impossible at the present time. For imagine a complicated network arranged with a cut-out on every section of main, and suppose a short-circuit on a given section, this short-circuit would allow a large quantity of current to flow for a short time. If all was in order, the circuit breakers on that section of main would be thrown, but in order to throw these circuits breakers large currents must have flowed through other portions of the network in order to reach this section, with the inevitable result that if the circuit breakers are set to cut off with extra current, they also are thrown, and the unfortunate engineer finds himself in the position of having perhaps a dozen cut-outs gone out of several hundred, with but a slight clue as to where these cut-outs are, as the course taken by the current will vary according to the conditions of the load at the time. If the question once be faced that a short-circuit cannot be efficiently provided against by means of cut-outs, but has to be burned out, then the advantages of a large network become manifest, for the relative importance of a short-circuit diminishes as the extent of the scale of operation increases. Consider the case of a station supplying half a million lamps, and distributing at 400 volts. When all lamps are alight their combined resistance between the outer conductors is only about one four hundredth part of an ohm, and it must be an extremely bad short-circuit which has, and can maintain, as low a resistance as this. There is a good chance of burning out a fault quickly if the network will admit of heavy currents being delivered at any point.

(To be continued.)

MECHANICAL FEATURES OF ELECTRIC TRACTION.*

BY PHILIP DAWSON.

(Continued from page 175.)

Driving.—A great diversity of opinion used to exist as to whether the engines should drive the generators by belts or ropes or be directly coupled. The great objection advanced against direct coupling was the want of elasticity, which in the event of sudden and heavy overloading might cause a breakdown of the engine itself. It is said that belts and ropes act as a spring, and prevent sudden shocks from damaging the engine. It seems, however, to be beyond doubt that for large stations having direct-coupled engines of 500 h.p. and upwards, slow-speed compound-condensing engines, horizontal and vertical, are preferable. Direct coupling is steadily gaining ground, and should always be used for units of 100 kw. and upwards. Stations should always be built as compact as possible; but space, light, and, above all, ventilation, should never be grudged in the engine-room. Whether vertical or horizontal engines are adopted seems to depend primarily upon the available space; and secondly, and to a large degree, upon the fancy of the designing engineer.

Power.—Tramway work being of such a character that even in the largest stations the average load rarely exceeds two-thirds of the maximum, it becomes necessary, in order to have an economical engine, for it to be so constructed that at its most economical cut-off it will give out two-thirds of its maximum power. Thus, supposing an engine at its most economical cut-off of 28 per cent. will give 350 h.p., at its maximum cut-off of 80 per cent. it will give 520 h.p. When, therefore, an engine of 350 h.p. is ordered, it is expected to be able to run at 50 per cent. overload, the generators being constructed to stand the same strain. All bearings must be of such ample dimensions as to run perfectly cool when the engine is working at 50 per cent. above its rated power.

Engines.—In consequence of the difference of conditions between a lighting and a traction station, all engine builders who have had experience in tramway work now build an entirely different kind of engine for traction from that which they supply for lighting stations, as far as dimensions and weights are concerned, as indicated in Table 10. The conditions under which a tramway engine works are, if anything, more onerous than those of a rolling-mill engine. A slight variation, either in number of revolutions per minute or in angular velocity per revolution, is of the greatest importance in a traction station, whereas it is of small importance in a rolling-mill. A traction station should always be so arranged that if the normal load be suddenly thrown on or off an engine, the speed shall not vary more than 2 per cent. In some cases a maximum variation of 1½ and 1¼ per cent. is all that is allowed. Where polyphase currents are used, constant speed is of even greater importance; and a guarantee should be required that under no circumstances shall the angular velocity during one revolution vary more than three-quarters of 1 per cent., and in some cases not more than half of 1 per cent. With heavy flywheels and governors properly designed for tramway work, especially when the governors are of the flywheel kind, it is quite practicable to fulfil the above conditions. A shaft governor is undoubtedly far more satisfactory in every way than any ball-governor driven by belt or gearing from the engine shaft.

TABLE 10.—Comparative Weights of Engines for Lighting and for Traction.

Power of engine.	Weight of engine. For lighting.	Weight of engine. For traction.	Difference.
I.H.P.	Lbs Tons.	Lbs. Tons.	Lbs. Tons.
90	13 000 = 5·8	15,000 = 6·7	2,000 = 0·9
115	15,000 = 6·7	17,000 = 7·6	2,000 = 0 9
140	21,000 = 9·4	23,500 = 10·5	2,500 = 1·1
215	33,000 = 14·8	37,000 = 16·6	4,000 = 1·8
325	46,000 = 20·5	50,000 = 22·3	4,000 = 1·8
400	53,000 = 23·7	58,000 = 25·9	5,000 = 2·2
500	74 000 = 33 0	80,000 = 35·7	6,000—2·7

Governing.—During the last few years there have been several flywheel accidents in tramway stations in America. Respecting these accidents and flywheels in general, more is said later on. Most flywheel accidents have occurred with engines employing a releasing valve gear and a delicate ball-governor. When the load is suddenly thrown off, and when they have to work with no load and a vacuum, ball governors are too uncertain. They generally act; but occasionally the valve gear, owing to wear or bad adjustment, prevents the engine from controlling itself. To obviate this, a second governor is put in engines of this class, which governs some 10 revolutions slower than the main governor, and which, when it exceeds the speed it is set for, causes a stop-valve to trip, whereby the steam is entirely shut off from the engine. This seems to be an admission that such engines are liable to run away. With powerful shaft governors connected directly to the cut-off valves by means of positive mechanism, it is impossible for engines to run away.

TABLE 11.—Weights of Engines and Flywheels for Electric Traction.

Description of governor.		Flywheel governor			
Power of engine	at economical load i.h.p.	583	1,070	500	800
	maximum i.h.p.	911	1,650	1,000	1,600
Weight of engine	lbs.	106,000	177,000	186,000	325,000
	tons	47 4	79·0	83 1	145·0
Flywheel	diameter ...feet	11	15	15	20
	weight ... lbs.	25,000	45,000	60,000	100,000
	tons	11·2	20·1	26 8	44·6
Bearings	diameter ...inches	13	15	18	20
	length ...inches	25	30	34	36
Ratio of length to diameter of bearings		1·92	2·00	1·89	1·80

Table 11 gives the standard dimensions of bearings and flywheels, and the weights of typical engines now successfully working large tramway stations; the first two examples are

* Paper read before the Institution of Mechanical Engineers.

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TABLE 13.—Tests of Pratt-street Electric Power Station, City and Suburban Railway, Baltimore.

Date of test, 1895	August	14	16	17	21	Average.
Average indicated horse-power for 20 hours	i.h.p.	1,860	1,873	1,773	2,000	1,876·5
,, electric ,, ,, ,,	e.h.p.	1,395·5	1,405	1,330	1,499	1,407·4
Coal used, total	lbs.	75,678	70,885	72,885	74,511	73,490
,, ,, per i.h.p. per hour, engines only	lbs.	1·83	1·70	1·85	1·67	1·76
,, ,, ,, ,, ,, other machinery	lbs.	0·20	0·19	0 21	0·19	0·20
,, ,, ,, ,, ,, entire station	lbs.	2·03	1·89	2·06	1·86	1·96
,, ,, ,, e.h.p. ,, ,, ,,	lbs.	2·71	2·52	2·74	2·48	2·61

Coal Consumption.—The above consumptions are based on the total amount of coal actually used in the station for the above electric output, no deductions being made for ash, clinker, or moisture. *Load.*—The heaviest load was 781 i.h.p., the lightest 366, and the average during four hours 553 i.h.p. *Generators.*—Four 500-kw., by General Electric Company, of 670 e.h.p. each, making 2,680 e.h.p., and one 200-kw., of 268 e.h.p.; total, 2,948 e.h.p. *Boilers.*—Campbell and Zell water-tube, four sets of 700 h.p., making 2,800 h.p. total. *Engines.*—Four compound, by McIntosh and Seymour, cylinders 20in. and 36in. diameter by 36in. stroke, of 750 economical indicated horse-power each, making 3,000 i.h.p.; one compound by same makers, cylinders 15in. and 23in. diameter by 17in. stroke, of 250 economical indicated horse-power; stoker, hoisting, and conveying engines of 50 i.h.p.; total, 3,300 i.h.p. Two Blake vertical twin air-pumps and condensers, each 1,800 h.p. capacity, making 3,600 h.p.; one horizontal ditto, 250 h.p.; total, 3,850 h.p. capacity. Two Blake duplex feed pumps, 14in. and 8½in. diameter by 12in. stroke, each 2,800 h.p. capacity, making 5,600 h.p.; two combined pumps and receivers, 6in. and 4½in. diameter by 7in. stroke, each 4,500 h.p. capacity, making 9,000 h.p.; total, 14,600 h.p. Hunt's coal and ash conveying apparatus. Roney mechanical stokers.

TABLE 14.—Electric Tramway Generators.

Rated power.	Total weight of generator.	Diameter of shaft.	Armature. Diameter.	Armature. Weight.	Number of poles.	Revolutions per minute.	Commercial efficiency. Full load.	Commercial efficiency. Half load.	Commercial efficiency. Quarter load.	Rated power.
Kilowatts.	Lbs. Tons.	Inches.	Inches.	Lbs. Tons.		Revs.	Per cent.	Per cent.	Per cent.	Kilowatts.
150	13,100 = 5·8	7 to 9	45	6,000 = 2·7	6	200	93½	92½	89	150
225	37,000 = 16·5	9 ,, 11½	59¼	14,520 = 6·5	6	120	93¾	93	89½	225
	34,300 = 15·3	9 ,, 11½	59¼	13,920 = 6·2	6	150				
	21,000 = 9·4	9 ,, 10½	45	7,000 = 3·1	6	200				
300	60,400 = 27 0	14 ,, 16	59¼	20,720 = 9·3	6	100	94	93	89½	300
	43,900 = 19·6	14 ,, 16	59¼	16,650 = 7·5	6	150				
	39,100 = 17 4	14 ,, 16	59¼	15,500 = 6·9	6	200				
400	74,250 = 33·1	15 ,, 18	72	31,480 = 14·0	8	80	94	93	89½	400
	71,440 = 31·9	15 ,, 18	72	30,580 = 13·6	8	100				
	64,300 = 28·8	15 ,, 18	72	28,740 = 12·8	8	120				
	59,700 = 26·6	14 ,, 16	65¼	24,900 = 11·1	6	150				
500	87.150 = 38·9	16 ,, 18	88½	30,580 = 16·0	10	75	94	93	89½	500
	76,000 = 34·0	16 ,, 18	88½	32,000 = 14·3	10	90				
	71,300 = 31·8	16 ,, 18	88½	30,500 = 13·6	10	100				
	64,300 = 28·8	16 ,, 18	88½	27,100 = 12 1	10	125				
800	110,000 = 49·1	19 ,, 22	94½	49,440 = 22·1	10	80	94½	93¾	90	800
	100,900 = 45 0	19 ,, 22	94½	45,520 = 20·3	10	100				
	94,400 = 42·2	19 ,, 22	94½	41,170 = 18·4	10	120				
1,300	158,930 = 71·0	24 ,, 27	126	69,910 = 31 2	12	80	95	94	90¼	1,300
1,500	163,200 = 72 5	24 ,, 27	126	73,100 = 32·6	12	75	95	94	90¼	1,500
250	40,000 = 17·8	12 ,, 14	60	15 000 = 6·7	—	100	—	—	—	250
400	60,000 = 26·8	16 ,, 19	75	25,000 = 11·2	—	90 to 100	—	—	—	400
500	90,000 = 40·2	18 ,, 21	80	30,000 = 13·4	—	90	—	—	—	500
800	125,000 = 55·8	21 ,, 23	90	40,000 = 17·8	—	80 to 90	—	—	—	800
1,200	195,000 = 87·1	23 ,, 25	115	65,000 = 29 0	—	80	—	—	—	1,200
1,500	240,000 = 107·0	24 ,, 27	130	70,000 = 31·3	—	75	—	—	—	1,500

engines with flywheel governors. The smaller engines are fitted with single or double piston valves, and the larger with gridiron valves. In small engines the governor acts only on the high-pressure cylinder; but in large engines it is so arranged as to act on both cylinders. Table 12 gives the dimensions of some standard Continental engines, most of which are driving rolling-mills. On comparing the dimensions of the bearings in this table with those of the tramway engines it will be seen that the ratio of the length of the bearing to its diameter in the tramway engines is generally somewhere near 2 to 1 (Table 11); whereas in the engines not designed for tramway work it is nearer 1½ to 1 (Table 12). The main bearings are usually provided with cylindrical shells, which can be taken out by simply jacking up the shaft to take the weight off the bearings. The shells are made hollow for water circulation, which can be used in case the bearings should heat from dirt or other cause; by this means the engine can be enabled to complete its run.

Table 12.—Proportions of Bearings in Rolling-Mill and other Continental Engines.

Cylinder	diameter, in.	17·7	23·6	23 6 35·4	23·6 39·3	25·6	27·5	49·2
	stroke, in.	27½	43	41	39	25½	39	49
Revolutions per minute		66	75	60	120	105	100	85
Bearings	diameter, in.	6·7	12·6	8·6	9·8	9·6	10·2	17·1
	length, in.	10·8	24·4	14·2	14·5	15·7	16·5	23 6
Ratio of length to diameter of bearings		1·61	1 93	1·65	1·48	1·63	1·62	1·48

Mean ratio of length to diameter of bearings, 1·63.

Tests.—Table 13 gives the results of tests recently made in a large American station. There are four tandem compound condensing engines: high-pressure cylinder 20in. diameter, low-pressure 36in., stroke 36in.; initial pressure 125lb. per square inch, economical cut-off 5-16ths of stroke in high-pressure cylinder; vacuum, 24in. of mercury; revolutions, 103 per minute. These four engines each drive by belt a 500-kw. generator; and there is one direct-coupled engine, with cylinders 15in. and 23in. diameter, and 17in. stroke, driving a 200-kw. generator. The results may be considered highly satisfactory. Practically the minimum coal consumption is 1·67lb. per indicated horse-power, and 2·48lb. per electrical horse-power at the switch-board. It therefore appears safe in a well-designed and fairly large station to estimate the coal consumption per indicated horse-power at 2lb., and per electrical horse-power at not more than 2·66lb., so that the coal consumption per Board of Trade unit will not exceed 3·3lb.

Flywheels.—The use of flywheels in electric traction stations is important. Owing to the need of keeping the angular velocity as constant as possible, especially in large stations where, owing to Board of Trade regulations, polyphase transmissions become a necessity, the flywheels have to be much heavier than for ordinary lighting work. The strains they may be called upon to bear occasionally are enormous. The dynamos for tramway work are now constructed with such an amount of copper, and with such fireproof insulation, that they can stand short-circuiting without serious damage. Circuit breakers are, of course, supplied, and are generally prompt in action; but it may happen, and has occasionally occurred, that something goes wrong with the circuit breaker, and it will not immediately break the line when a short-circuit occurs. It may therefore happen that an engine may be practically stopped dead, and enormous strains may thus be put on the flywheel. Moreover, the moment the flywheel has stopped the circuit breaker may happen to act, and the full power behind the piston may be applied to rotate the wheel, thereby again subjecting it to great strains. The utmost care has therefore to be taken in the design of flywheels. Accidents cause terrific havoc, and as far as the damage done is concerned are nearly as bad as boiler explosions, if not worse. In America the circumferential speeds allowed, even with cast-

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iron wheels, are much in excess of those to be met with in this country or on the Continent; over 90ft. per second is frequently allowed, as seen from some of the tables, whereas in English practice it is not considered safe to go beyond 80ft. This may possibly be owing to the better quality of cast iron in America. Flywheels built up of rolled plates, and constructed more like a boiler or a bridge, have been adopted to some extent in electric tramway stations in America. These built-up wheels generally have a cast-iron centre or hub, with brackets to which the armature is bolted, so as to take some of the strain off the two keys that hold the armature on the shaft. To the centre of the hub are connected segmental web plates extending to the extreme outside diameter of the wheel. The plates are faced along their edges, so as to form a good joint. Outside of these segments are two circular plates, bolted through each segment and through both plate and hub. The segments are generally braced by truss pieces, held in the centre by cross bolts which act as struts. Outside the web plates surrounding the rim is a strip riveted through the rim; and outside of this is a second strip also riveted through. The rims of these wheels are usually turned down after the wheels have been riveted up and fixed on the shaft. Accidents to flywheels may generally be attributed to three chief causes: (1) poor castings or internal strains; (2) faulty design and construction; (3) excessive speed. In designing a flywheel it is easy to calculate its parts so that it shall be perfectly safe to bring it to a standstill within a given angle. Investigation of some of the best flywheels for tramway stations show that their design permits of their being stopped in less than one revolution, with factors of safety varying from 17 to 18.

Generators.—The kind of generator to be used for electric traction is an important question. As in the case of the engines, tramway generators (Table 14) must stand heavy overloading without damage. Moreover, as one pole is earthed the greatest care must be taken that the best insulation is used throughout. Since the loads to which they are subject are extremely variable, dynamos as usually constructed for lighting work would require the position of their brushes to be constantly altered. To obviate this, heavy magnetic inductions are allowed for in designing tramway generators, thus rendering it unnecessary to shift the brushes, and also avoid sparking. It is the universal and best practice to use toothed armatures in tramway work.

As to the kind of field winding which should be adopted, it would seem from tests made on a large scale with separately excited, shunt-wound, and compound-wound machines, that the best suited to tramway work from every point of view is the over-compounded generator. The usual pressure of current employed on trolley lines is 500 volts; and for this tension dynamos are so designed that the pressure between their terminals is 500 volts at no load, and is increased to 550 volts when the full load comes on. The over-compounding can be regulated up to 10 per cent. by varying a German-silver shunt placed on the series coil.

DISCUSSION.

Mr. R. E. Crompton, in opening the discussion, said that the thanks of the institution were due to Mr. Dawson for his paper, which, however, by its praise of American practice touched on a sore point with English manufacturers. Under present circumstances the local authorities forbade the English contractor paying anything but the union rate of wages, yet the former willingly accepted tenders from America in which the labour clauses were not conformed to. He agreed with Mr. Dawson in his praise of the American traction system, and said that their engineers had worked out a noble job. Still, he fully believed that if local authorities would only give English engineers a chance to manage their own works, they could turn out work which would be quite as good in quality. As regarded the generating plant, the author's conclusions were not to be accepted as gospel, and he (the speaker) held that in that department England was ahead of America. As an instance of this he quoted the town-lighting at Brooklyn, where the supply was very irregular until accumulators were introduced. The question of the engine speed was one great point of difference in the practice of the two countries, and he thought one company had taken a retrograde step by taking out the Willans engines and replacing them by slow-speed ones. In fact, a glance at the efficiency table which the author had given showed him nothing he should be proud of, as he had obtained much better efficiencies. In fact, there was nothing in the steam-engine practice recommended by the author that he desired to see copied by English manufacturers.

Prof. W. E. Ayrton said he could bear out Mr. Dawson's statements as to the extraordinary development of traction work in America. On a recent visit to the States he had been privileged to go through one of the largest works, where 200 cars per week were turned out regularly. The factory was even capable of despatching 500 cars per week on emergency. Again, he had travelled some 35 miles on a trolley car, going from Boston to an outlying district. In many parts of the route he passed for miles along country roads, the condition of which showed that the electric trams were replacing other traffic. The speed attained averaged 12 miles per hour. He was also struck by the development of the Boston power stations. The first was laid down in 1888 or 1889, and contained some 50 100-h.p. dynamos, with belt driving and countershafts. That station was soon considered obsolete, and replaced by another having 300-kw. units of power. Even that was now discarded, and the present station contained ten 2,000-h.p. direct-coupled sets. He agreed with Mr. Dawson in recommending that the trucks should be built entirely separate from the car bodies, and that allowed one truck to be used with two car bodies, one for summer and one for winter use. One point which was particularly noticeable in the large power stations delivering, say, 10,000 amperes was that the fluctuation due to cars starting, which was so marked in small power stations, entirely disappeared. He had watched an ammeter on the power circuit at Boston, and could detect no sudden fluctuations. Prof. Ayrton also referred to the mistaken idea in England that trolley wires were ugly and that they disfigured roads. The London County Council had taken up that view. For instance, in Euston-road and Tottenham Court-road the arc lamp-posts in the centre of the road were not considered a disfigurement, and the addition of trolley wires to these posts would really not be noticed. Still, were the objections more strongly held, there was no reason why a conduit system should not be used with success, as had been done at Washington for the last four years.

Mr. J. S. Raworth referred to the large number of electric traction schemes now being brought forward in this country, and to the importance of the money for these works being economically spent. He considered that the practice upheld by the author of the paper was not based on figures or logic, and that if the author's conclusions were endorsed by the Institution of Mechanical Engineers it would result in too high expenditure. In fact, the practice in America was subject to a periodical change. Prof. Ayrton had pointed out that the equipment of the Boston station had been completely changed three times in the last 10 years. This showed that the Americans were proceeding on a trial and error method of evolution, and one should know at what stage of evolution they had arrived before endorsing their practice as correct. The author had referred to the great shocks to which engines used to drive dynamos in traction stations were subjected to. He (the speaker) was prepared to state that there were no such extraordinary shocks. The shock due to the admission of steam was the only one to be provided for, and nothing they could do to the flywheel would increase the boiler pressure. Supposing a short-circuit did occur, the largest power which could be exerted was that due to the steam admitted to the engine provided there was no great flywheel action. In fact, he considered that with no flywheel there was no shock in the working parts, and that the larger the flywheel used the more trouble there would be due to the increased shock. Another point on which he joined issue with the author was on the range of governing, stated to be 1½ per cent. He could see no advantage from such close governing, and it was absurd to talk of the great flywheel power to overcome sudden fluctuations of load when the speed was practically constant. In electric lighting work they were accustomed to over-compound dynamos to make up for engine losses, and it could also be done for traction sets. As regarded the size of bearing, which the author said should be longer than two diameters, that figure was given for an over-hung crank with single bearing, while in the Universal engine two bearings, each of 2½ diameters, were used. In conclusion, he held that English makers could supply engines more suitable for traction work than those imported from America.

Mr. Chambers remarked on the construction of the pole called S S S, which was said to be the American standard type. He was sure that in this country such poles could be made in one piece He had thought at first three joints were for ease in transport, but found that this was not so. If a similar pole had to be made in this country he should advise it being called T T T—*i.e.*, tapered, turned, and tight—and would undertake to make a better job in that way.

Mr. Graham Harris pointed out that under the test arrangements advised by the author good poles were not ensured. In fact, 33 per cent. of bad poles would not cause the whole batch to be refused.

Mr. W. M. Mordey said he admired very much the progress of electric traction in America, but practice there must not be taken as gospel. The American engineers were inclined to change their standard types too frequently. If English corporations wanted to rebuild their stations three times, they could not do better than place their orders abroad. He saw the Boston station some years ago, and the courteous manager explained to him the great advantages of the belting and countershaft, which had then been obsolete in England for some time. The 2,000-unit generator belt driven was then said to be the system of the future. In fact, enormous and most costly changes were constantly being made in the States, and there were hardly any stations in that country which had not been rebuilt at least twice.

The **President** then proposed that the discussion on the paper should be adjourned to the February meeting, as so many others wished to speak. He proposed a hearty vote of thanks to Mr. Dawson for his paper, which was carried unanimously.

THE RONTGEN SOCIETY.

The inaugural meeting of this society was held at St. Martin's Town Hall on the 5th inst., when the president, Prof. Silvanus P. Thompson, D.Sc., F.R.S. (author of "Light Visible and Invisible," noticed in another column), delivered his address before a very numerous audience.

Prof. THOMPSON gave a brief review of what has been achieved

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with respect to Röntgen rays, starting from Prof. Röntgen's discovery of the action of these rays when transmitted through a vacuum tube on to a fluorescent screen, which only dates back to November 8, 1896, and giving due credit to Sir W. Crookes and others who worked before that time. He discussed the improvements which have been made in appliances, the materials used, and in the methods of exciting the tubes. The first great application of the rays had been to the diagnosis of dislocations and fractures, the study of bone disease, and the detection of foreign bodies in various parts of the human frame. A great boon was an apparatus by Mr. Mackenzie Davidson, by which any intelligent person could at once localise to within one-hundredth of an inch the exact position of a foreign body within any part of the human frame without going into complete geometric calculations referring to oblique projection. The Röntgen rays had also brought a new disease, seeing that exposure to them frequently resulted in severe local inflammation, accompanied in some cases with destruction—at least temporary—of the hair, which fell out and left bald patches. It was disputed whether this effect was direct, like sunburn, or whether it was indirect and due to the chemical action of ozone generated by the ionising of the oxygen of the air, or, finally, whether it was electrical. As regarded the physical problems presented by the rays, they had been found to possess a dissociating, or more strictly, an ionising effect on the molecules of gases through which they passed, with the result that electrified bodies placed in an atmosphere thus affected were discharged. Further, it was now generally admitted that the rays were not themselves homogeneous—that they were of many kinds, differing in penetrative power—the quality of the mixture depending on the state of the vacuum as well as on the form of the tube and the nature of the emitting surface. Many speculations had been put forward as to the physical nature of the rays themselves. Crookes, Tesla, and others held them to consist of flights of minute atoms or hyperatoms; on the other hand, there was an hypothesis that they were merely an extreme sort of ultra-violet light, consisting of transverse waves of excessively minute wave length. Jaumann and, apparently, Röntgen regarded them as due to longitudinal vibrations, while Sir George Stokes had put forward the view that they might be transverse waves, not in regular trains, but consisting of innumerable solitary waves. Another wide field of research was opened up by the discovery of other analogous kinds of rays. That the salts of uranium, glow worms, fireflies, and sticks of phosphorus should be able without any electrical stimulation to give out rays that could produce photographic action through substances that were opaque to every known kind of light was very suggestive, but such rays were not Röntgen rays, and obeyed different laws. He also cautioned experimenters to leave Tesla's oil-induction coil severely alone when using Crookes tubes, stating that on account of the oscillation the method of induction used by Röntgen was by far the better, while, on the other hand, Tesla's induction coil, giving high-frequency discharges direct from any electric supply, produced excellent results with tubes especially designed by the inventor for that purpose. As an example, he quoted a life-size skiagraph taken by Dr. W. J. Morton of the entire skeleton of a full-grown woman. This was exhibited in the hall, and was stated to have been taken in one exposure.

Sir William Crookes, K.C.B., in proposing a vote of thanks to the President, alluded in eulogistic terms to the latter's great achievements in that science.

Dr. J. H. Gladstone seconded, and the motion was carried unanimously.

Very interesting lantern shows by Mr. Greenhill, Mr. Mackenzie Davidson, Dr. Low, and others; demonstrations of the living body (hands, spine, etc., of the audience being the objects under observation), by Messrs. Moore and Webster, at which the latter's 20in. spark Apps-Newton coil was used; and demonstrations of tubes (with more or less perfect vacuum, which showed phosphorescent shells, brilliantly-hued stones, etc.), by Herr Isenthal and Dr. Fenton, with a 10in. spark coil and apparatus lent by the Earl of Crawford, concluded the programme. Selections were rendered during the evening by various artistes. The exhibition of photographs included many specimens worthy of note. Dr. Gladstone, F.R.S., exhibited photographs of alkaline and other metals in order of their power of absorbing Röntgen rays (with Mr. Walter Hibbert); Mr. F. H. Neville, M.A., F.R.S., Cambridge, microskiagrams of sections of sodium-gold alloys, showing internal constitution of alloys; and Mr. F. C. Abbott, F.R.C.S., photographs of bullets taken at the seat of the recent Greco-Turkish war. Natural history, biological, and other objects were displayed by Messrs. Gifford, Gardiner, Griffith Wilkin, Greenhill, Drs. Norris Wolfenden and Walsh. A large collection of apparatus illustrating recent advances in Röntgen methods as regards tubes, screens, interrupters, rheostats, and other accessories were shown, amongst others, a stereoscope, by Dr. Hedley; a motor interrupter, etc., by Dr. Barry Blacker; an influence machine, etc., by Mr. James Wimshurst; coils, interrupter, and apparatus, by Mr. Ernest Payne; and various tubes, cinematographic apparatus, etc., by Dr. Macintyre. Also a new pattern of induction coil, invented by Mr. Nikola Tesla, giving high-frequency oscillatory discharges direct from any ordinary electric supply with small expenditure of energy (no thin wire is used in connection with this apparatus); fluorescent screens for shortening exposure, plate and film boxes for reception of plates, etc., by Max Levy, M.D., Berlin; transparency of plates to illustrate his work, "The Röntgen Rays in Medical Work," by Dr. Walsh; and various exhibits by Messrs. Binko and Co. ("Dolphin contact breaker," and other apparatus); Mr. A. C. Cossor (tubes of own manufacture); the Electrical Company (screens, tubes, etc.); Messrs. Fuerst Bros. (special Röntgen-ray sensitive plates); Lithanode Electrical Storage Company (various batteries); Messrs. Maw, Son, and Thompson (Röntgen apparatus, etc.); Messrs. Miller and Wood (induction coils, Tesla apparatus, etc.); Messrs. Newton and Co. (coils, tubes, current meters, etc.); Messrs. Rebman and Co. (archives of the Röntgen ray); Mr. W. K. Schall (accelerating screen, motor interrupter, rheostats, actinometer for testing tubes, etc.).

EALING ELECTRIC LIGHTING.

We give herewith the revenue account and general balance-sheet abstracted from the statement of accounts for the year ending March 31, 1897, just issued by the Ealing Urban District Council. The total expenditure on the undertaking up to March 31 last amounted to £49,813. 13s. 1d.:

Revenue Account.

Dr.				£	s.	d.
Generation of Electricity.						
Coal or other fuels, including dues, carriage, unloading, storing, and all expenses of placing the same on works	£1,893	17	2			
Oil, waste, water, and engine-room stores	303	6	3			
Wages at generating station	741	4	4			
Repairs and maintenance as follows:						
Buildings	4	6	10			
Engines, boilers, machinery, etc.	252	3	5			
				3,194	18	0
Distribution of Electricity.						
Repairs, maintenance, and renewals of mains, including materials and laying the same	0	4	2			
Repairs, maintenance, and renewals of transformers, meters, switches, fuses, and other apparatus on consumers' premises, including cost of materials	23	15	6			
Repairs, maintenance, and renewals of apparatus at distributing stations	8	9	7			
				32	9	3
Public Lamps.						
Attending and repairing lamps	215	15	1			
Renewal of lamps	181	6	1			
				397	1	2
Rates and taxes				232	11	6
Management Charges.						
Salaries of engineer's department	427	18	0			
Collector's commission	28	3	4			
Stationery and printing	44	10	10			
Establishment charges	55	15	0			
				556	7	2
				4,413	7	1
Balance carried to net revenue account				562	10	10
				£4,975	17	11

Cr.	£	s.	d.
Sale of current, at 6d. per B.T.U.	1,162	10	5
Ditto, at 5d. per B.T.U.	659	17	10
Ditto, at 4½d. per B.T.U.	17	17	9
Ditto, at 4d. per B.T.U.	4	8	9
Sale under contracts	349	3	0
	2,193	17	9
Rental of meters on consumers' premises	70	14	0
Public lighting, £2,301. 6s. 10d.; and attending, repairing, and renewing public lamps, £397. 1s. 2d.	2,698	8	0
Fees for testing consumers' installations	3	15	0
Miscellaneous	9	3	2
	£4,975	17	11

General Balance Sheet.

Liabilities.	£	s.	d.
Capital account—amount received	52,978	0	0
Sundry creditors on revenue account	777	4	7
Consumers (deposits)	90	0	0
Excess of assets over liabilities	446	18	1
	£54,292	2	8

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Assets.	£	s.	d.
Capital account—amount expended	49,813	13	1
London and County Bank (balance on loan account)	3,164	6	11
Stores on hand at March 31, 1897 : coal, £203. 14s.; oil, waste, etc., £8. 12s. 6d.; cables, carbons, etc., £42. 7s. 6d.; miscellaneous, £50	304	14	0
Sundry debtors for current supplied to March 31, 1897	1,001	10	0
Due from surveyor on labour account	7	18	8
	£54,292	2	8

STATEMENT AS TO ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units			379,857
Quantity sold	Public lamps	130,575	246,902
	By contract	22,275	
	Private consumers by meter	94,052	
Excitation units, transformers			100,980
Excitation units, alternators			18,454
Quantity used on works			11,338
Quantity not accounted for, being loss in distribution			2,183
Number of public lamps	Arc lamps		75
	Street incandescent lamps, 8 c.p.		244
Total maximum supply demanded in 24 hours (B T.U.)			2,130
Highest reading at a given time (B.T.U.)			189

COMPANIES' MEETINGS AND REPORTS.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.

The report of the directors of the Western and Brazilian Telegraph Company, Limited, for the half-year ended June 30 last, to be presented at the general meeting to be held in London on the 12th inst., states that the total earnings amount to £59,755, as against £71,082, a decrease of £11,327 compared with the first half of 1896. The loss of revenue is to a great extent owing to the very low rate of exchange prevailing during the half-year, and also to a falling off in traffic. This is partially accounted for by the fact that the cables of the River Plate Telegraph Company, Limited (between Monte Video and Buenos Ayres, and with which company this Company has a working agreement), were closed by order of the Argentine Government from January 30 to August 9. The working expenses amount to £44,576, as against £37,429, an increase of £7,147, the greater part of which — namely, upwards of £6,000—was caused by the hire and expenses of shipping to replace the "Norseman" during repairs, and on account of maintenance. Including the amount brought forward (£6,405), the balance to the credit of the revenue account is £29,085, from which has to be deducted £8,984 for debenture interest, and £1,625 for income tax. For the purpose of equalising dividends, the directors have transferred £7,500 from the reserve fund, and now recommend the payment of a dividend free of income tax, for the half-year, at the rate of £2 per cent. per annum, the same as for the corresponding period last year, carrying forward £3,868. There is no change in the position of affairs between the Government of Brazil and the Company as to the purchase of the cables. The directors report with regret the death of their colleague, Mr. C. W. Earle. Mr. T. W. Andrews has been elected to fill the vacancy. The conversion of ordinary shares into preferred ordinary and deferred ordinary shares is suspended until further notice.

IMPERIAL TRAMWAYS COMPANY, LIMITED.

An extraordinary general meeting of the shareholders of the above Company was held on Saturday at the Company's office, Clare-street House, Bristol, Mr. George White (chairman of the company) presiding.

The **Chairman**, referring to the proposed increase of borrowing powers and capital, said : I have to refer to the position and prospects of the new Middlesbrough, Stockton, and Thornaby electric tramways. I explained to you at our last meeting that this undertaking was, in our opinion, a typical electric tramway scheme, joining up and permeating three important boroughs which embrace a population of over 170,000 people. I also told you when we last met that the moment we felt assured of obtaining the parliamentary powers our managing director and engineer, Mr. Robinson, had at once set to work to prepare all his plans, and to give out orders for rails and permanent-way material. We are pushing on all the works very rapidly with the intention of opening in good time for next summer's traffic, and from the rate of progress already made by Mr. Robinson I have no doubt we shall succeed. Since the last meeting we were approached by an important company who were anxious to purchase our old lines with the benefit of the new Act, but we preferred proceeding with our programme and obtaining the full result of our work for our own shareholders. We know we have an undertaking in hand which not only ourselves, but other experts who have studied the subject, believe is capable of yielding a good return upon the capital outlay. We have now made satisfactory purchases of all material, and our estimates of labour cost are being justified. We have laid seven miles of single tramway since September 1, and, therefore, can closely gauge our position on this item. We have also concluded a very satisfactory cash contract with the British Thomson-Houston Company for the electrical plant and equipment of the line. Included in the present equipment are 50 double bogie cars, each capable of carrying 60 passengers. I mentioned at our last meeting that our capital expenditure would be from £200,000 to £250,000, but I can now tell you that the lower sum is not likely to be exceeded. I will give you the details so that you may follow the position exactly. The amount at which the old lines stood in the Company's last capital account was about £18,000; to this there has since been added the purchase price of Stockton and costs of the Act, which, after allowing for the purchase of Darlington, carried to a separate account, and the amount to be received for old plant, brings the initial cost out at about £30,000. Our new lines will cost approximately £73,000, and our electrical construction, plant, machinery, and cars about £70,000, whilst the purchase of land for depôts, building of power station and car-sheds, payments to local authorities in connection with roads, interest on outlays up to date of opening, etc., will be approximately £25,000; thus the total outlay upon this undertaking will be covered by about £200,000.

The **Solicitor** having explained the amendments proposed in the articles of association, the **Chairman** moved the formal resolution approving the alterations.

Mr. Everard seconded the proposition, and it was carried unanimously.

The **Chairman** moved the resolution increasing the capital.

Mr. W. N. Tribe seconded the proposal, and this also was carried unanimously.

The proceedings then terminated.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Blackburn.—The Blackburn Corporation Tramways Company are prepared to receive tenders for eight tramcar bodies, with trucks, motors, controllers, trolley poles, etc., for particulars of which we refer to our advertising columns. Tenders by Nov. 27.

Madrid. — The Government Telegraph Department invite tenders for 25,000 insulators. The estimated maximum cost is one peseta per piece, and the deposit required is 5 per cent. preliminary, 10 per cent. final. Particulars may be obtained and models seen, at the Offices of the Department (Office No. 7), at Madrid; or at the Civil Government Offices at Barcelona and Leon. Tenders by November 21.

Salisbury.—The Salisbury Electric Light and Supply Company, Limited, invite tenders for the erection of offices and works. Plans and specifications of proposed buildings can be seen at the offices of the company, The Close, Salisbury, any time between 10 a.m. and 1 p.m. and 2 and 4 p.m. until 12th inst. Tenders, endorsed outside "Tender for Works," are to be sent to Mr. A. R. Malden, secretary, by 12 noon on 13th inst.

Burnley.—The Corporation invite tenders for the supply and delivery at their electric lighting station of lead-sheathed, armoured underground cables. Specification, schedule of quantities, and form of tender may be obtained on application to Mr. W. R. Wright, borough electrical engineer, on payment of a deposit of £1. 1s., which will be returned on receipt of a bona fide tender. Sealed tenders, endorsed "Tenders for Cables," and addressed to the Chairman of the Electric Lighting Sub-Committee, Town Hall, Burnley, must be delivered by November 17.

Queensland (Australia).—The Municipal Council of Ipswich, Queensland, is inviting tenders for the supply and erection of the following electric lighting plant, etc.: tubular boilers, pipes, pumps and heaters, alternators and exciters, switchboard, high and low tension mains, junction boxes, transformers, etc. Specifications and all particulars as to conditions, etc., may be obtained from Messrs. Gordon and Gotch, St. Bride-street, Ludgate-circus, London, E.C., and tenders have to be forwarded to the town clerk (Mr. Albion Hayne), Council Chambers, Ipswich, Queensland. Tenders by November 15.

Bradford.—The Guardians are prepared to receive tenders for the electric light wiring of the nurses' home at the workhouse. Plans can be inspected, and copies of the specification and conditions of contract can be obtained, at the Poor-Law Offices, 22, Manor-row, on payment of a deposit of 10s., which will be returned on receipt of a bona fide tender. The tender of any person or firm paying less than the minimum standard rate of wages and who does not observe the hours and conditions of labour generally recognised in the district, will not be accepted. Tenders to be sent under cover, marked "Electric Wiring," to Mr. Thomas Crowther, clerk, 22, Manor-row, Bradford, by November 16.

Blackpool.—The Corporation are prepared to receive tenders for the following works required in the conversion of their present system of electric traction: (Section A) steel columns, brackets, and straining posts; (B) trolleys, trolley wire, and insulators; (C) controllers motors, and gearing; (D) main and section fuses. Tenders will be received for one or more sections, but not for part of a section. Specification, general conditions, and form of tender may be had on application to Mr. Robt. C. Quin, borough electrical and tramway engineer, Corporation Electricity Works, Blackpool, on prepayment of £2. 2s., which will be returned on receipt of a bona fide tender upon the prescribed form, and within the stated time. Drawings and plan of route may be inspected at

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the office of the Borough Electrical Engineer during the usual office hours. Sealed tenders, addressed to the Chairman of the Electric Lighting and Tramways Committee, and endorsed "Tender for Traction Material, Section —," to be delivered to the Borough Electrical Engineer by 10 a.m. on November 22.

Madras.—Tenders are invited for the utilisation of water flowing from the Periyár Lake for purposes other than irrigation and not incompatible with the use of the water for drinking. The irrigating season extends over nine to ten months, during which time the discharge is likely to be from 1,100 to about 500 cubic feet a second, according to the demands for irrigation and the available quantity in the lake. Subject to the risk of interruption by accident or drought, supply can be given throughout the irrigation season. No supply can be guaranteed at other times, but, so long as water is available, the Government will be prepared to issue it in such daily quantities as may seem to it advisable with reference to the time which is likely to elapse before the supply is replenished by the setting in of the rains. The fall from the tunnel to the foot of the hills is approximately 900ft., and the distance measured along the course of the stream about 6,800ft. One cubic foot per second falling 900ft. is estimated to produce over 60 effective horse-power. Intending lessees should state the quantity of water required in cubic feet per second and the annual rent offered for each cubic foot per second. No rent will be charged for the first year from the date of the concession; for the second year the charge will be one-fifth, and an additional charge of one fifth will be made every year until the full rent is reached. The whole or part of the concession may be surrendered on a year's notice being given. Lessees will construct at their own expense, on plans to be approved by Government, all the weirs and other works required to divert the water from the river below the tunnel. For further information, application may be made to the Chief Engineer for Irrigation, Madras, by whom tenders will be received up to July 1, 1898.

RESULTS OF TENDERS.

Derby.—The following tenders have been accepted for transformer boxes, etc., and dynamo and engine, in connection with extensions: Crompton and Co., transformer boxes, etc., £867. 5s.; Ferranti, Limited, dynamo and engine, £7,132. 10s.

Salford.—The Town Council have accepted the following tenders: British Insulated Wire Company, Limited, for high and low tension cables, £2,351. and for one mile of concentric high-tension cable. £150; Mather and Platt, motor-transformer, £692; Nalder and Hilton, switchboard, £189. 11s. 6d.; A. B. Pescatore, accumulator, £1,860.

BUSINESS NOTES.

Personal.—Mr. Storey has been appointed engineer to the Truro Corporation electric lighting works.

Hornsey.—The District Council have referred the question of the electric lighting of the Hornsey district to a special committee.

Dorking.—Mr. F. J. Warden-Stevens has completed his report for the Dorking Council on the electricity supply scheme for the district.

Mexican Telegraph. — Telegrams have been exchanged recently direct between Mexico and Boston. The messages were transmitted over 5,000 miles of unbroken wire.

Cape Electric Tramways, Limited.—A company has been registered, with a capital of £400,000, to construct, work, etc., by electric or other power, any tramways or light railways in Cape Colony.

Aberdeen.—The Docks and Pilotage Committee of Aberdeen Harbour Board have decided to adopt electric lighting for the quays, and also that the necessary current be obtained from the Corporation.

Wolverhampton. — The Lighting Committee of the Town Council in their annual report state that there has been an increased demand for the electric light, and that an extension of the plant will be necessary.

Lewes.—Mr. F. J. Warden-Stevens's report on the electric lighting of the borough has been considered in committee, and the Corporation have decided to act upon it, and are applying for a provisional order this session.

Aldrington.—The Urban District Council of Hove have given formal notice that they intend to apply to the Board of Trade on or before December 21 next for a provisional order under the Electric Lighting Acts, 1882 and 1888.

St. Annes-on-Sea.—The Urban Council on the 10th inst. decided unanimously to apply for a provisional electric lighting order. Complaint was made as to the bad lighting of the new esplanade, and it was intimated that in future the electric light would be used there.

Competition.—The Sanitary Committee of the Leicester Corporation invite designs and tenders for motor vehicles for the collection of house refuse, particulars of which are detailed in an advertisement in another column. Designs are to be submitted by January 31.

Fire.—Considerable damage was done by an outbreak of fire at Messrs. Siemens's electrical works, Woolwich, on Saturday evening, the conflagration having its origin in the sawmills, carpenters' workshops, and stores, consisting of three floors, 140ft. by 90ft.

Auckland.—An exchange says: "There is still a lot of talk about getting the electric light into the town. Then there will be a possibility of getting the streets lighted at a cheaper rate than the present."

Walton.—At the last District Council meeting a letter was read from the Board of Trade stating that the Walton-on-Thames Electric Light and Power Company had intended to proceed in the ensuing session of Parliament with the application for the provisional order.

Paisley.—A rumour, which is said to be based on good authority, is current in the town to the effect that a company is about to be formed to buy over the Paisley tramways, with the object of supplanting the present system of horse haulage with electric driving power.

Bermondsey. — Upon the recommendation of the Electric Lighting Committee, it has been resolved by the Vestry that the County Council be informed that the Vestry is willing to pay for the additional fittings if the Council will illuminate the Tower Bridge approach by electricity.

Bournemouth, Poole, and District Light Railways (Electric) Company, Limited.—This Company was registered on October 23, with a capital of £10,000 in £10 shares, with the object to make, construct, equip, and work with electrical or other power any light railways or tramways in Hants or elsewhere.

Colne.—At the last meeting of the Gas and Lighting Committee of the Town Council, the gas manager submitted a plan showing the proposed sites for the erection of an electric station. The plan was approved. The Town Council have adopted the committee's recommendation to light the town by electricity.

Long Eaton.—A special meeting of the Urban District Council will be held to discuss the advisability of putting down plant to light the town with the electric light, and to supply the same to manufacturers and others. A small committee has been appointed to obtain some particulars to lay before the Council.

Maidstone.—The Urban District Council have decided: "That the electric lighting provisional order be carried out by the Council themselves, and that the Electric Lighting Committee be instructed to take the matter into consideration and report fully to the Council." It was stated that the order would be carried out at once.

Finchley.—A letter from the Finchley, Hendon, and Hampstead Electric Railway Company, stating that they had asked the Light Railway Commissioners to sanction the undertaking, and asking the Council whether it assented or dissented from the proposal, has been referred to the Highways Committee of the District Council.

Argentine.—The Buenos Ayres and Belgrano Tramway Company, Limited, have received cable advice of the authorisation of the substitution of electric for horse traction over its entire system, extending from Plaza Victoria, the centre of the city of Buenos Ayres, to the suburb of Belgrano, the duration of the permit being 99 years.

Great Northern Telegraph Company.—The number of telegrams transmitted by this Company in the first nine months of this year was 1,784,782, as compared with 1,723,913 in the corresponding period of 1896. The revenue collected in the first nine months of this year was £203,600, as compared with £212,000 in the corresponding nine months of 1896.

Bournemouth.—The Roads Committee have decided to have all the three applications from Messrs. Burt and Haviland, the Bournemouth, Boscombe, and Westbourne Omnibus Company, Limited, and the British Electric Traction Company, printed and circulated for the benefit of the Council, and refer them to a committee of the whole Council.

Waterloo-with-Seaforth.—The surveyor has been instructed by the Urban District Council to obtain tenders for five electric lights to be fixed in various streets. Permission to lay mains has also been given to the Liverpool District Lighting Company, Limited. The chairman of the committee has been empowered to approve of such applications in the future.

Winchester.—The Electric Lighting Committee of the City Council have sent in an account of the costs and expenses connected with the application for and the obtaining of the provisional order and its transfer to the Winchester Electric Light Company, Limited, amounting to the sum of £413. 19s. 2d. The company have agreed to pay the amount, and the business will be completed.

Crosby.—At the last monthly meeting of the Urban District Council it was resolved that the clerk be authorised to appoint Messrs. Sharpe, Parker, Pritchards, and Barham parliamentary agents for the purposes of the proposed provisional order, and that their proposals as to costs be approved. The proposal of the Liverpool District Lighting Company to extend their electricity mains was sanctioned.

Appointment Vacant. — The Urban District Council of Llandudno invite applications for the appointment of clerk of works to supervise, under the consulting engineer, the erection of the electric lighting plant and other works in connection therewith, full particulars of which, as well as of various other appointments vacant, appear in another column. Applications are to be sent in by November 22.

Branksome.—There were two applications before the last meeting of the Urban District Council for their consent to the laying of electric tramway lines in the Council's district (in connection with proposed lines from Bournemouth to Poole), but the Council, whilst in favour of an electric tramway in the district,

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resolved that they could not give assent to either company without first obtaining more comprehensive details.

Derby.—The electric lighting station, by permission of the Watch Committee, has been connected with the fire-station system of telephones. A feed-water softener has been purchased from Messrs. Macphail and Simpson at a cost of £316, inclusive of pipe connections. This amount is included in the sum of £20,000 granted by the Council in April last.

Bootle.—At the last meeting of the Bootle Town Council a letter from the town clerk of Liverpool (Mr. Harcourt E Clare) was read with respect to tramways, and a report by the town clerk that the provisional order proposed to be obtained by the Corporation of Liverpool in the ensuing session of Parliament will not include any new tramways in Bootle or any connecting lines between proposed tramways in Bootle and the existing tramway system.

Amalgamation.—We are informed that in consequence of the rapid increase in their trade, Messrs. H. Binko and Co. and Ridsdale and Co. have decided to turn their businesses into a limited company under the style of Binko, Ridsdale, and Co. The management remains the same, and no shares will be offered to the public, the capital being full subscribed by the present owners and their friends. New and additional premises and plant have lately been provided for the new company.

Kinver.—The survey for the proposed line to Kinver has been pushed on, and Kinver people who have so long wished for the advantage of railway accommodation have now before them an electric tramline and an ordinary light railway scheme. The electric line does not seem to meet with the approval of the Parish Council, for they have passed a resolution to oppose it, and have also asked the County Council to do likewise. If, however, they got both schemes, they perhaps would not object after waiting so long for a railway.

Llandudno.—The Council in committee have passed a resolution to the effect that the Council forthwith apply for a provisional order for the construction of tramways within the Council's area in spite of opposition, for the support of which it was argued that in face of the application to be made at Colwyn Bay to the Light Railway Commissioners by the syndicate seeking powers to connect Colwyn Bay, Llandudno, Deganwy, and Conway by a light railway, the local scheme for Llandudno was a disastrous and profitless scheme to embark upon.

Gillingham.—Mr. Fraser who was accompanied by Mr. F. F. Smith, solicitor, Rochester, had an interview with the Council last week respecting the proposed electric tramway in the district, and after answering several questions he suggested that a committee of the Council should be appointed, as had been done at Chatham and Rochester. The Council agreed with the suggestion, and passed a resolution approving of the general principles of the scheme, subject to the terms being satisfactorily settled between the Council and the promoters.

Winton.—At a meeting of the Parish Council held last week, three applications were received from promoters of tramway schemes—one from Messrs. Burt and Haviland, another from the British Electric Traction Company, and one from the Bournemouth, Boscombe, and Westbourne Omnibus Company—asking for permission to lay tramways through the district. The Council expressed their general approval of having some tramway scheme, but reserved their support of any one scheme until a later date, relegating the matter to a small committee.

Burslem.—At the last meeting of the Corporation, the General Purposes Committee reported the receipt of a communication from the British Electric Traction Company, stating that they were promoting a Bill under the Light Railways Act for an electrical tramway from Longton to High-street, Hanley, thence to Leek-road, Burslem, and along Nile-street and Queen-street into St. John's-square, so as to unite with the authorised tramway at the top of Newcastle-street. The question was discussed at some length, and its further consideration was deferred.

Treeton.—At the dinner held in the Treeton National School to appropriately celebrate the introduction of the electric light into the village by the Parish Council, it was mentioned that the total cost of the installation was £650. The plant consists of one Brush series dynamo capable of running 26 2,000-c.p. Crompton-Pochin arc lamps in series, and the cable—highly insulated copper wires—is carried by leather slings from a wire of galvanised iron, supported on creosoted poles 20ft. above the ground. The power is obtained from the mechanics' shop at the colliery. Messrs. Dewhurst and Son, of Sheffield, have been the contractors.

Telegraph Buoys.—The Eastern Telegraph Company have reported to the Board of Trade that one of their telegraph cable mark buoys off the coast of Portugal had been found to be pierced in seven places by bullets, and it is supposed that some person had tried to sink it under the impression that it was a buoy which had broken adrift. Masters and officers are informed that the telegraph cable mark buoys of this company may be known by the fact that they carry a pole with a circular wire cage on the top, with a flag in the day time and a lamp at night, the top of the buoys being painted with alternate black and white or red and white squares.

Folkestone.—A meeting was held last week to consider and to take steps to oppose the introduction of electric tramways into Folkestone. It was resolved that: "This meeting feels that the proposed introduction of tramways into the borough of Folkestone would be most detrimental to the interests of the town." It was stated on behalf of Lord Radnor that, whatever his personal views might be he would pay due regard to the wishes of his leaseholders. If the Railway Commissioners reported favourably, they could go before the Board of Trade before they confirmed the order. They should let the Board know at once that they were opposed to it. A committee was formed.

Birkdale.—The minutes of the Lighting, Town Hall, and Licensing Committee, which are under consideration by the Council, contain the following resolutions: "That the Council take the necessary steps for the supply of the electric light in Birkdale, and that this committee be authorised to employ the services of an electrical engineer to give notice for and to obtain a provisional order for such supply"; and "That this committee accepts the offer of Messrs. Wood and Brodie, electrical engineers, to prepare plans and estimates and to do all other things that may be necessary, and to assist the Council in obtaining a provisional order for an electric installation for Birkdale."

Acton.—Three letters were read at the Council meeting from the secretary of the British Electric Traction Company giving notice that the company is promoting an electrical tramway from the termination of the existing West London Tramway through Ealing to the Broadway, Hanwell. The letters were referred to the Law and Parliamentary Committee without discussion. Messrs. Goddard and Aldridge wrote informing the Council of their intention to apply to the Board of Trade, on behalf of Mr. James de Lara Cohen, on or before December 21 for a provisional order authorising him to supply electricity for any public or private purposes within the area known as Friars-place Estate.

Hampstead.—Mr. E. S. Payne informed the Vestry at the last meeting that the new plant at the central electric lighting station would probably be all fixed in a fortnight's time. The Vestry would then be in a position to supply a very large amount of current. It was decided to order 500 yards of $^{7}/_{16}$ house cable from Messrs. Siemens Bros. The Chairman said that the question of lighting the High-road, Kilburn, with electricity had been postponed until the Willesden District Council obtained their provisional order. A notice of motion was tabled that when the lighting by electricity of High-street, Heath-street, and Haverstock-hill is carried out the old part of Heath-street may also be so lighted. The vestry clerk was instructed to take the necessary proceedings for the recovery of the amounts due from the consumers enumerated in a report submitted by him to the committee.

Dorset.—The Clerk reported to the last meeting of the County Council that within the last few days formal notices had been received from the Bournemouth, Poole, and District Light Railways (Electric) Company, Limited, and from the British Electric Traction Company, Limited, intimating that they were proposing to apply for powers to lay an electric railway through the Poole, Branksome, Kinson, and Christchurch district, and enquiring if the County Council assented or dissented. They had merely received the formal notices, and had no idea what the nature of the works would be. He therefore suggested that they be referred to the Parliamentary Committee to take what steps they might deem necessary. Meanwhile he might give formal notice to the companies that the County Council objected until they were assured that their rights over the county roads were sufficiently safeguarded. The matter was referred to the Parliamentary Committee with power to act.

Plymouth Refuse Destructor.—We have received another letter from Mr. G. Watson, of the Horsfall Furnace Syndicate, in reply to the one by Mr. Debnam published on the 29th ultimo. The letter in question is rather too lengthy for our correspondence columns, and hence we give the following condensation of it here. Mr. Watson contends that the sums realised at Hamburg for the by-product must be in fairness deducted from the costs when calculating the cost per ton for destroying the refuse. He considers Mr. Debnam wrong in dismissing entirely from his balance sheet the question of the value of the steam raised on account of any uncertainty as to the actual quantity. He proceeds to describe the situation of the Hamburg works, and concludes that the refuse at Plymouth contains much more combustible material than that at Hamburg. Finally, Mr. Watson gives figures obtained from Oldham, where he says that "for years past the total cost of burning the refuse, excluding only the rent of the site, has been 1s. 2d. per ton, without making any allowance for the steam delivered to the electricity station."

Norden.—On November 1 an adjourned special meeting of the Surveyor's Committee was held at Red Lumb. The members present were shown patent gas and electrical lighting apparatus at work. It was decided to recommend to the Council that the road from the White Lion Inn to Red Lumb-road should be lighted by electricity, and that the work be done in accordance with an estimate submitted to the committee. In reply to a question as to the probable relative cost of lighting the road by acetylene gas and by electricity, the Chairman explained that in regard to the cost of electricity they thought that a very reasonable arrangement could be made with Mr. Cudworth for the engine to be placed in one part of his premises, that they could also arrange for the engine to be looked after, and that there would be no necessity to provide a man specially for that work. The dynamos would want attention about every half-hour. When considering that matter they must bear in mind that the dynamo at his premises was one for 200 lights. A committee was appointed to carry out the proposed electric lighting.

Skipton.—At the last meeting of the Urban District Council a reply was read from Dr. Hopkinson, electrical engineer, stating the terms upon which he would consent to advise the Council as to the provision of electric light for the town. The Chairman thought there was not the slightest chance of the electric lighting question being considered by itself. It ought to be considered along with the question of purchasing the gasworks. It was

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pointed out that the clerk had been instructed to look into the financial position of the gas company, but they had never yet had his report. The Clerk said he had been prepared to report for some time, but the pressure of business on the Sanitary Committee had led to its being postponed time after time. It was decided that the Council go into the question of purchasing the gasworks at their next meeting, and consider the clerk's report, based on an examination of the gas company's balance-sheet and the Act of Parliament. In connection with the electric lighting proposal, a letter was read from the Skipton Traders' Association expressing approval of the action the Council had taken in approaching an electrical engineer to advise on the question generally.

Brierley Hill.—A meeting of the Lighting Committee, with three representatives from the Kingswinford Rural District Council, was held on October 11, as reported in a previous issue. The meeting was called to consider the advisability of applying for an electric lighting order for the districts of Brierley Hill and Kingswinford, with a view to providing a dust destructor in conjunction with an electric lighting plant for the two districts. The deputation from Kingswinford stated their Council had considered that the electric lighting of the two districts should be in the hands of the local authorities, and having regard to the size, population, and ratable values of the two districts considered that a license or provisional order under the Electric Lighting Acts should be applied for by both Councils, either jointly or separately, as early as possible. The committee, after fully discussing and conferring with the deputation on the matters referred to, adjourned the meeting to further consider the same and prepare a report for presentation to the Council. At an adjourned meeting held on October 29 it was reported that as yet the committee were unable to present the report alluded to, but hoped to be able to present it at the next monthly meeting of the Council. The report of the committee was adopted at the last meeting of the Council.

Oldham.—There has been some talk about what would happen supposing the Electric Traction Company finally abandoned their intention to complete the rails from Oldham to Ashton. Operations have certainly come to a dead stop for the present, although some of the material lies in a field near Oldham-road Station. The Corporation have entered upon an expensive scheme on the faith of this company becoming a large customer, and if it did not fulfil its part of the bargain the whole business might become very costly to the town. At present the buildings are forging ahead, and a large chimney is towering up close to the Corporation yard, while the streets in most parts of the borough have been up in order that cables might be laid down. From an Oldham paper we see that last week the Oldham Electric Lighting Committee had submitted to them two communications from the British Electric Traction Company apprising them of that company's intention of promoting under the Light Railways Act a tramway to run from Rhodes to Middleton, and then on to Oldham. The line, it was stated, would be worked by electricity on the overhead system by the most approved and modern method. The company is connected with the proposed electric tramway between Oldham, Ashton, and Hyde, and other tramways in different parts of England. The Town Clerk thought it would be advisable to take steps to prevent the company obtaining any powers in that district, and instructions to that effect were given.

Swindon.—A special joint meeting of the members of the Old and New Swindon District Councils to receive and adopt the charter for the incorporation of the town, which it is proposed to apply for, has been held. The Chairman referred to the advertisement which had appeared in the local papers with regard to the establishment of a light railway or tramways for Swindon. He said that was a most important matter, because in the case of an outside company establishing the light railway, the Council's interests must be looked after and protected. Then there was the more important matter of electric light. That was in a peculiar position at the present moment, from the fact that New Swindon had an electric lighting order and Old Swindon had not. Any person on considering the question could understand that at that stage of the proceedings as to incorporation, if they proceeded with the electric light instalment the whole town should be considered. The site for the works was a most important matter, and the whole question should be fully looked into by a committee of the two Councils It was moved that the Joint Incorporation Committee should consider the question of joint action in regard to the provision of electric light and tramways for the town, and report to a joint meeting of the Councils; and that the joint committee be strengthened by the addition of not more than three members from each Council. United action would be far preferable and more profitable in this matter. This was carried unanimously.

Wimbledon.—At the last meeting of the Urban District Council it was proposed that the Electric Lighting Committee should consider the question of constructing a dust destructor in connection with the electric lighting scheme approved of by the Council, and report at an early date; also that they be requested to visit the electric lighting works at Shoreditch. It was pointed out that from 830 to 850 tons of house refuse had to be disposed of in Wimbledon during the year, and it appeared very desirable to erect a destructor for its future disposal in connection with the shaft which would have to be constructed at the electric lighting works. The Council already spent £75 a year for sorting and disposing of the rubbish, but if they were to apply the money to the purpose suggested it would pay the interest on a loan of £2,500 at 3 per cent., and thus meet any extra expenditure which might be incurred in erecting the destructor. This recommendation received the assent of the Council after the Road, Drainage, and Farm Committee had been substituted for the Electric Lighting Committee. It was resolved concerning the electric lighting scheme: (*a*) that Mr. Preece should be paid the usual commission of 5 per cent. upon the cost of the work carried out under his supervision; (*b*) that the Electric Lighting Committee should meet on Tuesday next to confer with Mr. Preece on the preliminary plans, etc.; (*c*) that Mr. Porter should be added to the committee; (*d*) that electric mains should be laid in the 11 private streets now about to be made up by the Council.

Newcastle-on-Tyne.—The report of the Roads and Bridges Committee, presented at the last quarterly meeting of the Northumberland County Council, contained the following recommendation: "Quite recently the British Electric Traction Company, Limited, have given notice to the Council that they intend to apply to the Light Railway Commissioners for an order authorising light railways in the borough of Tynemouth and in the urban district of Whitley. The proposed light railways are really an extension of the existing tramway system from Saville-street to the New Quay, and from the termination of the present lines to Whitley. The application will be made to the Commissioners this month, and it may be that the enquiry which will be held by the Commissioners will take place before the meeting of the Council in February next. The committee have not yet had an opportunity of communicating with the local authorities, nor of fully considering the matter, but inasmuch as it is one which will not admit of delay they propose to do both at an early date. For the same reason—that of urgency—they recommend that, so far as the law permits, all the powers of the Council in connection with the company's proposal be delegated to the committee; that the common seal of the Council be affixed to such documents as may be necessary or advisable in the opinion of the committee for the purpose of giving effect to any determination they may come to in the presence of the chairman or vice-chairman of the Council or of any two county aldermen, and of Councillors Middleton and Williamson, and of the clerk of the Council or his deputy; and that the acts and proceedings of the committee in the premises be not required to be submitted to the Council for approval." The recommendation was agreed to.

Dudley.—As already previously reported, it is the intention of the British Electric Traction Company to promote in the next session of Parliament a Tramway Bill which will include Wednesbury, Tipton, Dudley, Brierley Hill, Kingswinford, and The Lye. The enquiry at Dudley, to which we referred in our last issue, will be held to-morrow, when representatives of the various local authorities will have an opportunity of expressing their views on the matter. The principal, if not the only, point of difference between the company and the authorities has reference to the supply of electrical power. The company offer to erect electrical plant at various points, and to supply the various towns and villages along the route with electric light. Neither Stourbridge, Brierley Hill, nor the Tipton authorities are inclined to permit the tramway promoters to obtain electric lighting monopolies in their districts, Tipton District Council on the 9th inst. resolving to keep the privilege within their own hands. The Dudley Town Council, in view of the tramway scheme and the lighting question generally, obtained an electric lighting order some time ago, and it was understood that the company would purchase their supply of motive power in that district from the Corporation. It appears, however, that a deadlock had occurred in reference to the price per unit of supply. Expert evidence as to what is a fair and reasonable price differs as far as from 1d. to 6d. per unit. This condition of things has suggested to the Council the propriety of municipalising the local tramways, the lease of which expires four years hence. It is thought that Dudley, in conjunction with the authorities of Brierley Hill, Kingswinford, Stourbridge, The Lye, and Rowley, might carry out a comprehensive scheme of tramway inter-communication and electric lighting.

Messrs. Downie and Adams.—This firm announce that they have acquired the patents for sale and manufacture throughout the British empire of the Brillé electricity meter. They have now issued a descriptive list of the same, which will be interesting reading to all those who are not acquainted with the principle on which this meter works. That this principle is not fully understood by many was evidenced by the want of knowledge of it shown by some of the expert witnesses in the recent great meter law case. It is not a motor meter, as supposed by them, in which a motor action directed against a brake registers the current passing. Instead of this, a series of braking magnets are rotated round a copper cylinder, and the force produced is balanced against that set up by a dynamometer through which the current to be measured is passing. The resultant deflection closes rheostat connections influencing the speed of the motor, but the makers claim that in this way greater accuracy and range can be obtained. The actual energy required in this type of meter is said to be only one watt. The advantages claimed for the meter are summarised as follows: Absence of iron in the measuring apparatus. All the constituent parts of the meter being absolutely at rest when not in circuit. The indications are strictly proportional to the consumption. There is absolutely no friction from passive resistances on the measuring apparatus. The use of an electro-dynamometer of very high electrical resistance (more than 10,000 ohms for 100 volts), exercising a considerable effort. The energy absorbed by the motor being in proportion to its speed and to the maximum of four watts, the expenditure of the meter is almost nil. A certainty that the motor will start as well with a feeble as with as a full load. No temperature error, as the resistance of the electro-dynamometer and that of the disc vary equally. A good law and great sensitiveness, all meters registering $\frac{1}{1000}$th of their load. The meters can be seen at the firm's offices at 24, Newman-street, Oxford-street, W.

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Crewe.—The General Purposes Committee, in compliance with the request of the New Mutual Telephone Syndicate, Limited, Manchester, have resolved to urge upon the Post Office to allow competition in the telephone service of this country. At the last meeting of the Town Council it was stated that the Electric Sub-Committee had had before them the report of a deputation who had visited Chester, and after hearing their report decided to recommend the General Purposes Committee to apply to the Board of Trade for a provisional order under the Electric Lighting Acts, 1882 to 1890, and to instruct the town clerk to take such steps and do such things as may be necessary in connection therewith. In answer to questions, the Chairman stated that electric lighting in Chester was so far a complete success, and had caused the price of gas to be reduced from 3s. 2d. per 1,000 cubic feet to 2s. 11d. per 1,000ft., with a discount of 10 to 20 per cent. for cash payment. The sub committee further resolved that the order be asked for the whole area of the borough, and that the streets in which it is proposed electric lines should be laid down within a specified time be Earle street, Victoria-street, Market-street (in a northerly direction as far as the Crewe Co-operative Friendly Society's premises, High-street, Exchange-street, Mill-street, and Nantwich-road, the borough surveyor to supply the town clerk with a list of the private streets in the borough over which powers are proposed to be taken. The minutes of the sub-committee were approved, and the Town Council at its meeting of the 5th inst. decided to apply for a provisional order. The Town Clerk read a letter from the British Electric Traction Company, Limited, stating they were prepared to consider the question of undertaking the supply of electricity for lighting at Crewe from the same power station as they proposed to erect for the purposes of the electrical tramways, the light railway order for which was before the Commissioners. The town clerk was instructed to reply to the letter that the Council had decided to apply for a provisional order under the Electric Lighting Act.

Airdrie and Coatbridge Tramway Scheme.—The Coatbridge Town Council have agreed unanimously to oppose the application of the British Electric Traction Company, Limited, to lay a light railway through the streets of the burgh. The Council are at present in negotiation with the New General Traction Company, Limited, who propose to lay a line of tramway under the Tramways Act. It was explained that a light railway would become the property of the company in perpetuity, while a tramway would be under a concession terminable in 21 years, so that the corporations could then take it over.—The *Airdrie Advertiser* states that the minute of the Joint Tramway Committee of Airdrie and Coatbridge Town Councils showed that a letter was read from the Electric Construction Company, Limited, declining to submit an offer for the concession of the streets, a decision which they had arrived at after making all necessary enquiries. A letter was read from the New General Traction Company, Limited, however, in which they say: "We have gone carefully into the question of tramways for Coatbridge and Airdrie, and find that we are unable to submit alternative propositions as suggested by the Joint Tramways Committees of the Town Councils of Coatbridge and Airdrie held on September 13, and we therefore submit the following, which we trust will meet the views of the Corporation. We propose to lay a line of single track, with passing places, through the main street of Coatbridge and Airdrie, from the Woodend public-house in Coatbridge, to the Stirling and Carlisle-road in Airdrie, a distance of about 3⅝ miles; also a branch line of single track running from the Cross of Coatbridge past Sunnyside Station; the length of this line will be just over half a mile. We propose to equip the lines with the overhead method of electric traction as being the only system we consider financially possible. The branch line to Sunnyside Station will be carried by brackets supported on standards placed on one side of the street; the main line can either be carried on span wires supported by standards placed on each side of the road, or the tramway line might be laid sufficiently out of the centre of the road to enable the bracket form of suspension to be used. In this latter case there would be no need for laying the lines closer to the curb than would give ample space for vehicular traffic between them and the curb. We would put down an electrical equipment on the most modern lines and a sufficient number of carriages to run a 10 minutes' service for the entire line, and we would run cars for as many hours a day as the traffic seemed to demand, probably from 5.30 or 6 in the morning until after 11 at night, and on Sundays such service as the traffic might require. We propose to pave the whole line with whinstone setts—such are now used in Coatbridge—to a distance of 18in. outside the rails, and, where double track is used, at the passing places we should pave the whole distance between the tracks, and would, of course, maintain all the paving laid by us. The fares would be 1d. per mile. A special fare of ½d. per mile would be charged for workmen between the hours of 6 and 8 in the morning and 5 or 7 in the evening, and between 1 and 2 at noon, or such other time as might suit the local customs as to dinner hour. No fare less than 1d. would be charged. The Corporation would, of course, have the usual protective clauses as to their sewers and other public works. We have already intimated to your committee we should not be prepared to consider the construction of this tramway unless Section 43 of the Tramways Act were modified very considerably, and the purchase clause which we should require in place of this section would be about as follows: "The Corporation to have the right to purchase at the end of 15 years, 25 or 35 years by paying the then value as a going concern, with due allowance for profits, etc., but under no circumstances shall the Corporation have a right to purchase at a price less than the original capital of the company. After 35 years the Corporation to have the right to purchase as a going concern at the end of each five years without regard to the capital of the company." The company are quite prepared to find all the capital required for carrying out the enterprise, and would push the work to completion as rapidly as possible. It was also stated that a copy of the minute of meeting of the committee held on September 13 last had been sent to Messrs. Doddrell Bros., the British Thomson-Houston Company, Limited, and Mr. A. Walker, all of London, at their request, with a view of their making an offer, but no reply had been received from them. After some conversation it was agreed that the respective committees should consider the offer of the New General Traction Company, Limited, and that after they had done so another meeting of the Joint Committee should be held on as early a date as possible, Provost Sharp to be convener of the Joint Committee. The Town Clerk stated that the British Electric Traction Company had since given public notice of their intention to apply this month to the Light Railway Commissioners for an order under the Light Railways Act, authorising them to lay a light railway from Deedes-street to Graham-street, and he submitted two letters referring to the subject from the British Electric Traction Company.

TRAFFIC RECEIPTS.

Bristol Tramways.—The traffic returns for the week ending November 5 were £2,545. 7s. 5d., compared with £1,929. 4s. 9d. for the corresponding period of last year, being an increase of £616. 2s. 8d.

Dover Tramways.—The traffic receipts for the week ending November 6 were £103. 12s. 10d. The total receipts up to the same date were £1,140. 9s. 7d. The mileage open at present is only two miles.

Birmingham Tramways.—The traffic receipts for the week ending November 6 were £3,511. 0s. 0d., as compared with £3,123 7s. 2d. in the corresponding week in 1896, being an increase of £387. 12s. 10d.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended November 7 amounted to £1,341, as compared with £1 065 in the corresponding week of the previous year, being an increase of £276.

City and South London Railway.—The returns for the week ended November 7 were £1,041, compared with £1,036 for the corresponding period of last year, being an increase of £5. The total receipts for the half-year 1897 amounted to £17,580, compared with £17,747 for the corresponding period last year, being a decrease of £167.

South Staffordshire Tramways.—The traffic returns for the week ending November 5 were £655. 2s. 3d., as compared with £617. 1s. 4d. in the corresponding week of the previous year. The aggregate receipts so far this year were £28,131. 11s. 8d., as compared with £27,256. 13s. 1d. in the corresponding period in 1896.

S.D. Tramways, Dublin.—The traffic receipts for the week ending November 5 were £489. 3s. 11d., as compared with £441. 17s. 7d. in the corresponding week in the previous year, being an increase of £47. 6s. 4d. The number of passengers carried was 79,121 in 1897 and 67,328 in 1896. The aggregate returns up to date are £13,316. 0s. 2d., as compared with £12,756. 7s. 0d. last year, being a decrease of £559. 13s. 2d. The mileage open is the same as last year—viz., eight miles.

PROVISIONAL PATENTS, 1897.

NOVEMBER 1.

25299. Improvements in electrical rain gauges. Alfred John Victor Rapkin, Robert Henry Duncan Rapkin, and Arthur Douglas Wilson, 78, Fleet-street, London.

25302. Improvements in electrical conductors. Walter Judd, Beechcroft, Hook-road, Surbiton.

25307. Improvements in or connected with drum armatures for dynamo-electric generators and motors. Valere Alfred Fynn, 47, Lincoln's-inn-fields, London. (Complete specification.)

25335. Improvements in electric stop motions for drawing frames used in the preparation of cotton or other fibres for spinning. Mark Thomas Makin, James Lee, Smith Knott, 6, Bank-street, Manchester.

NOVEMBER 2.

25364. Improvements in electric switches. Vittorio Giovanni Lironi, 251, Western-bank, Sheffield.

25369. Improvements in electromagnetic circuit breakers. William George Heys, 70, Market-street, Manchester. (Daniel C. Spruance and Montgomery Waddell, United States.) (Complete specification.)

25388. Improved compositions for use in the construction of electrical heating apparatus and resistances and the processes for their manufacture. Louis Parvillée, 2, Lancaster-place, Strand, London. (Complete specification.)

25403. Improvements in or relating to current collectors for electric railways. Alfred Julius Boult, 111, Hatton-garden, London. (Frederick Augustus Anderson and David Marsden Anderson, United States.)

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25386. Improvements in chemical-electric generators. Henry Kasper Hess, 11, Southampton-buildings, Chancery-lane, London. (Complete specification.)

25412. Improvements in electrical resistances. Thomas Edward Gambrell and Arthur Frederick Harris, Grasmere, Allfarthing-lane, Wandsworth, London.

25434. Improvements in trolley-wire hangers for use in overhead lines of electrical railways or tramways. Philip Dawson, 47, Lincoln's-inn-fields, London.

25437. Process and arrangement for intensifying telephonic reproduction. Georg Cohn, 18, Southampton-buildings, Chancery-lane, London.

25441. Improvements in electric accumulators. Henry Harris Lake, 45, Southampton-buildings, Chancery lane, London. (Gaston De Digoine, France.)

25446. Improvements in apparatus for electrically controlling engines, electromotors, and other machinery. William Horatio Harfield, 4, South-street, Finsbury, London.

25453. Improvements in dynamo electrical machines. Felix Caire, 40, Chancery-lane, London.

NOVEMBER 3.

25480. Improvements in electric accumulators. August Graemiger, 4, Corporation-street, Manchester.

25519. Improvements in electrodes. James Hargreaves, 191, Fleet-street, London.

25528. Improved valve apparatus for electric batteries. William Hopkin Akester, 321, High Holborn, London. (Complete specification.)

25537. Improved electrical appliance or lamp for dental and other purposes. Albert Mayo Stansfield, 6, Lord-street, Liverpool.

NOVEMBER 4.

25581. A lighting regulator for gas and petroleum motors lighting electrically. Henry Crouan, 8, Rue des Princes, Bruxels.

25582. Electric lighter for gas and petroleum motors. Henry Crouan, 8, Rue des Princes, Bruxels.

25594. Improved high-voltage ceiling rose and special adjustment pulley ring for balance weight with special constructed terminals. John Edwards Bunce, Bell Hall Mount, Halifax

25599. Improvements in electricity meters. Chamberlain and Hookham, Limited, and Sydney Holmwood Holden, 18, Southampton-buildings, Chancery-lane, London.

25646. An improvement in the manufacture of bulbs for electric glow lamps. Forest William Dunlap, 53, Chancery-lane, London.

25647. An improvement in the manufacture of globes and shades for electric and other lamps. Forest William Dunlap, 53, Chancery-lane, London.

25650. Improvements in armatures for dynamo-electric machinery. Joseph Slater Lewis, 322, High Holborn, London.

25653. Improvements in or applicable to incandescent electric lamps. Simon Biheller, 226, High Holborn, London.

25659. Improved manufacture of electrical vacuum tubes Frederick Harrison Glew, 156, Clapham-road, London.

NOVEMBER 5.

25674. Generation of electricity at gasworks by utilising waste gases. Samuel Thomas White, 2, Queen Anne-buildings, Baldwin-street, Bristol.

25703. Improvements in electrical batteries. William Wallace Hanscom and Arthur Hough, 17, St. Ann's square, Manchester. (Complete specification.)

25712. Improvements in closed-conduit systems of electric traction. Alfred Bertram Loach, 50, Cherry-street, Birmingham.

25723. Improvements in alternating electric current motors. Gustave Adolphus Scheeffer, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

25744. Improvements in alternate-current induction motors. The British Thomson-Houston Company, Limited, and Henry Metcalf Hobart, 70, Chancery-lane, London. (Complete specification.)

25745. Improvements in reactance coils The British Thomson-Houston Company, Limited, and Henry Metcalf Hobart, 70, Chancery-lane, London. (Complete specification.)

25755. Automatic electric signal device for preventing railway accidents. Bronislav Georg Sabat, Johan Drohomirecki, and Albert Rosenberger, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

25757. Improved manufacture of electrodes for electrical accumulator or secondary batteries. Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (La Société Anonyme pour le Travail Electrique des Metaux, France.)

NOVEMBER 6.

25771. An electric fire-alarm. James Higgins, Ballyduff, Claremorris, co. Mayo.

25805. Improvements in and relating to overhead conductors for electrically-propelled tramcars and the like. John Thomas Wood and John Alexander Bodie, 26, Castle-street, Liverpool.

25786. Improvements in submarine cable signalling. Sidney George Brown, 1, St. John's-road, Chelmsford.

25816. Improvements in insulators. Daniel Sinclair and William Aitken, Oxford-court, Cannon-street, London.

25818. Improvements in electric bells. John Mackenzie, 70, Wellington-street, Glasgow.

25830. Improvements in or connected with electric burglar alarms, also applicable as a door or house bell. Wilhelm Menze, 6, Lord-street, Liverpool.

25832. Improvements in dynamos, electromagnets, and the like, and in wire or winding for the same, and for other electric purposes. Charles Frederick Blundell, 6, Lord-street, Liverpool.

25869. An improved system for the distribution of electric currents and apparatus therefor. Georg Möller, 4, South-street, Finsbury, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1895.

22661.* Indicating and recording electric supply. Baron Kelvin. (Amended.)

1896.

19757.* Electric lamp circuits. Lake. (Black.) (Amended.)

23242. Electric incandescence lamps. Dunlap and Quain.

23512. Electricity meters for alternating currents. Hookham.

26968. Construction of spring-jacks used in telephonic switchboards. Sinclair and Aitken.

28139. Lead accumulators. Dodd.

28578. Bonding of rails used for electrical railways or tramways. Crompton.

29499. Alternating-current motors. Heyland.

30050. Manufacture and production of flexible metal bars, cables, or the like, suitable for use as electric conductors or for other purposes. Edmunds.

1897.

4183. Electric incandescent lamps. Dolley, Hawkins, Lightfoot, and Goodwin.

9173. Electro-therapeutical lamp. Mayer.

14963. Trolleys for electrically-propelled cars. Hoegerstaedt.

18035. Electrolytic apparatus. Jones. (Balbach.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	11-11½
Brush Company, Ordinary	5	1½-1⅝
—— Non. Cum., 6 per cent. Pref.	2	1⅝-2⅛
—— 4½ per cent. Debenture Stock	100	107-111
—— 4½ per cent. 2nd Debenture Stock	100	98-102
Callender's Cable Company, Debentures	100	108-113
—— Ordinary	5	7-8
Central London Railway, Ordinary	10	9⅞-10½
——	6	5⅝-6
Charing Cross and Strand	5	12-13
Chelsea Electricity Company	5	10-10⅝
—— 4½ per cent. Debentures	100	110-113
City of London, Ordinary	10	25-26
—— 6 per cent. Cumulative Pref.	10	17-18
—— 5 per cent. Debenture Stock	100	131-136
City and South London Railway, Consolidated Ordinary	100	69-71
—— 4 per cent. Debenture Stock	100	137-140
—— 5 per cent. Pref. Shares	10	15½-15⅝
County of London and Brush Provincial Co., Ordinary	10	12⅝-13½
—— 6 per cent. Cum. Pref.	10	15½-15⅝
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1⅝-2
—— 5 per cent. Debentures	—	89-94
Edison and Swan United Ordinary	5	2⅛-2⅜
—— 5 per cent. Debentures	5	4-5
Electric Construction, Limited	2	1⅞-2⅛
—— 7 per cent. Cumulative Pref.	2	3⅛-3⅜
Elmore's Copper Depositing	1	⅛-¼
Elmore's Wire Company	2	⅛-¼
W. T. Henley's Telegraph Works, Ordinary	10	19½-20½
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	9-9½
—— 7 per cent. Preference	5	10½-11½
India Rubber and Gutta Percha Works	10	21-22
—— 4½ per cent. Debentures	100	103-107
Kensington and Knightsbridge Ordinary	5	14-15
—— 6 per cent. Pref.	5	8-8½
London Electric Supply, Ordinary	5	2-2½
Metropolitan Electric Supply	10	17½-18½
—— 4½ per cent. First Mortgage Debenture Stock	100	119-123
National Telephone, Ordinary	5	6½-6⅝
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	14-16
—— 5 per cent. Non. Cum. Third Pref.	5	6-6½
—— 3½ per cent. Deb. Stock	100	104-109
Notting Hill Company	10	15½-16½
Oriental, Limited, £1 shares	1	1⅛-2
—— £5 Shares	5	8½-8⅝
—— £4½ shares	4½	7½-7⅝
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	103-105
South London Electric Supply, Ordinary	2	1⅝-2⅛
St. James's and Pall Mall, Ordinary	5	16-17
—— 7 per cent. Pref.	5	9½-10½
Telegraph Construction and Maintenance	12	38-39
—— 5 per cent. Bonds	100	103-105
Waterloo and City Railway, Ordinary	8	12⅝-13
Westminster Electric Supply, Ordinary	5	14½-15½
Yorkshire House-to-House	5	8-9½

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NOTES.

Trade in the Soudan.—A Reuter's telegram from Cairo states that it is officially declared that there is absolutely no foundation for the statement contained in a Paris telegram, published by a London morning paper on the 2nd inst., that the future trade of the Soudan had been secured by a British syndicate.

Vibration Telegraphy.—*Indian Engineering* says that the Government of India have sanctioned a bonus of £250 to Major P. Cardew for his invention of "vibration telegraphy," which has been extensively introduced in that country. The Imperial Government made him a similar present on behalf of the home telegraph system.

The Royal Institution.—Prof. Oliver Lodge, F.R.S., will deliver the first of a course of six Christmas lectures (specially adapted to young people), on "The Principles of the Electric Telegraph," at the Royal Institution on December 28. The remaining lectures will be given on December 30, 1897, and January 1, 4, 6, 8, 1898.

Cheshire Chemical Industry.—Last week 70 joiners, fitters, and others in the construction department at the chemical works of Messrs. Brunner, Mond, and Co., Winnington, Northwich, were discharged. The Cheshire chemical industry continues in rather a depressed condition, and the tariff is still having a most serious effect on trade with America.

The Telephone in Italy.—A telephone line between Treviso and Venice was inaugurated on Sunday by Signor Sineo, Minister of the Postal and Telegraphic Department, who in his speech on the occasion said that he was anxious to promote the opening of State telephones, and hoped that the condition of the country's finances would soon allow this object to be realised.

The "Review."—We congratulate our contemporary upon its issue of last week, in which it commemorates the close of the twenty-fifth year of its existence. The greater part of the number is devoted to the history of the progress of applied electricity during the past quarter of a century. Each branch of the subject has been dealt with by capable hands, and we are quite sure the pages of this issue of the *Review* will be widely read and appreciated.

The Progress of the Telephone Battle.—At the last meeting of the Commission of Sewers the solicitor reported the service on the Commission of a summons, at the instance of the Postmaster-General, under the Telegraph Act for withholding their consent to the opening of certain streets for the laying of telegraph and telephone tubes. The matter, in the first instance, will come before the City of London Court, and, in the event of an appeal, will be heard by the Railway Commissioners.

Minerals and X-Rays.—The *Journal* of the Chemical Society publishes an abstract of an interesting paper by Mr. Cornelius Doelter on "The Behaviour of Minerals with the X-Rays." The author uses the methods described in a previous paper. Phenakite is one of the most transparent of minerals, and is placed in the author's Group II. Olivine, tourmaline, biotite, zoisite, and sphene have about the same transparency as calcite (Group VI.). Sapphire seems to be more transparent than ruby, and aquamarine is more transparent than the darker coloured emerald.

Society of Arts.—At the first ordinary meeting of the one hundred and forty-fourth session of the Society of Arts held on Wednesday night in the Society's Hall, Adelphi, Sir Owen Tudor Burne distributed medals to several gentlemen who had read papers before the society during the previous session. Among them was Mr. W. B. Esson for his paper on "Transmission of Power to Long Distances by Alternating Currents of Electricity." As chairman of the council, Sir O. T. Burne gave his inaugural address, the subject of which was "The Colonies: Their Arts, Manufactures, and Commerce."

Mining Electricity.—The new electric equipment at the De Beers mine has been supplied by the General Electric Company of New York, and consists of three engines of the tandem compound type, capable of developing 175 i.h.p.; two 50-kw. six-pole compound-wound dynamos, one of which generates at pressure of 220 volts and the other at a pressure of 115 volts; a large switchboard provided with voltmeters and ammeters, and 12,000ft. of large copper cable. The plant is intended for the lighting of the mine, also to drive a number of motors during the day.

An Old Friend in a New Guise.—We are pleased to see that Indian enterprise has at last produced a monthly periodical which ought to have a successful future before it. We refer to the *Indian and Eastern Engineer*, which, in the absence of editorial explanation, we presume to be the phœnix of the weekly paper of the same name, and considering the importance of India as a field for engineering in all its branches, this paper ought to take up a prominent position somewhat on the lines of certain English prototypes. The field is open if the opportunity be not missed, and the proprietors of the *Indian and Eastern Engineer* have wisely started by making their paper attractive.

The Engineering Outlook.—A truce has been called, and the masters and the men both seem willing to arrange terms to end the disastrous struggle in which they have been engaged. On Wednesday two members of the Employers' Emergency Committee and two members of the joint committee of the allied trades met and made arrangements for a conference. From the statements they have issued to the Press we learn that the conference is to be held at the Westminster Palace Hotel on Wednesday next at 11 a.m., that each side is to have 14 representatives, and that each party shall appoint its own chairman. The terms of the truce are that until the termination of the conference the employers will suspend any notice not already carried into effect and will not post further notices, and the societies will not interfere in any way with men who may be in employment at any time during the conference.

The Capitalisation of Electric Supply Companies.—A correspondent contributed to the *Financial News* last week a long article on the comparative capitalisation of the various electric lighting companies in London. This is a subject to which we have referred frequently in our columns, pointing out that in almost all electric lighting undertakings the capital charges contribute largely to the actual cost of supply. The correspondent in question, however, rather exaggerated this factor, and, writing from a financial standpoint, has neglected the influences of the character of the district supplied on the success of an electric lighting undertaking. His most serious error is one which we should hardly have expected from a financial gentleman, of considering that the expenditure in contracts of an electric lighting company represents the total capital of that company. As he also compares in certain cases estimated figures with actual results, a certain number of his conclusions must be accepted with caution.

An Unusual Method of Summoning Help.—The person who wrote that electricity was one of the "mighty agents of nature enchained by the ingenuity of man" can scarcely have contemplated in his wildest dreams the full extent of that ingenuity. For instance, he is scarcely

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likely to have prophesied that a sick man far from the habitations of civilisation would have cut a telegraph wire in order to obtain assistance. And yet such has really occurred. The whole of the vast continent of Australia was practically cut off from European news for nearly 24 hours in the middle of September in consequence of an interruption on the line between Adelaide and Port Darwin. Enquiries were made, and it was found that the wire had been cut by a cyclist who was taken ill while on a journey across the continent. It is not related how he set about it, but he had the satisfaction at any rate of getting what he wanted. It is not desired to establish this as a precedent of summoning help under inconvenient circumstances.

New Telephone for Warships.—The new battleship "Cæsar," at present completing for sea at Portsmouth, has been fitted with a new system of patent loud-talking naval telephones, the invention of Mr. Alfred Graham. The instruments were tested last week in the presence of the Commander-in-Chief, Admiral Sir Michael Culme-Seymour, Rear-Admiral Rice, Admiral-Superintendent of the Dockyard, and several naval officers. The new system has been adopted for connecting the conning tower with all the casemates on the starboard side, while for the port casemates the ordinary voice tubes are used. In using the new telephone for speaking to any given number of places, it is only necessary to displace one shutter. Articulation is perfect, and messages may be heard at the distance of 10ft. from the receiving instrument. It is claimed that Mr. Graham's invention will not be affected by the noises occasioned by machinery or gun fire, whereas ordinary telephones are so injured by heavy gun fire as to become useless. The two systems of communication are to undergo a severe test when the ship is commissioned for the Channel Squadron.

African Telegraphs.—From the fourth annual report of the African Lakes Corporation, Limited, issued last week, we learn that "in view of the progress being made to the west of Lake Nyassa by Mr. Rhodes's international telegraph line, the Rhodesia Concessions, Limited, and the North Charterland Exploration Company, Limited, the corporation have erected and equipped a new station at Kotakota, about 150 miles up the lake on its western shores. The corporation has also opened an important station at Zomba, near the headquarters of the British Central Africa Administration. . . . . The line of the African Transcontinental Telegraph Company is being rapidly carried forward. The section south of the Zambesi between Salisbury and Tete is not yet reopened, the poles having been destroyed by the natives. The line is now being relaid under the direction of Dr. Jameson on another route, where it is being rapidly carried through. It is hoped that this section will be opened within three months, when Nyassaland will be in direct telegraphic communication with the outer world. In its progress northwards the wire has now reached Fort Johnson, at the south end of Lake Nyassa, and thus our headquarters at Mandala are in direct communication with the lake. The line has also been completed to Chiromo, whence messages can be sent over the Portuguese wires to Chinde on the coast. The corporation has undertaken a considerable amount of transport in connection with this telegraph enterprise."

The Field Collection.—The *Electrical World* of New York says that the National Museum at Washington has just been enriched by a very valuable (and to electricians more especially) interesting collection. This latter comprises the private papers of Mr. Cyrus W. Field relating to the laying of the first Atlantic cable, cable despatches first sent, objects with which Mr. Field worked out the idea of laying the cable, and many other things of interest pertaining to the project. The correspondence and autograph copies of telegrams sent by Mr. Field to the President of the United States and other eminent persons are included. The globe, which was constructed in London, and on which Mr. Field traced the course of the cable to be laid from Newfoundland to Ireland, forms an attractive object of the collection. It is about 18in. in diameter, on a stand, with a magnetic compass underneath, and shows many signs of hard usage. The journal kept by Mr. Field and notes of deep-sea soundings set down by him and officers of the "Great Eastern," which laid the cable, are part of the collection. Mr. Field's private library, with all the literature relating to the work of laying the cable, forms another part. There are also copies of medals presented to Mr. Field by Congress and the French Government, engrossed resolutions passed by public bodies in the United States and in Europe, a cane from the wood of the "Great Eastern," etc., as well as cases containing sections of the first Atlantic cable. The collection was secured by Prof. Watkins from Mrs. Isabella Field Judson, of Dobbs Ferry (New York State), who is a daughter of the late Mr. Field.

Electrical Oscillations. — Mr. Alexander de Hemptinne has contributed a paper to the Chemical Society on "The Chemical Action of Electrical Oscillations," of which the following interesting abstract has been published in the *Journal* of the Chemical Society: "In order to ascertain the effect of the wave-length the author determined the maximum pressure at which the tube became luminous when subjected to the influence of the oscillation, investigating the cases of tubes with allylic alcohol, acetone, propylic aldehyde, methylic alcohol, and ethylic alcohol. Of these, the two last showed a marked increase of sensitiveness as the wave-length increased, but in the other cases the pressure remained almost constant except for acetone, where a maximum of sensitiveness was obtained in the middle of the series. The author describes an experiment illustrating the metallic conductivity of a glowing tube, and points out that from the analogy to metals the chemical action would be expected to vary with the wave-length. According to Ebert, the spectra of vapours vary with the wave-length, but although the author also finds a slight variation in the compounds examined, he points out that this may be due to decomposition and the formation of new products; the influence on the spectrum of the substance itself, therefore, is doubtful. In general, the sensitiveness increases with the molecular weight, but it is dependent also on other data, thus ethylic ether is less sensitive than acetone. Temperature has also a marked effect, but its complete investigation was postponed; a magnetic field appeared to have no influence."

The Electric Arc.—The much-debated question as to whether there exists a counter E.M.F. in an electric arc has been taken up in a new aspect by Mr. W. R. Bonham and Harold Almert, whose experiments are described in a recent issue of the *Western Electrician*. The experiments, though interesting in themselves, have, after all, no bearing whatever on the question at issue. The experimenters' idea appears to be that if a counter E.M.F. existed in the arc, the energy absorbed would not be the product of the volts and amperes. They proceeded to investigate in the following way. The arc lamp was enclosed in a sheet-iron box 4ft. square, placed inside a room having a capacity of 700 cubic feet, which room had no apertures in the nature of windows, and only one small door. Thermometer readings were then taken of the temperatures of the air and of the air inside the iron box. The final constant temperature, obtained after a 9½ hours' run, was then taken by

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the experimenters to indicate the energy given off by the arc lamp. The lamp was then replaced by a resistance absorbing practically the same number of watts, which was found to give an equivalent rise of temperature. The discrepancy between the two sources of energy at equal temperature was found to be only about 6 per cent., and the authors conclude that, although they cannot account for the abnormal high resistance present in an arc, their experiments prove beyond a doubt that the phenomenon is not due to a counter E.M.F. Our conclusion would be rather that the authors have proved again beyond a doubt the well-known law of the conservation of energy. Their idea appears to be that the central-station engineers should only charge for the product of the current taken by the arc lamps, noting the difference between the E.M.F. supplied and the supposed counter E.M.F.!

The Dangers of Alternating Currents.—In Switzerland, more than in any other country almost, are to be found the comparatively greatest number of hydro-electric plants, with overhead wires carrying currents of several thousand volts. On road crossings these wires are duly protected, and naked high-potential wires are not allowed within the towns and villages. We are not aware that any accidents can as yet be traced to these uninsulated conductors, but the *Trade Journals' Review* says that Messrs. Brown, Boveri, and Co., of Baden, Switzerland, have now been prevented by the Government from issuing 5,000-volt feeders on the Gornergrat and the Stans-Stadt-Engelberg electric railways in course of construction. The firm have produced expert opinions in their favour, one also from the Baden-Baden-Oos line in the Grand Duchy of Baden. The most interesting report is that by Prof. Weber, of Zürich. Weber sent a current of 50 periods through a choking coil, from which he branched off short and stout copper bars at such intervals that he would increase the potential difference by steps of 10 volts by grasping various bars. With 30 volts and wet hands the pain was considerable, and the arm almost paralysed; it required a strong effort to let go again, although the current was not more than 0·015 ampere. With 50 volts Weber could not release his hold again, and not bear the pain for more than two seconds. With dry hands he could stand 90 volts at the outside. Ch. Brown himself, repeating these experiments, could not trace as much. In other tests Weber stood on an imitation permanent way of an electric railway. When the gravel was damp after rain, Weber could bear 2,000 volts; standing on wet loam, on which coal dust had been spread, 1,300 volts caused an intense burning and a shock in the one hand by which he took hold of the contact-bar, and he was unable to let go again.

The Heilmann Locomotive.—The first public trial trip of the Heilmann electric locomotive took place on Friday on the Western Railway, from the Gare St. Lazare at Paris to Mantes and back, a distance of 37 miles. A large party was invited to witness the trial. The *Times* correspondent says the train was composed of 12 first and second class carriages and a luggage van. About 250 persons were in the train, which thus loaded weighed about 150 tons—that is to say, the average weight of an ordinary train. The object was not to make a trial of speed. Such trials are to be made later on, and are to be combined with a progressive increase in the weight of the train. A slight speed of only 18 miles was attained, but the electric locomotive will shortly be called upon to draw trains of 200 tons at a speed of 25 or 30 miles an hour, and then of 225 tons at a speed of 37 or 43 miles an hour, with the object finally of reaching a weight of 300 tons, with a speed of 62 miles an hour. A speed of 60 miles an hour is not unheard of even in France, for the mail trains frequently attain a speed of from 68 to 74 miles an hour. But what has not yet been seen here, nor probably elsewhere, are heavy trains, even goods trains, capable, without extra cost and without wear and tear of the line or the rolling-stock, of attaining a speed equal to that of the fastest passenger trains, and making the distance between Marseilles and Paris half a day's journey, whereas at present heavy merchandise loaded on heavy trains takes a week, or even two, to cover that ground. The Heilmann engine draws a closed tender containing a steam-engine of the Pilon pattern, which works the dynamos producing electricity. The motive power is transmitted directly to the eight wheels, which are only 1m. 5cm. in diameter. The consumption of coal by the engine thus producing electricity is less than that of the ordinary engine, so that the locomotive can go greater distances with fewer and shorter stops for replenishing coal and water.

The Electro-Harmonic Society.—A ladies' concert will be held at St. James's Hall Restaurant (Banquet-room), Regent-street, W., on Friday evening, November 26, 1897, at eight o'clock. The artists will be Miss Kate McKrill, Miss Catherine Kipps, Miss Dewhurst, and Mr. Clifford Essex; solo violinist, Mr. T. E. Gatehouse; solo pianist, Mr. Alfred E. Izard; ventriloquial and musical sketches, Mr. Sidney Gandy and Mr. Quenton Ashlyn. The small string orchestra comprises the following: first violins, Messrs. T. E. Gatehouse, E. Cryer, and Harold Pywell; second violins, Messrs. J. Greebe, W. A. Hewlett, and W. Thornton; viola, Mr. Sidney Venables; violoncello, Mr. George Pywell; contra bass, Mr. C. Skinner. The musical directors are Mr. T. E. Gatehouse and Mr. Alfred E. Izard. The following is the programme:—Part I.: Overture, "Couronne d'Or" (Herman), Orchestra; song, "Thine am I, my Faithful Fair" (Somerville), Miss Catherine Kipps; ventriloquial exposition, introducing the well-known figure, "Ebenezer Twiddlepump," Mr. Sidney Gandy; pianoforte solo, "Deux Etudes" (Chopin), Mr. Alfred E. Izard; duet, "You can read it in my Eyes" (Slaughter), Miss Dewhurst and Mr. Clifford Essex; idyl, "Evening Breezes" (Otto Langey), Orchestra; recit. and aria, "O, Luce di quest Anima" (Donizetti), Miss Kate McKrill; musical sketch "The Duchess of Stilton's Reception," Mr. Quenton Ashlyn. Part II.: suite of three pieces, "Highland Memories" (By the Burnside—On the Loch—Harvest Dance) (Hamish MacCunn), Orchestra; songs, (*a*) "The Farewell," (*b*) "Hymn before Action" (H. W. Davies), Miss Catherine Kipps; musical sketch, Mr. Sidney Gandy; solo violin, "Scenés de la Czarda" (Hubay), Mr. T. E. Gatehouse; duet, "Cunning Little Coon" (Cammeyer), Miss Dewhurst and Mr. Clifford Essex; song, "Snowdrop" (Eva Lonsdale), Miss Kate McKrill; musical sketch, "The Curate" (Ashlyn), Mr. Quenton Ashlyn; finale, (*a*) "Chanson Triste" (Tschaikowsky), (*b*) "Czardas" (Michiels), Orchestra.

Patents.—The Society of Patent Agents held their annual general meeting in London on Wednesday, and Mr. J. Sinclair Fairfax, A.I.E.E., delivered his presidential address, which was really a paper on the classification of patents in relation to a preliminary search for novelty, and patent law reform. He said that complaints were frequently made by disappointed patentees that the British Patent Office granted patents without a preliminary search for novelty, and the complainants erroneously believed that an alteration making the law similar in this respect to the United States, Canada, Germany, and other countries would ensure the validity of all patents granted. It was only in the Courts that a particular patent could be pronounced valid after evidence had been taken against it. The fundamental principle

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of British patent law was that of encouraging the introduction of a new manufacture into the country, and, so long as there was no fraud, the patent was given to the first applicant without question. But under the United States system the principle adopted was that of issuing the patent to the original inventor only, who was not necessarily the first applicant, and therefore the Patent Office there institutes a search amongst all existing patents wherever issued, as well as into books of reference and other material, to see if some prior inventor has described the invention. Necessarily, the United States examiners have the power of rejection; and even when this was fully justified by clear anticipation, Mr. Fairfax was not convinced that the same power officially used here would be beneficial to the British inventors. He expressed himself strongly in favour of an index museum of models at the Patent Office and not at South Kensington Museum, and says if we had such a museum in which devices performing similar functions were placed together, and references on them to their respective classes, it would be seen how easily inventors could follow the line of development, and perceive the applicability of particular forms of mechanism to new purposes.

The Physical Society.—An ordinary meeting of the society was held last Friday, Mr. G. Johnstone Stoney, vice-president, in the chair. Mr. J. Rose-Innes read a paper on "The Isothermals of Ether." Mr. W. L. Waters then read a paper on the "Variations in the E.M.F. of the H-form of Clark Cells with Temperature." The authors (Messrs. F. S. Spiers, F. Twyman, and W. L. Waters) have investigated how nearly the true E.M.F. of Clark cells can be computed at different temperatures by applying the ordinary temperature correction. As a standard, two cells of the Muirhead type are employed. The four cells under test could be put through cycles of temperature in a special heating bath, containing oil circulated by a centrifugal pumping vane. E.M.F.'s were determined by a potentiometer method, and a careful study was made of the "lag" of E.M.F. behind temperature. The results are given in the form of curves. It is shown that "lag," in the H-form of cell, is less than in the "Board of Trade" form. Under ordinary conditions, when the rate of variation of temperature is less than 2deg. C. per hour, by applying temperature corrections the true E.M.F. of the H-form can be found to within a ten-thousandth of a volt. In this respect there is little to choose between the H-form and the "Muirhead" cell. Mr. W. R. Cooper thought the authors did not express the case clearly. The E.M.F. of the "Board of Trade" cell could not, with reason, be itself stated within 1 per cent. But in some cases, when, for instance, cells were used differentially, greater accuracy might be required; as, for instance, when a constant source of E.M.F. was being compared with the variations of another source. Here it might be necessary to know the "lag." He would like to know with what degree of accuracy the E.M.F. of the standard cell was determined by the authors. The lag that occurred in the "Board of Trade" cell was probably due to diffusion, crystallisation, and solution. Mr. Waters said the E.M.F. of the standard was measured by a Kelvin balance to one in ten-thousand. The Vice-President proposed votes of thanks to the authors, and the meeting adjourned until November 26.

Michael Faraday.—A most pleasing and interesting ceremonial took place on Monday at the Michael Faraday Board School, Faraday-street, Walworth, when a white marble bust of Michael Faraday was unveiled. The bust was presented to the school by the managers of the Royal Institution of Great Britain, and is a copy of the original bust executed by Matthew Noble. It stands upon a pedestal of Aberdeen granite 4ft. in height, and has been placed in the boys' hall of the school. On the wall immediately behind the bust a large brass tablet has been affixed, bearing the following inscription: "Michael Faraday, natural philosopher, D.C.L., F.R.S., born at Newington, Surrey, September 22, 1791. He was a patient student, an eloquent expounder, and a brilliant illustrator of the laws of nature. Fullerian Professor of Chemistry in the Royal Institution of Great Britain, 1833 to 1867. Faraday's noblest monument is his 'Experimental Researches in Electricity and Magnetism' from 1831 to 1851. He died at Hampton Court Green August 25, 1867, and was interred in Highgate Cemetery." The unveiling meeting, which was crowded with the boys and girls of the upper standards and with a large number of parents and visitors, was presided over by General Moberly, the vice-chairman of the London School Board. The Royal Institution was represented by Sir James Crichton Browne, F.R.S., Dr. Donald Hood, Mr. Basil Woodd Smith, and Mr. Young, assistant-secretary to the institution. General Moberly, in opening the proceedings, stated that the presentation of the bust was due to the Rev. A. W. Jephson, the member in charge of the school, who had suggested that the Royal Institution should be applied to to present some object to the school which should be a lasting memento of the great man who had been born in the locality. Faraday had had no such educational advantages as were now enjoyed, but had nevertheless succeeded in rising to the highest ranks. Sir J. Crichton Browne unveiled the bust, and expressed his pleasure at being permitted to unveil this statue of a great man who had spent a long life in unveiling the hidden mysteries of nature. He hoped the sight of that bust would be an inspiration to the children, and that they would learn who Faraday was and what he did. He suggested that one day every year should be set apart in the school in memory of Faraday, when some part of his work should be explained; and this suggestion extracted a promise from the headmaster of the school that a day should be so set apart.

The Construction of Electric Railways.—A writer in an American technical paper recently said that when the English did fully wake up to the advantage of electric traction, they would set about it in the same way that they did with the railways. He held our railways up as a pattern to the world as regards the permanent equipment and the general management, and said the way the English lines had been laid, regardless of expense, made them the ideal field for the development of electric traction. We are slow, he says, in adopting innovations, but we are persistent in carrying out progressive ideas. For once an American has touched the keynote of our characteristics, and it would be well if the conditions of each country, as governed by its national characteristics, were more often borne in mind. We are quite willing to concede that America was easily first in adopting electric traction, and we are not ungrateful for the lessons we have learnt thereby. We in this country occasionally do a little in the way of pioneering, and we know how difficult it is to restrain the impulse to race when it is better to walk; but if we are passed on the road by more hasty pioneers, we do not mind following at our own pace and learning what we can from the failures and mistakes of our predecessors. Thus we gain solidity of commercial enterprise, though we may not be first in the market. Before we try to start anything we test every detail as far as possible, so as to avoid costly mistakes and useless expenditure. This probably makes us seem slower, but when we read of the struggles which American street railroads have had for existence, we realise more than ever

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that the race is not always to the swift. Mr. George W. Knox, in a paper read before the convention of the American Street Railway Association, said that many an electric road now in the hands of the receiver would be making neat incomes for the investors had a closer study and practice of the principles of economy been made. In the first place, they should always select good motormen. In the operation of a car, a good motorman will save power, prevent breakdowns, and avoid accidents, while a careless man will do the reverse. As regards machinery, that has reached a high state of efficiency, but it is necessary for those in charge to have better opportunities for meeting each other to discuss matters of detail in construction and operation, so as to accommodate them to local conditions. The author also says that another point to be studied for economy is the supply department. There is an immense sum of money needlessly squandered in supplies and repairs for an electric road in a year. The roads have not yet arrived at a standard in design of the apparatus which they use, to which too much importance cannot, he says, be attached. The unwary railway man has had an immense amount of experimental machinery inflicted upon him, all of which costs dearly, and if maintained reduces economy. Altogether, the paper cries out against carelessness of control.

A Possible Cause for Flywheel Accidents.—Flywheel accidents are due to various causes, and they are principally attributed to the failure of the governor of the engine, the breaking of the generator pulley, and to the sudden shocks caused during a short-circuit by throwing the load on and off. The *Street Railway Review* places on record a recent experience of the engineer of a large street railway plant. In this particular power station there are four direct-connected units, two of 500 kw. and two of 800 kw., all operated in multiple. The pressure at the bus bars is 570 volts; the normal speed is 100 revolutions per minute; and the generators are compound wound. On this occasion there were running two 500-kw. and one 800-kw. generators, carrying about 3,200 amperes collectively. Suddenly one of the 500-kw. generators began to sing and spark at the brushes, but for an instant the engine seemed to be merely racing, the indications being the same as though the machine circuit breaker had opened the circuit. The action of the governor was perfect, and as the speed continued to increase, although the governor had completely shut off steam, the engineer realised that the fault lay with the dynamo and signalled the operator to pull the switches. The engine had then attained a speed of about 175 revolutions. Just before going to the switchboard the operator heard a slight explosion and saw a flash beneath the engine-room floor, where all the wires connecting the dynamos and switchboard are located. Immediately afterwards the dynamo commenced to screech and spark, and the operator found that the ammeter indicated 900 amperes, but dropped steadily, and with the increase of speed just before the circuit breaker and switches were opened the ammeter registered 600 amperes. Upon the machine circuit breaker being pulled the engine immediately slowed down, proving conclusively that the machine was running as a motor. Investigation showed that the shunt field wire, running from the rheostat at the switchboard to the negative terminal at the dynamo, had grounded on the positive main machine cable running from positive brush-holders to switchboard, and the shunt field wire being practically a negative at the point of contact was quickly burned off, thereby opening the shunt field circuit. The shunt field coils thus becoming ineffective, caused the E.M.F. of the dynamo to fall at least 200 volts below that of the bus bars. Then the load on the dynamo, minus the shunt field, almost instantly fell from a load of 850 amperes to zero, and still lower, to a point where it quickly changed from a compound dynamo supplying power to a series motor, the field being maintained by the heavy series winding. Fortunately no significant damage was done, but if the engine had been wrecked the true cause of it would never have been known, and it would have been surmised that the governor failed to operate properly. It is also fortunate that the flywheel proved equal to the stresses of an abnormally high rim speed, otherwise the damage must have been enormous.

Royal Meteorological Society. — The opening meeting of the session was held on Wednesday evening at the Institution of Civil Engineers, Mr. E. Mawley, F.R.H.S., president, in the chair. Mr. R. H. Curtis gave the results of a comparison between the sunshine records obtained simultaneously from a Campbell-Stokes burning recorder and from a Jordan photographic recorder. The Campbell-Stokes recorder consists of a sphere of glass 4in. in diameter supported in a metal zodiacal frame. A card being inserted in one of the grooves according to the season of the year, the sun when shining burns away or chars the surface at the points on which its image successively falls, and so gives a record of the duration of bright sunshine. The Jordan recorder consists of a cylindrical box, on the inside of which is placed a sheet of sensitive cyanotype paper. The sunlight, which is admitted into the box by two small apertures, acts on the paper, and travelling over it by reason of the earth's rotation, leaves a distinct trace of chemical action. In an improved pattern two semi-cylindrical boxes are used, one to contain the morning and the other the afternoon record. The Campbell-Stokes instrument gives a record of sun heat and the Jordan instrument a record of sun light; and whilst it is probably true that, as a rule, the burning and chemical effects vary directly with the brightness of the sun's rays, yet it by no means follows that the conditions which will produce the most active chemical action must necessarily and always be those most favourable for burning. It has been the opinion of most observers that the photographic instruments yield a larger record than those of the burning type. In order to set the matter at rest, the council of the Royal Meteorological Society determined to institute a comparison between the Campbell-Stokes and the Jordan recorders, which should thoroughly test the capabilities of the two instruments, and at the same time afford reliable data for determining how far the records yielded by the one may be accepted for comparison with those obtained from the other. These simultaneous observations were carried out by Mr. E. T. Dowson at Geldeston, near Beccles, and extended over a period of 12 months. The records were sent to Mr. Curtis for tabulation, and he drew the following conclusions from the figures: (1) in the case of the Campbell-Stokes instrument the records are capable of being measured with a very fair degree of accuracy; (2) the records of the Jordan instrument afford room for much greater difference of opinion as to what ought to be tabulated, and consequently measurements of the Jordan curves are open to considerably more doubt than are measurements of the Campbell-Stokes curves; (3) when the whole of the photographic trace which can be distinctly seen, but including portions of it which are decidedly faint, has been carefully measured, the amount will approximate sufficiently to that of the Campbell-Stokes instrument to allow of records obtained from both forms of instrument being compared *inter se*. From an examination of the records at other stations it appears that on some occasions the instruments have begun to record within 13 minutes after sunrise, and have continued up to 10 minutes before sunset.

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NOTES ON ACCUMULATOR CONSTRUCTION.

BY DESMOND G. FITZ-GERALD.

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XXVII.

Other means have been adopted for the purpose of producing a spongy layer on the surface of lead plates without having recourse to the ordinary Planté method of formation. M. Dujardin uses, as the electrolyte during formation, a half-saturated solution of nitrate of soda in dilute sulphuric acid. This solution is really one of sodic sulphate and nitrate, with free nitric acid; and I should imagine, therefore, that this process involves the difficulty referred to in the section above—that of getting rid of the last traces of nitric acid before the accumulator is put to work. For the same purpose, M. Boettcher recommends the addition of acetic acid to the dilute sulphuric acid. Dr. Schoop uses, in similar manner, a solution of bisulphate of soda with a very small percentage of chlorate of potash; he also recommends a solution of sulphate of ammonia with hydrofluoric acid. In my own laboratory I have found iodine the safest agent in producing the requisite degree of surface porosity.

XXVIII.

The production of lead in a spongy form by the action of zinc upon a solution of the former metal, resulting in the arborescent crystals commonly known as Saturn's tree, and the application of this spongy lead to a plain or perforated plate of lead, constitute an old and well-known process. But it is only recently that attention has been given to the electro-deposition of lead in the same form by the current from a dynamo machine, and to the simultaneous, or almost simultaneous consolidation of the material, by means of machinery, on to the surface of a suitable conducting support. In this way the spongy lead may be deposited by a continuous process upon large surfaces of sheet metal to be subsequently cut up into plates of suitable size. If the extent of surface (S) and also the depositing current (I) from the dynamo machine be known, then the weight (W) of lead deposited per unit of surface in the time (θ) can, of course, be calculated. Taking θ in *hours*, we have:

$$W = \frac{I\,\theta}{S \times 7{\cdot}4} \text{ oz. avoirdupois.}$$

The ounce avoirdupois is, no doubt, a very unscientific unit of mass; but at the factory is found to be a convenient unit of weight. Taking grammes as the unit, the formula becomes

$$W = \frac{I\,\theta \times 3{\cdot}847}{S} \text{ grammes.}^*$$

S may be any unit—say, square feet in the former and square metres in the latter formula.

We can calculate also the capacity per unit of area of the plates cut from the lead sheet after the completion of the depositing process. In the case of an accumulator to be discharged slowly (see Section III.) it will be:

$$C = \frac{W(\text{oz.})}{{\cdot}53} \text{ ampere-hours.}$$

But the divisor will augment as the rate of discharge increases, becoming ·6, ·7, or ·8. The capacity should, of course, be the same for each element, under the given conditions in regard to rate of discharge.

This process of manufacture, which, on a large scale, would appear to be very advantageous in point of economy, admits of the pressure brought to bear upon the deposited metal, and consequently the degree of porosity of the latter, being regulated according to requirements. Thus, if the required capacity per unit of area is but small, the pressure applied may be great, and may be the same throughout the whole period of deposition. If a high capacity be required, the initial pressure may be high, but should be slackened as the deposit increases in thickness, in order to increase the porosity of the superficial layers, and thus to render the increased capacity effective.

* This is a theoretical value; in practice the weight deposited is less.

The spongy-lead plates manufactured by this process will challenge comparison with any others, more especially if the capacity per unit of area be not very high. They may be very light, and yet be durable. But the same cannot be said of the peroxide plate—that on which the active material has been converted by electrolysis into peroxide of lead—unless it is subjected to a further process of consolidation. Otherwise it may exhibit the defects which have been so obvious in many other forms of the peroxide plate. These defects, however, may be remedied by several means; and the experiments which have been made with regard to the process of consolidation here referred to have already given encouraging results.

XXIX.

Under the last section I have referred to a practical system of electrolytically depositing and consolidating spongy lead upon both plates or supports, and subsequently converting the spongy lead on one of the elements into peroxide of lead. Under the present section I have to describe the methods by which peroxide of lead (or a lower oxide) may be deposited on one electrode and spongy lead on the other. But the earliest patent I can find relating to the latter process embraces also "a metallic deposit on all the plates," but without mentioning any means of consolidating this deposit, which, as obtained under the patent, would be of the usual loose and non-adherent character. The patent in question, which was granted to Alexander Muirhead (June 6, 1882, No. 2,658) is an extraordinary example of the careless and inconsequent manner in which patent specifications are sometimes drawn up. The date is one day earlier than that of the specification next to be mentioned, which latter was drawn up with sufficient care, at least, to avoid the invalidation of the patent. But Mr. Muirhead's provisional and final specifications are hopelessly at variance. In the former, he stated that, in carrying out his invention, "the formation of the active surfaces of the lead plates is effected by decomposing electrically a solution of a salt of lead, such as the *acetate*, which is kept flowing in a continuous stream, during the electrolysis, between the two sets of plates to form the electrodes of the battery, and these plates are coupled with a dynamo-electric machine. A rapid and uniform deposition of peroxide of lead on one set of plates, and of finely subdivided metallic lead on the other set, is thereby produced." With the solution mentioned, no deposition of peroxide of lead takes place on one set of plates (the anode); but these would be dissolved, whilst crystals of metallic lead would be loosely deposited at the cathode. In his final specification, the patentee says: "I find it best in the first instance to obtain a metallic deposit on all the plates." He then goes on to say that he charges a vat with a solution of protoxide of lead in caustic potash ($KHPbO_2$), containing, say, 10 per cent. of the protoxide. Now this is a solution from which peroxide of lead *can* be deposited at the anode; but the inventor states that he makes all the plates "positive," and a central leaden partition "negative" (a course that would peroxidise the plates whilst depositing metallic lead on the central partition), and that "on the current passing, metallic lead in suitable condition is deposited on all the plates." Having proceeded so far, the inventor states that "the electroplating vat is now charged as before, but with a different solution—viz., a solution of sulphate of lead in dilute sulphuric acid, containing, say, 20 per cent. of H_2SO_4 and as much sulphate of lead as this will dissolve." Unfortunately, sulphate of lead is insoluble in dilute sulphuric acid. The overflow being "received into a cistern containing finely-divided oxide of lead," from which cistern the supply for the "electroplating" tank is drawn, would not mend matters, for even the acid would now in great measure disappear, and plates cannot be "formed" in water. The only point of any value in this patent is the circulation of the alkaline solution over "finely-divided oxide of lead," to keep the solution saturated with the metal.

The letters patent dated June 7, 1882, No. 2,676, were granted to A. M. Clark with respect to a communication from abroad by Jean Marie Anatole Gérard-Lescuyer, of Paris, for an improved process of "forming" or preparing electrodes for secondary batteries. In the specification the inventor gives valuable information, though it should be

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stated that the *discovery* of the deposition of oxides of lead at the anode in certain solutions of the metal was not his, being due, I believe, to the elder Becquerel. The inventor describes the main points of his process as follows: "I generally use sodic or potassic plumbite, which I prepare by dissolving massicot or litharge in a boiling alkaline lye at 32deg. to 35deg. Beaumé,* in the proportion of 15 to 20 grammes of massicot or litharge per litre (about 1,000 to 1,400 grains per gallon). A small excess of the oxide is advantageous, to compensate for waste and maintain the bath always at the point of saturation. When this combination is effected the bath is fit for use, and as soon as it has cooled down to 70deg. C. (158deg. F.), I immerse therein the secondary pair, which I attach to the positive pole of the electrical generator; and for greater simplicity I use the containing vessel itself as the cathode. The action commences at once; the sides of the vessel become covered with loosely adherent spongy lead, and the pair of lead plates become covered with a coat of a fine red colour, which is plumbate of protoxide of lead, or minium. If the temperature of the bath falls to about 15deg. C. (59deg. F.), minium is no longer formed at the anode, a brown coat of plumbic acid (PbO_2) being then obtained. The hot method is the most rapid; a few hours, three or four at the outside, sufficing to transform completely through a plate of lead 2mm. ($\frac{1}{12}$in.) thick." "Transforming the plate completely through" is evidently a mistaken expression; for we are told immediately afterwards that "the oxide thus formed is crystalline and strongly adherent to the lead, which it envelopes like a sheath."

The inventor points out that if the temperature of the bath be raised, the oxide deposited may be redissolved. The spongy lead deposited is not utilised in the production of so-called negative plates, although it might be so utilised under the conditions referred to in the preceding section. In the Gérard-Lescuyer process it was redissolved by reversing the current after the plates had been removed, and replaced by a cathode of comparatively small surface. When the solution is used cold, peroxide of lead, as above stated, is deposited; it has a peculiar velvety aspect, and it also adheres strongly to the lead. But the process, as might be expected, is not in this case so rapid as when the solution is used hot. Under the more favourable conditions the inventor was able in three hours to "form" a couple, with two plates of lead 3ft. 3in. long by 8in. broad, which plates were capable at the first charging of taking a current of 45 amperes during 20 minutes.

In a patent (No. 2,350, May 9, 1883) granted to Norman C. Cookson and James Swinburne, the patentees claim, amongst many other things, that they "may coat a support with closely adherent peroxide of lead by electrolysis of a suitable lead solution such as litharge in sodium hydrate and water."

In 1885, we find M. de Montaud manufacturing on a somewhat large scale in France an accumulator which was tested with very favourable results by Dr. d'Arsonval. The principle of manufacture was described as follows by the *Revue Internationale de l'Electricité*: "If into an alkaline bath saturated with litharge added in excess we plunge two lead electrodes, and pass through them a current of suitable tension and intensity (tension, by the way, is not a property of the current), there is deposited upon the anode a layer of peroxide of lead, whilst the cathode is covered with reduced lead. The liquid of the bath supplies material for both deposits, whereas in galvanoplastic operations the anode supplies it to the cathode. The principle of the formation consists in utilising currents of great intensity, and thus abridging its duration. Of two plates thus treated, the one becomes positive and is covered with a thick layer of peroxide of lead. After removal from the bath, it undergoes various preparations and several washings, and is then fit to be mounted with others in an accumulator and charged. The other or negative plate has become covered with a thick sponge of lead. It is carefully washed, preserved in water with exclusion of air, and subjected to very considerable pressure. After this operation, it presents the appearance of ordinary sheet lead; but, though the physical porosity has disappeared, the chemical porosity is intact, and this alone comes into play in accumulators. When a negative plate has been so treated, it is ready to be combined with the positives to form an accumulator."

According to Dr. d'Arsonval, the most striking quality of the Montaud accumulator is its durability. Plates were shown to him which were stated to be five or six years old, and which were wholly formed of peroxide with the exception of a thin core of metallic lead sufficient to conduct the current. The adhesion of the peroxide was such, that to detach it a hammer and anvil were requisite. It must not be supposed that because accumulators of a type similar to the above have not come into use, the process of manufacture is necessary a failure. It is by no means always the case that the best invention obtains the best commercial development.

Dr. Schoop has used as electrolyte a solution of sulphate of lead in ammonic tartrate. With this he has obtained a crystalline and adherent deposit of peroxide of lead at the anode, and a non-adherent deposit of spongy lead at the cathode.

* Specific gravity, 1·285 to 1·320.

WATER POWER, WITH REFERENCE TO ITS APPLICATION TO ELECTRICAL MACHINERY.

BY J. HERMANN FIELD.

IV.

The turbine station at Galway, in Ireland, which has been in successful operation for some years, utilises a small

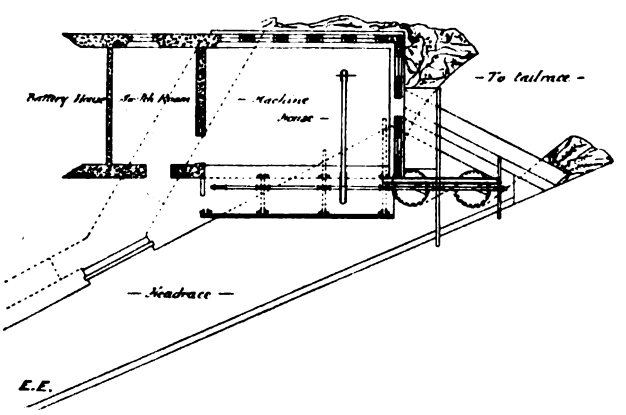

FIG. 18.—Plan of Works.

part of the immense power formerly going to waste on the River Corrib in its short run of three miles from the lough to the sea. Some general plans of this station during erection are shown in Figs. 18 and 19, including the lower end of the headrace, penstock, setting of turbines, and support for the concrete dam. The head of water is about 13ft

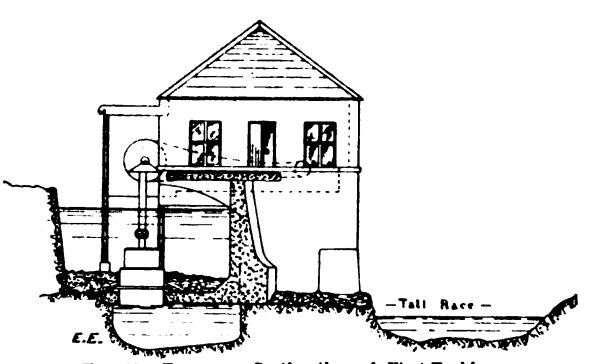

FIG. 19.—Transverse Section through First Turbine.

Two 100-h.p. Hercules reaction turbines, with cylindrical gate and hand regulation, work by helical steel gearing, and through friction-and-claw clutches, on to the main driving shaft, from which power is belted to the various incandescent and arc lighting machines. Bare copper tube mains distribute the current in the town, the price to consumers being 5d. per unit. A Dowson gas plant and Crossley engine stand in reserve, but the water supply is very regular, and no appreciable "tailing up" is encountered.

The power station, illustrated in Figs. 20 and 21, on

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the Aare River affords a good example of average Swiss working, and, being a municipal concern, its management is necessarily subject to the close public scrutiny that attaches to undertakings of a like nature the world over. Situated on a sharp bend of the Aare, the station takes

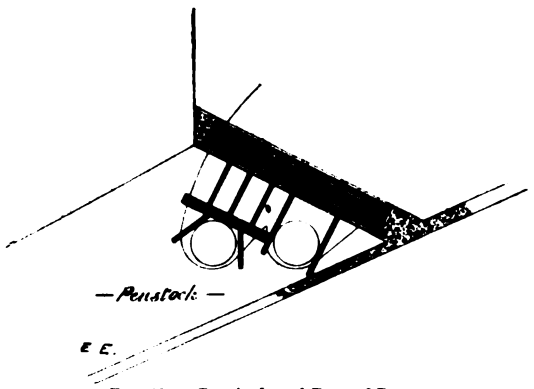

FIG. 19A.—Penstock and Base of Dam.

advantage of the 16·1ft. fall between the water levels above and below its position. A dam which spans the river below the point of intake raises the headwater level by 2·6ft. It is constructed of pilework, ballasted, and has a length of 310ft. and a breadth of 53ft. The headrace, or canal leading to the power house, is 7,900ft. long, and cuts

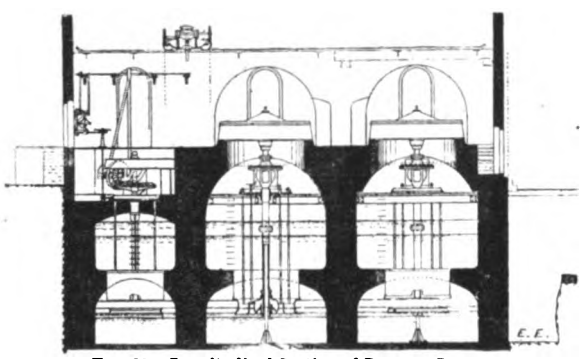

FIG. 20.—Longitudinal Section of Dynamo-Room.

directly across the loop of the river. Its sides are formed of piles bound together and cemented to present smooth faces to the water, of which it is able to pass a sufficient volume at high water to give a total of 800 h.p., or 1,000 h.p. at low water. When the water supply is lowest, and with a depth of 5·4ft. in the canal, the lost head from end to end is 3·15ft., leaving a net fall of 13ft. nearly, and an output of 908 h.p. assuming a turbine efficiency of 75 per cent. As a mean for summer working, however, the depth would be 8·2ft.; lost head, 2ft. only; net fall, 14·1ft., and horse-power, 1,394. A by-pass or overflow channel by the turbine-house relieves any sudden rise of water-level on shutting down the turbines, which rise, if allowed to reach the unprotected part of the side walls above the cemented facing, would entail damage to the works.

The power station contains three turbines in all, two of 400 h.p. each, used for electricity generation, and the third, of 200 h.p., driving a cement factory by mechanical transmission through bevel wheels and a horizontal shaft 260ft. long. The turbines are of the Rieter reaction type, each wheel consisting of two concentric portions separately controlled. Regulation is effected in the outer ring of each wheel, either by hand or by the automatic governor shown in the figure, variation of speed with any ordinarily quick 15 per cent. change of output being kept thereby within 4 per cent limits. The turbines are set in open flumes, and have their vertical driving shafts 23ft. in length; their step bearings are above water-level, and similar to that illustrated in Fig. 13. The relationship of pedestal, stationary inner shaft, and cylindrical driving shaft is well shown in the longitudinal section of Fig. 20. Some brake tests on the 200-h.p. factory machine showed an output of 250 h.p. with 12·5ft. head, the water

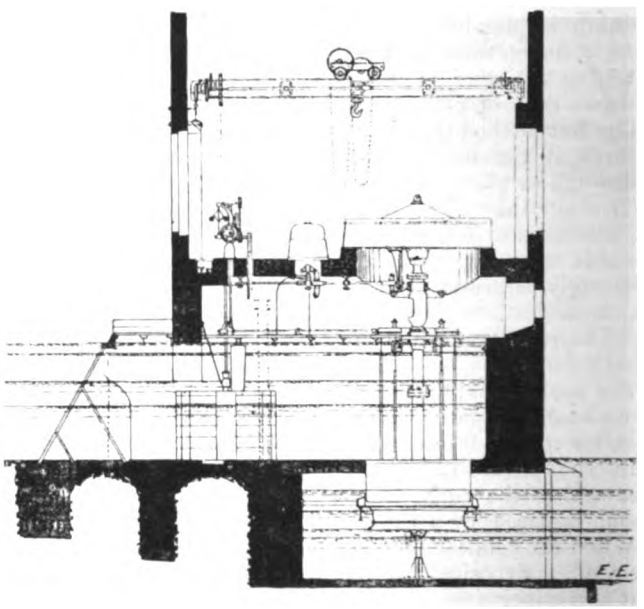

FIG. 21.—Transverse Section.

measurements during these trials indicating with this amount of power an efficiency of 80 per cent. The turbine shafts directly carry the revolving field magnets of their respective generators, and when working at the normal speed of 48 revolutions per minute, a two-phase current with a frequency of 40 periods and a pressure of 2,000 volts is passed to

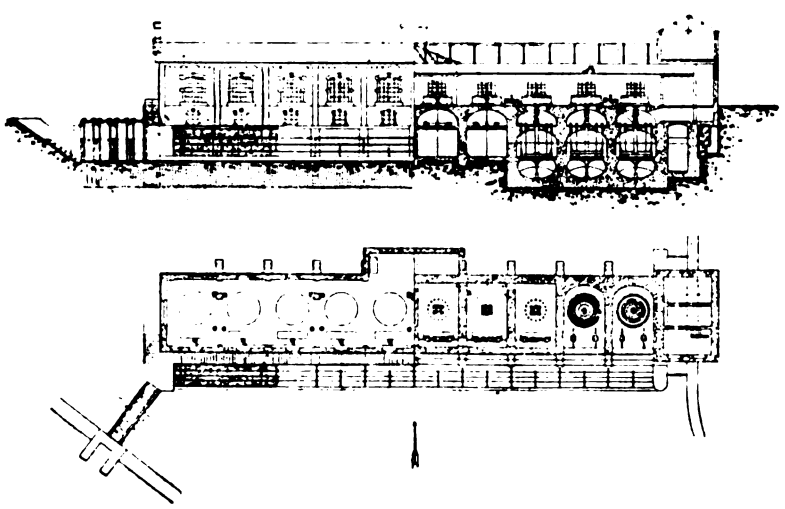

FIG. 22.—The Power Station at Olten Aarburg.

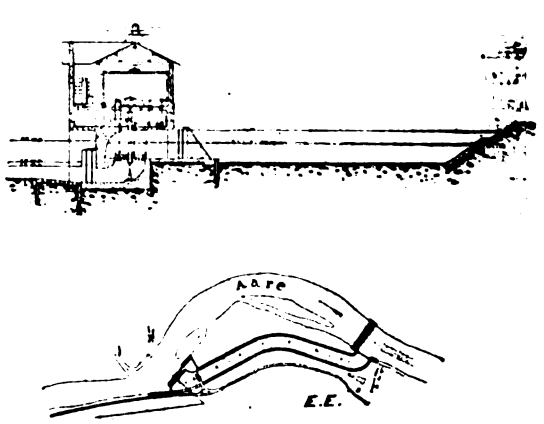

FIG. 23.—Detail of Water Work.

line. The generator magnets have 96 poles, and each machine is separately excited by dynamos running from the turbine shaft by bevel gearing. Either of the two exciters is capable of serving both alternators simultaneously.

From the power station, five overhead circuits, two-phase, four wires each, diverge, three of these circuits crossing the Aare with a 590ft. span. One circuit runs the lighting station, which contains three 100-h.p. sets of two-phase

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motors running at line pressure and 750 revolutions, each being directly coupled to two 50-h.p. direct-current dynamos. Distribution and service are on the three-wire system by overhead lines, and two batteries of Tudor accumulators, of capacity 970 ampere-hours, are placed across the outers. The remaining four circuits from the power-house are used for transmission of power, a total of 13 transformers and 270 kw. being in use, placed chiefly in sub-stations. The transformed pressure is 200 volts, and distinctions are clearly made between the high and low pressure lines by the respective colours—green or red—of parts of their carrying insulators.

Messrs. Brown, Boveri, and Co., of Baden, supplied the electrical machinery and outfit, and have made the working of the power station and switchwork so complete and simple that its manipulation requires the attendance of only one man. The capital expenditure on this station was approximately as here shown:

Canal, works, etc.	£10,200
Buildings, power and light stations	3,370
Turbine machinery	3,850
Electrical machinery	5,780
Accumulators, etc.	2,570
Power and light distributing system	6,000
Various expenses: tools, meters, fees, etc.	2,170
	£33,940

or approximately £33·94 per horse-power, inclusive of electrical plant.

A larger station on the Aare, at Olten Aarburg, also the work of Messrs. Brown, Boveri, and Co., for the electrical outfit, similarly cuts across a bend in the river, but only obtains a fall varying from 5·6ft. to 11·8ft., according to the season of the year and the state of the river. It is capable of giving an output of 2,500 h.p. with low water, at which time the head is highest, but at mid and high water this output is reduced by the lessening of the available fall. A dam of 375ft. length thrown across the stream raises the head level by 7·2ft. at low, and 3·3ft. at high water. It consists of a fixed lower part, and a top part of sluices, adjustable by hand or electric motors, space being provided for the free passage of drift matter, and also for a fish ladder. The headrace is 2,500ft. long, 148ft. wide at bottom, and has a gradient of ½ per cent. Its sides are faced with stonework up to the level of dammed up mid-water, and a by-pass near the power-house allows of overflow. The flow into the canal, 164ft. across at its head, is regulated by 20 sluices. The power-house itself, built of cement concrete, contains 10 turbines of

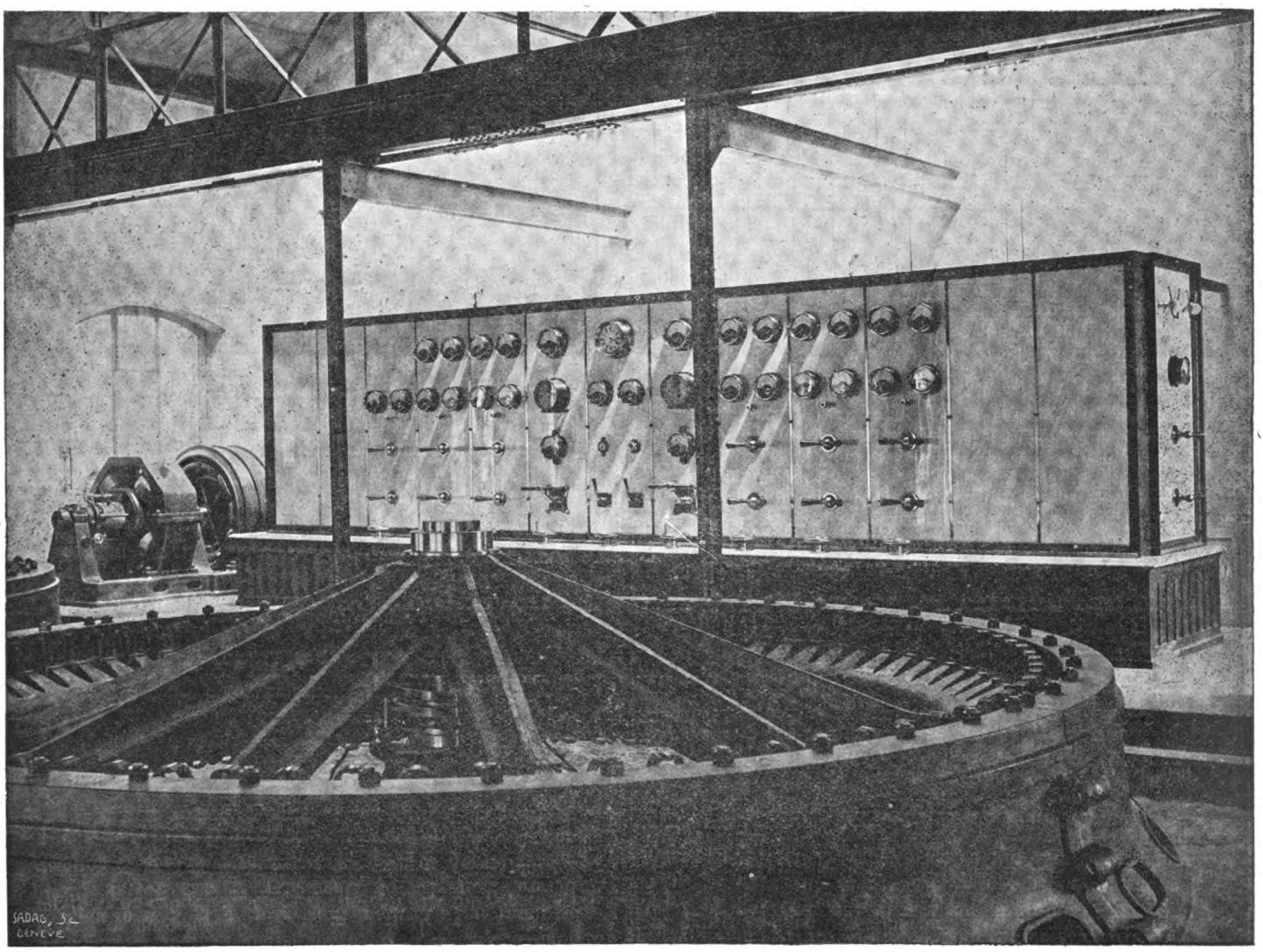

FIG. 24.—One of the Slow-Speed Generators.

300 h.p. each, in a single row; the size of the turbine floor being 270ft. by 38ft. The machines run at 28½ revolutions per minute, and are of interest as the slowest direct-coupled generators and turbines yet at work. Triple concentric Jonval wheels are employed, 15·7ft. in diameter, their inner divisions being regulated by hand, while governing is effected on the outer ones automatically. The magnet wheel has 84 pole-pieces, and is excited initially by means of a 300 ampere-hour storage battery. It is then continuously excited by the current obtained from a four-pole dynamo directly coupled to a high-pressure motor run from the alternators. This exciter gives 1,000 amperes at 70 volts. The high-pressure windings of the generators are insulated in mica tubes, and each is separately removable for repair in case of need. A two-phase 5,000-volt current is passed to line, where it is divided among six bare circuits from a distributing tower. The total length of high-pressure line is 41 miles; greatest distance covered, 12·4 miles. The wires are carried to

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the 21 transformer stations, of total 632 kw., on 33ft. creosoted poles, fitted with double-petticoated insulators, due precautions being taken against lightning. From the transformer stations run low-pressure distributing lines at 125 volts, of a total length of 15½ miles. These are used for lighting purposes and for motors less than 75 h.p., those of larger size drawing direct from the high-pressure wires. These works, not yet quite completed, are connected up for a supply of 250 h.p. in light and 1,100 h.p. in power, the latter being divided among the users of 64 motors. Some few figures of the capital cost of this station without electrical machinery have already been given on page 559, but the total outlay is approximately as follows:

Cost of dam	£36,640
Headrace and buildings	35,160
Turbine machinery	17,000
Electric generators	20,600
High-pressure bare circuits	16,400
Transformers and stations	4,700
Distributing circuits	5,100
	£135,600

station serves a line of its own, the two lower ones running in series with one another on the main line, the Volta functioning as the pressure regulator, while Galvani devotes his attention to working as hard as possible at constant pressure. Since all motors served by the line are in series and are cut out or put in by a short-circuiting switch, the pressure required at the terminals of the line necessarily varies greatly, sometimes by some thousands of volts in the course of a few seconds. The system of regulation, however, which has been adopted by Messrs. Thury has been found to answer practically instantaneously, and to give complete control.

The Galvani station was first at work in 1889, the two others following as many years later. The lowest station of the three contains one unit consisting of one 140-h.p. Piccard partial-injection turbine directly coupled by the elastic and insulating bands seen in Fig. 25 to two 50-h.p. six-pole Thury dynamos, excited and connected in series, each giving 1,070 volts and 47 amperes at the normal speed of 475 revolutions. Hand regulation is resorted to, as no quick response to changes of load is needed, all such being taken in hand by Volta. This plant runs continuously day and night without cessation, except on such occasions as holidays. The remaining spare power on this section is

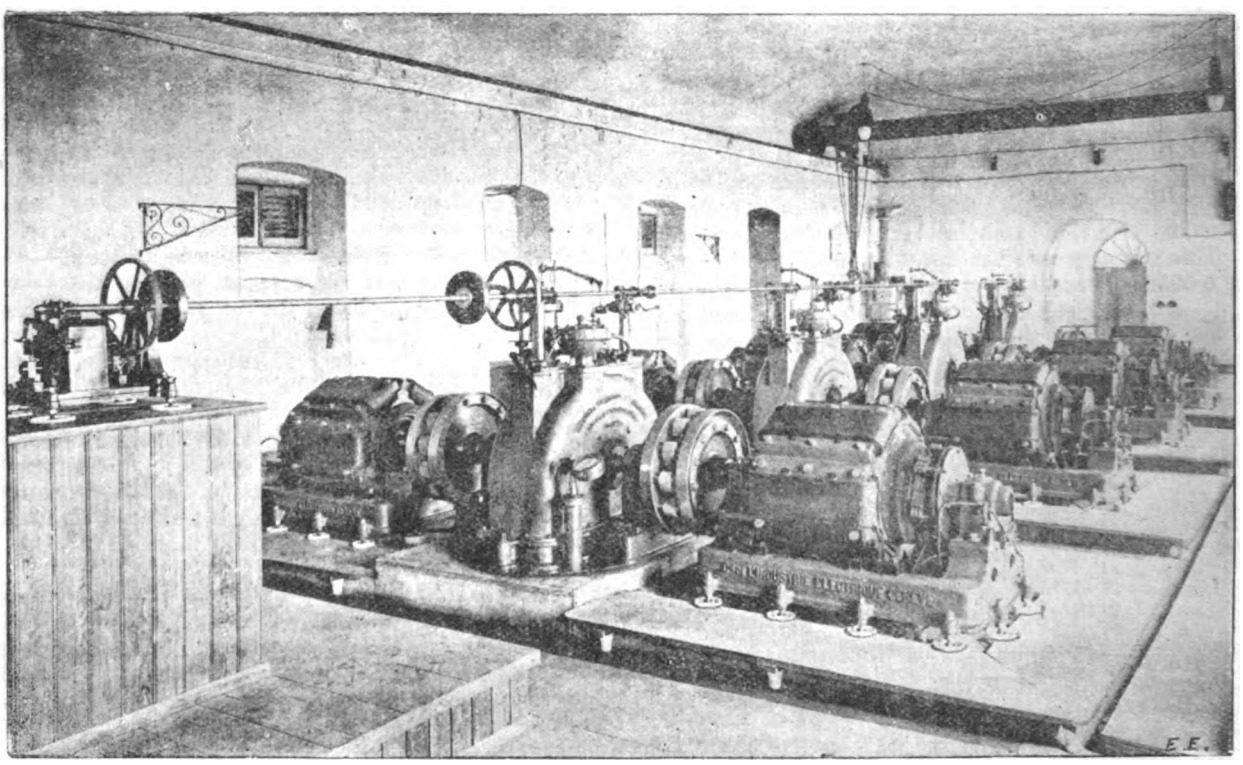

FIG. 25.—Interior of the Paccinotti Station, with High-Pressure Constant Continuous-Current System.

or £54·24 per horse-power. The annual upkeep stands at £2,200, but this figure will be increased when the total possible output is reached.

A further case, interesting as transmitting power by high-pressure continuous currents, is the triple power station worked by the Société de l'Aqueduc Ferrari-Galliera, near Genoa, from a large mountain supply stored in great lakes at a level of 1,800ft. above the sea. This great fall is divided into four portions, the upper three of which are used by the society for electric generation in their three stations, named after Paccinotti, Volta, and Galvani. Their scheme works with 47 amperes, continuous-constant current, at a pressure varying from 450 to 8,500 volts, according to the load on the series line. After passing through a mountain tunnel 1·5 miles in length, the first, or Paccinotti fall, of 360ft. is encountered, the available power being 733 h.p. The second fall is of the same magnitude, and gives the same power, as the same quantity of water is used again; while the third, or Galvani fall, is greater, and gives an output of 1,000 h.p. These three stations work together and supply lines, which reach to a distance of 18½ miles, at which point the farthest motor is placed. In ordinary working the top utilised by two 300-h.p. Rieter turbines, supplying a jute spinning mill.

The Volta station, started in 1891, contains four units of 140 h.p. each, with eight dynamos of 1,070 volts, 47 amperes, by the Compagnie de l'Industrie Electrique. They are of similar type to those in the Galvani plant, but regulation is effected automatically by changes in the exciting current, speed remaining constant. A separate 15-h.p. turbine is directly coupled to the exciter, of which the station contains a duplicate, and the main-line current, in passing through a solenoid apparatus, directly controls the opening of the turbine gate. This excitation governor, controlling all the machines in the station, is found to give a quicker response to variations of load than could be obtained by changes of running speed, and it is stated that no trouble at all is experienced from commutator sparking with the weakest field in use. The elastic couplings, already referred to, are found to give an excellent insulation of dynamos from turbine and earth; the insulation provided at the points of dynamo support may be clearly seen in the figure.

The last station, of Paccinotti, contains four similar units with eight dynamos, but its average speed is 400 revolu-

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tions and pressure 6,000 volts, 2,000 volts being kept in reserve. The machines are without the heavy flywheels which keep the Volta speed constant, as their rate is required to answer changes of load in their own separate line between wide limits. Regulation is automatic, but supplemented by hand. On this circuit rotary transformers allow of parallel working for light supply. Other long-distance transmission schemes carried out by the Compagnie de l'Industrie Electrique by constant continuous high-pressure currents are individually interesting. Among them are those of Val de Travers, 1,000 h.p., 10,400 volts, 65 amperes, 21 miles; Chaux de Fonds et Locle, 3,000 h.p., 150 amperes, 14,400 volts, 25 miles circuit; and Linarès, Spain, 1,300 h.p., 14,000 volts, 60 amperes, 37 miles circuit.

ON A DETERMINATION OF THE OHM MADE IN TESTING THE LORENZ APPARATUS OF THE MCGILL UNIVERSITY, MONTREAL.

BY PROFS. W. E. AYRTON, F.R.S., AND J. V. JONES, F.R.S.

This apparatus, made by Messrs. Nalder Bros., is in general arrangement and dimensions similar to the Cardiff apparatus described in the *Philosophical Transactions* of the Royal Society, 1891 A, pp. 1-42, and in the *Electrician*, June, 1895, vol. xxxv., pp. 231 and 253.

The field coil, in pursuance of a suggestion contained in the Royal Society's paper, consists of single layer of wire wound in a helical groove of semi-circular section, cut in the cylindrical surface of a massive marble ring of about 21in. outside diameter, 15in. inside diameter, and 7in. thick. This helical groove has 201 complete turns with a pitch of 0·025in. Bare wire, of mean thickness 0·02136in., was first used, and the outside diameter of the coil so wound was measured in the Whitworth machine with the following results:

Diameter. Deg.	Near front face.	Near middle.	Near back face.
0 – 180	21·04772	21·04765	21·04765
10 – 190	21·04795	21·04765	21·04952
20 – 200	21·04768	21·05755	21·04905
30 – 210	21·04805	21·04745	21·04818
40 – 220	21·04785	21·04755	21·04825
50 – 230	21·04808	21·04730	21·04812
60 – 240	21·04752	21·04755	21·04805
70 – 250	21·04755	21 04755	21·04822
80 – 260	21 04785	21 04795	21·04895
90 – 270	21·04812	21·04780	21·04942
100 – 280	21 04805	21·04815	21·04925
110 – 290	21·04808	21·04825	21·04898
120 – 300	21·04785	21·04840	21·04905
130 – 310	21·04828	21·04835	21·04915
140 – 320	21·04828	21·04815	21 04908
150 – 330	21·04805	21·04805	21 04932
160 – 340	21·04872	21 04795	21·04858
170 – 350	21·04778	21·04785	21·04812
Mean ...	21·04797	21·04784	21·04872

General mean = 21·04818in.

The temperature, which was taken at each observation, varied between 19·9deg. C. and 21deg. C., and had a mean value of 20·4deg. C. Correcting for the difference between the temperature at which the bars of the Whitworth machine have their specified value and this mean temperature, we have for the mean outside diameter of the coil, when wound with bare wire 0·02136in. thick, 21·04932in. at 20·4deg. C.

From the above measurements it is clear that the wire lay on a very true circular cylinder. With bare wire, however, of the thickness used it was found impossible to obtain sufficient insulation between pairs of convolutions. Hence, after much time had been spent in endeavouring to insulate the successive turns by forcing paraffin wax in between them, etc., the coil was unwound and rewound with double silk-covered wire which had been first dried, then drawn through paraffin wax, and, lastly, baked before the winding was commenced. To wind so large and heavy a ring was not a easy matter, and it was not until the winding had been performed three times that the layer looked sufficiently uniform and quite free from abrasion of the silk.

The mean thickness of the double silk-covered wire used in the last winding was 0·01914in., so that the outside diameter of the wound coil, calculated from the value given above for the coil wound with bare wire, was 21·04488in. at 20·4deg. C.

The coil was then brushed over with melted paraffin wax, bound round with silk ribbon that had been soaked in a solution of shellac, and finally loosely covered up with a wide silk ribbon that had been passed through paraffin wax.

During the time that the ring was unwound the linear coefficient of expansion of the marble was measured by Messrs. Spiers, Twyman, and Waters, three of the students of the City and Guilds Central Technical College. The experiment was attended with difficulty, for it was far from easy to bring so large a mass of a badly conducting substance to the same temperature, but ultimately the result 0·000004 per 1deg. C. was obtained.

At the conclusion of the resistance observations, recorded farther on, the silk ribbons and the protecting layer of paraffin wax were carefully removed until the silk covering of the wire appeared, and the diameter of the coil was measured along two directions at right angles to one another. The maximum difference between four measurements was only five hundred-thousandths of an inch, and, after the introduction of the proper temperature corrections, the mean value of the outside diameter of the coil was found to be 21·04687in. at 20·4deg. C.

This result is about one part in ten thousand larger than the calculated value given above, and the difference is probably due to the silk covering of the wire having swollen slightly when the wound coil was brushed over with melted paraffin wax. In the calculation, therefore, of the coefficient of mutual induction we have considered it more accurate to use the value obtained by direct experiment. Subtracting from that value — 21·04687 — the thickness of the double silk-covered wire—0·01914—we have for the mean diameter of the coil *from axis to axis of the wire*, 21·02772in. at 20·4deg. C.

Shortly before the last set of resistance measurements was carried out the edge of the phosphor-bronze disc was ground in position so as to be made quite true with the axis of rotation, and immediately after the completion of the measurements the diameter of the disc was measured and found to be 13·01435in. at 19·5deg. C. Messrs. Spiers, Twyman, and Waters had previously determined its linear coefficient of expansion to be 0·0000125 per 1deg. C., so that its diameter was 13·01451in. at 20·4deg. C.

During 1896, when Mr. W. G. Rhodes was an assistant at the Central Technical College, he carried out the long calculation of the coefficient of mutual induction between the coil, as wound with bare wire, and the disc by using the method given in the paper in the *Philosophical Transactions* above referred to, and with the following values:

Diameter of coil or $2A = 21{\cdot}02673$in.
„ „ disc „ $2a = 13{\cdot}01997$in.
Axial length of helix „ $2x = 5{\cdot}025$in.
Number of convolutions „ $n = 201$.

he found $M = 18{,}056{\cdot}36$in.
$= 45{,}862{\cdot}33$cm.

This calculation was checked by Mr. Mather and independently by one of the authors.

Now it can be shown that for the above values of A, a, x, and n,

$$\frac{d\,M}{M} = 1{\cdot}246\,\frac{d\,A}{A} + 2{\cdot}346\,\frac{d\,a}{a} + 0{\cdot}0997\,\frac{d\,x}{x},$$

and so the value of M for the particular values of 2 A and 2 a, given above—viz., 21·02772 and 13·01451—can be calculated. When this is done we find

$M = 18{,}037{\cdot}51$in.
$= 45{,}814{\cdot}45$cm.,

and this was the value of M which we employed in our final determination, after allowance had been made for the effect of the central brush, as will be described further on.

The accuracy of the preceding calculations was tested in the following way: Values of 2 A and 2 a

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differing slightly from those employed by Mr. Rhodes were selected, and by means of the formula for $\frac{d\,M}{M}$ the proportional change in M was determined by Mr. Twyman. Then the value of M for these changed values of 2 A and 2 *a* was calculated by the authors from a new formula, involving an elliptic integral of the third kind.*

The centre brush consists of a tube 0·135in. outside diameter, which projects into an axial hole in the disc of 0·144in. diameter. Contact with the edge of the disc is made by three small tangential phosphor-bronze tubes lightly pressed on it at points separated by angular distances of 120deg. Through all four tubes a small stream of mercury is kept flowing, as this is found to greatly diminish the disturbances caused by variations in the thermo-electric effects, and the employment of three brushes at the circumference, as suggested by Rowland, eliminates small errors due to imperfect centering of the coil and disc.

To prevent the mercury which drops out of the central tube-brush touching the disc at a larger radius than that of the hole in its centre, an ebonite boss is cemented to the disc, and this causes the mercury to drop away quite clear of the metal of the disc.

If we take as the effective outside diameter of the central tube 0·139in.—that is, the mean of 0·135in. and 0·144in.—calculation shows that the coefficient of mutual induction is reduced by 4·50cm., so that finally we have M = 45,809·95cm.

As the allowance for the central brush only diminishes M by 1 part in 10,000, it is clear that for that degree of accuracy an error of a few per cent. in estimating the diameter of the central brush is of no consequence.

The method of making the observations was the same as that described in the papers on the Cardiff apparatus read before Section A of the British Association at Nottingham and Oxford (*vide* Report of the Committee on Electrical Standards Appendices, 1893 and 1894). The use of an extremely sensitive Ayrton-Mather galvanometer of the d'Arsonval type, materially facilitated the readings being taken. Two such narrow-coil galvanometers were specially constructed by Mr. Mather himself for use with the Lorenz apparatus, and the data of the second instrument are contained in the following table:

Resistance of suspended coil	1·9 ohms.
,, ,, coil and suspension	5·75 ohms.
Periodic time of complete swing	7·6 seconds.
Scale distance actually used	1,412mm. 1,340 scale divisions.
Deflection in divisions at actual scale distance used	137 per micro-ampere. 23·8 per micro-volt.
Deflection in divisions at scale distance equal to 2,000 scale divisions	204 per micro-ampere. 35·8 per micro-volt.

The resistance coils used were those previously employed in the Cardiff determination of the ohm (*vide* Report of the Committee on Electrical Standards, Appendices II. and III., 1894). They have been tested once by Mr. Glazebrook and twice by the kindness of Major Cardew in the Board of Trade Electric Standardising Laboratory, with the following results:

Coil No.	A. Mr. Glazebrook. Jan.-March, 1894.	B. Board of Trade, November, 1896.	C. Board of Trade, August, 1897.
3,873	9·9919 at 14·8°C.	9·992994 at 14·86°C.	10·00712 at 19·3°C.
3,874	9·9926 at 14·9°C.	9·993213 at 14·91°C.	10·00775 at 19·3°C.
4,274	·100050 at 15·2°C.	·1000595 at 14·77°C.	·100078 at 19·4°C.
4,275	·100053 at 15·2°C.	·1000722 at 15·14°C.	·100081 at 19·4°C.

The coils Nos. 3,873 and 3,874 were stated by the makers, Messrs. Nalder, to be wound with platinum-silver wire, and the two others, Nos. 4,274 and 4,275, with manganin.

In the following are given the temperature coefficients as supplied originally by the makers, and as calculated from the tests A and C and B and C:

* An account of this new formula, as well as of that for $\frac{d\,M}{M}$, will shortly be published by Prof. Viriamu Jones.

Temperature Coefficients of Resistance per 1deg. C.

Coils.	As supplied by Messrs. Nalder.	From tests A and C.	From tests B and C.
No. 3,873	0·000276	0·000360	0·000318
,, 3,874	0·000300	0·000344	0·000331
,, 4,274	0·0000127	0·0000667	0 0000399
,, 4,275	0·0000127	0·0000667	0·0000207

These figures show that a redetermination of the temperature coefficients which we are now carrying out is necessary.

Fortunately, the last set of determinations of the resistances of these four coils was carried out at Westminster, within a fortnight of the completion of our absolute measurements, and we are much indebted to Major Cardew for his kind promptness in the matter. The temperatures of these 1897 Board of Trade measurements were so nearly those of the coils during our final absolute determinations, which were from 18·8deg. C. to 19·4deg. C., as to render the effect of possible errors in the temperature coefficients negligible to the degree of accuracy aimed at by us. We have, therefore, used the August 1897 Board of Trade values of these coils as transmitting the Board of Trade ohm to the laboratory in Exhibition-road.

The standard thermometers used in the investigation were sent to Kew, and their errors were determined at the time by the kindness of Dr. Cree; also, thanks to Sir J. Norman Lockyer, the clock in the mechanical department of the Central Technical College, which transmitted seconds to the fast-running Bain chronograph, was frequently timed by reference to the current sent hourly to his room from the General Post Office, and at 10 a.m. from Greenwich.

The results of successive measurements of the absolute resistances became very concordant after, little by little, various possible causes of small errors had been eliminated. Nine sets taken on July 30, 1897, gave the following results for the value of the Board of Trade ohm in true ohms without allowance being made for the error in the clock rate:

1·000286	1·000277
1·000256	1·000306
1·000285	1·000284
1·000351	1·000307
1·000295	Mean, 1·000294.

Or, since the clock was found to lose during the daytime at the rate of three seconds per 24 hours, it follows that according to this investigation—

One Board of Trade ohm = 1·00026 true ohms.

It is important to consider in which direction this result will be affected by sources of error that cannot be removed by careful adjustment, centering, etc. They may be classified as follows:

Source of Error.	*Effect Produced.*
1. Over-estimation of the diameter of the coil arising, for example, from the stress on the copper wire having caused it to compress the under side of its silk covering.	Result would be too small.
2. Under-estimation of the diameter of the phosphor-bronze disc from a neglect of the tips of the circumferential brush tubes being possibly pushed away from the disc by the stream of mercury issuing, etc.	Result would be too small.
3. Presence of iron pipes, girders, etc., in the neighbourhood of the apparatus.	Result would be too small.
4 Traces of iron in the phosphor-bronze disc.	Result would be slightly too small.
5. Defective insulation between the support of the central brush and the supports of the circumferential brushes.	Result would be too large.
6. Defective insulation between the convolutions on the coil.	Result would be too large.
7. Traces of iron in the marble ring.	Result would be too large.
8. Defective insulation of parts of the circuit from one another.	Effect would depend upon the position of the leaks.
9. Permanent magnetic field at the apparatus.	No effect, for the current through the field coil was periodically reversed.

As regards (4) and (7) special induction balances were

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constructed and used by Mr. Mather to test the permeability of both the marble ring and the phosphor-bronze disc, but although a deviation from unity of one part in 15,000 could have been detected in the permeability of either, no such deviation was observed.

As regards (5) and (8), careful tests were made every day of the insulation resistance of the apparatus, and it was always found to be greater than 1,000 megohms.

(6) The insulation between the adjacent convolutions of wire could not be measured when they were silk covered and buried in paraffin wax, since a small leak between a pair of turns would not change the apparent resistance of the copper coil by as much as the variation in temperature of a fraction of 1deg. We had, therefore, to content ourselves with the precautions previously described, which were taken to secure high insulation in the winding of the coil.

When the ring was wound with bare wire, it was possible to roughly compare the insulation resistance between pairs of convolutions by sending a constant current through the coil and measuring very accurately the potential difference between every adjacent pair of the 201 turns. This we did several times, but it was a long and laborious task.

When constructing a new Lorenz apparatus it will be well to consider whether two separate helices should not be cut in the cylindrical surface of the marble ring in which two independent bare wires would be bound, a turn of the one being everywhere (except at the extreme ends) between two turns of the other. The insulation resistance, therefore, between the two windings would measure the insulation between the adjacent turns, while in the ordinary use of the apparatus the two windings would be joined in series so as to constitute a single coil. In this way it may be possible to be more sure of the absence of (6) than by using paraffined double silk-covered wire, and at the same time to entirely remove (1).

The direction of our experimental result, which shows that the Board of Trade ohm is between two and three parts in 10,000 larger than the true ohm, could not, however, arise from (1). Nor could it from either (2) nor (3). Still, many experiments were made to detect any evidence of the effective diameter of the disc being larger than its true diameter, as measured in the Whitworth machine. But no change in the pressure of the circumferential brush tubes, nor alteration in the shape of their ends, etc., indicated that, with the brushes as we employed them, the effective diameter of the disc differed from its true diameter.

Our thanks are due to the three of the students whose names are given above for much assistance in carrying out the long series of observations, to Mr. Harrison for bringing to bear, from time to time, the experience that he had already gained in the use of the Lorenz apparatus, and we are especially indebted to Mr. Mather for the suggestive aid that he rendered us throughout the whole of the present investigation.

ALTERNATOR DESIGN.*

BY J. FISCHER-HINNEN.

(Continued from page 622.)

Table III. is interesting also from another point of view. From (11) we get that the strength of the current is proportional to the value $\frac{X}{q}$. This may be used to solve the following problem:

Example 2.

Supposing a single-phase alternator is able to give a current of 100 amperes on a non-inductive circuit ($\cos\phi = 1$) with a drop of voltage from no load to full load of 15 per cent., that is $\eta = 0{\cdot}85$. Then what current can be taken from the machine at the same excitation and the same drop of voltage when it is supplying an inductive circuit, say, with motors where $\cos\phi = 0{\cdot}5$? It is assumed that the coefficient q is 0·7 in the first case, and = 0·8 in the latter. Then, from Table III.:

$\eta = 0{\cdot}85$ and $\cos\phi = 1$ $\quad X = 0{\cdot}525$,
$\eta = 0{\cdot}85$ and $\cos\phi = 0{\cdot}5$ $\quad X' = 0{\cdot}167$,

or, since the strength of the current is proportional to $\frac{X}{q}$, we get the current in the second case from the following equation:

$$J' = J \cdot \frac{X'}{X}\frac{q}{q'} = 100 \cdot \frac{0{\cdot}167}{0{\cdot}525} \cdot \frac{0{\cdot}7}{0{\cdot}8} = 28 \text{ A.}$$

Hence under these circumstances the output of the alternator is only 30 per cent. of that on a non-inductive circuit.

Example 3.

Supposing a generator is able to deliver 100 amperes at 110 volts, with a drop of voltage of 20 per cent. ($\eta = 0{\cdot}8$) upon a circuit with a $\cos\phi = 0{\cdot}8$, what maximum output is obtainable, the excitation and $\cos\phi$ remaining the same, with a drop of voltage of only 15 per cent. ($\eta = 0{\cdot}85$)?

In the first case $X = 0{\cdot}287$.

In the second case $X' = 0{\cdot}221$.

Neglecting q, which remains the same in both cases, the current strength is

$$100 \cdot \frac{0{\cdot}221}{0{\cdot}287} = 77 \text{ amperes.}$$

But the potential difference at the terminals is increased to

$$100 \cdot \frac{0{\cdot}85}{0{\cdot}8} = 117 \text{ volts.}$$

The output is therefore decreased from (110×100) to (117×77), or in the ratio of 11 to 9.

Example 4.

If an alternator working on a non-inductive load can give 100 amperes with a 10 per cent. drop of voltage, what will the short-circuit current be? Assume in this case that $q = 0{\cdot}7$ and $q' = 1$. From Table III. we get that $X = 0{\cdot}436$, and when on short-circuit $X = 1$. Hence,

$$J_0 = J\frac{g}{g'} \cdot \frac{X'}{X} = 100 \cdot 0{\cdot}7 \cdot \frac{1}{0{\cdot}436} = 160 \text{ amperes.}$$

Table III. also shows that a machine is more susceptible to a difference of phase in proportion as the fall of voltage decreases under normal running.

The strengths of current at non-inductive load and short-circuit are for $\eta = 0{\cdot}95$:

$$0{\cdot}31 : 0{\cdot}05 = 6,$$

while for $\eta = 0{\cdot}5$ the proportions become

$$0{\cdot}865 : 0{\cdot}5 = 1{\cdot}73.$$

In this we have not taken into consideration the coefficient q, which makes the proportion yet more unfavourable. The same table also demonstrates that a machine having a drop of voltage of 25 per cent. at an inductive load with $\cos\phi = 0{\cdot}85$ would have a drop of 30 per cent. for the same current and $\cos\phi = 0{\cdot}7$.

THE MAXIMUM OUTPUT OF A GENERATOR.

We will suppose that a machine is constructed, and that we want to ascertain its maximum output independent of its drop in voltage. If we multiply both sides of equation (9) by J, we get the output in volt-amperes as follows:

$$V\,A = J\sqrt{E^2 - e^2\cos^2\phi} - J\,e \cdot \sin\phi.$$

If we then differentiate with respect to J and equate to 0—*i.e.*,

$$\frac{d\,V\,A}{d\,J} = 0,$$

and express e in terms of J and R. In this case R is used to denote the apparent resistance of the machine. Under the above assumptions we get the maximum output when

$$J = \frac{E}{\sqrt{2\,R}} \frac{1}{\sqrt{\sin\phi + 1}} \quad . \quad . \quad . \quad (15)$$

We may here repeat that J stands for the power current divided by $\cos\phi$. We can substitute the value of J in equation (9), and from that ascertain the value of η for the maximum output:

$$\eta = \frac{1}{\sqrt{2} \cdot \sqrt{\sin\phi + 1}} \quad . \quad . \quad . \quad (16)$$

The maximum output is therefore—

for $\cos\phi = 1$, $\sin\phi = 0$ with $\eta = 0{\cdot}7$,

or for $\cos\phi = 0$, $\sin\phi = 1$ with $\eta = 0{\cdot}5$;

and

$$(\text{volt} \times \text{ampere})_{max} = \frac{E^2}{R}\frac{1}{2(\sin\phi + 1)} \quad . \quad (17)$$

* From the *Elektrotechnische Zeitschrift*.

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In order to express this in watts we multiply the right side by cos ϕ.

The Leblanc Damping Coil.

Some of the dynamos in Table I. are fitted with damping coils. These coils consist usually of copper bars placed on the surfaces of the magnets, the two ends of the bars being joined by copper rings, as in the short-circuited armature of induction motors. The armature action induces a current in these bars which is nearly 180deg. different in phase from the armature current, and which in consequence neutralises part of the lines of force caused by the latter. Leblanc damping coils further serve (1) to diminish the self-induction of the armature, and hence to raise its output; (2) to keep the machine more stable for the purpose of parallel running.

The first object can of course only be obtained with single-phase machines, since in the case of multiphase machines a revolving field is caused, which rotates synchronously, and which consequently does not cause any secondary current. We see that also from the value of the coefficient K″ in Table I. But the damping coil acts at once, when two machines run in parallel and one of them from some reason or another tries to get out of step by changing its speed.

Let us first consider the influence of the damping coil with reference to the reduction of the self-induction in a single-phase machine. In order to render this easier of comprehension, we will think of the stationary variable armature field as being divided into two revolving fields of half the strength each, both turning in opposite directions with an angle velocity of $2\pi c$. With respect to one of these fields the following symbols are to be used:

$v_1 \Phi_1$ = the total number of lines of force induced by the armature reaction.
Φ_1 = that part of the same which enters the damping coil.
$v_2 \Phi_2$ = the total number of lines induced by the damping coil.
Φ_2 = that part of the latter which enters the armature.
$v_1 v_2$ = Dr. Hopkinson's coefficient.
$\phi_1 \phi_2$ = the phase difference between E.M.F. and current, both primary and secondary, assumed to be 90deg.
L_1 = self-induction coefficient calculated on the effect of a single revolving field.
$L = 2 L_1$ = self-induction coefficient for the combined effect of both revolving fields—*i.e.*, of the stationary variable field.

Now we know that $v_2 \Phi_2$ is at right angles to the resultant flux Φ_m, and that this quantity consists of the

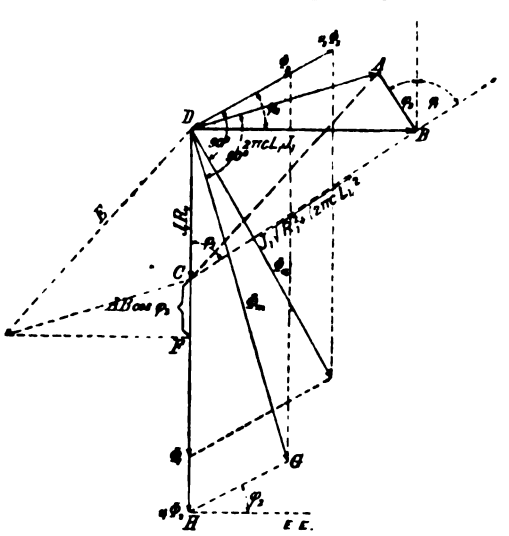

Fig. 10.

lines induced by the damping coil and those lines which enter it from the armature. Also the E.M.F. of the original primary self-induction, D B, is at right angles to J_1—viz., $v_1 \Phi_1$—and that of the resulting primary self-induction, D A, is at right angles to Φ_a, formed of $v_1 \Phi_1$, and Φ_2. Thus we get the diagram shown in Fig. 10.

(To be continued.)

THE CONDUIT TRAMS AT BRUSSELS.

The current number of the *Elektrotechnishe Zeitschrift* contains a full description of the various tramways at Brussels, but more particularly of the new lines recently

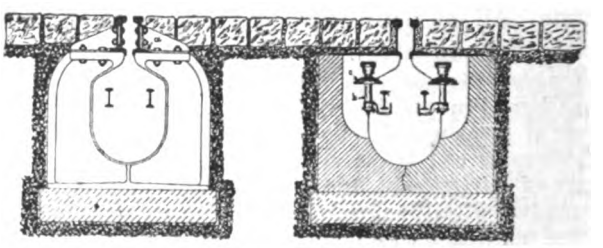

Fig. 1.

equipped on the conduit system by the Union Elektricitäts-Gesellschaft, of Berlin. Leaving the overhead systems, which are arranged on the usual Thomson-Houston method, we extract from the article in question the following details of the conduit and collecting plough. The conduit is shown in Figs. 1 and 2, from which it will be seen that the channels to carry the conductors are placed under the two inner running rails. The slot, to give access to the plough,

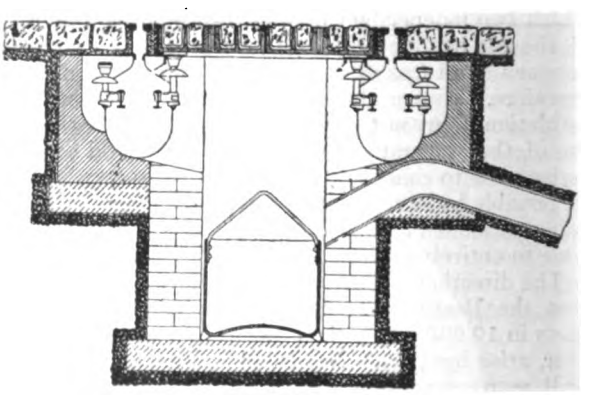

Fig. 2.

then comes between the running rails and the guard rails. Two conductor rails are fixed in each channel—one for the positive and one for the return current. The tramcar carries two contact ploughs, one on each side. These ploughs are situated between the wheels, and only one is used at a time. This one is the plough situated on the left of the direction in which the car is travelling. These

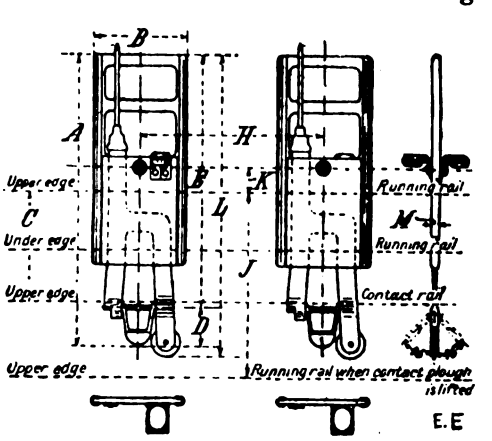

Fig. 3.

ploughs can be raised or lowered from the front platform, and it is claimed that the ploughs can be withdrawn at any point on the line. The conduit is placed under the inner rails to reduce the expenses. A layer of concrete, 6in. thick, forms the bed of the conduit, and on this is placed the iron casting forming the support to the rails, and giving the shape of the conduit. These castings are placed 4ft. 1in. apart. The method of attaching the rails to them is seen in the illustration. The slot between the two rails is nearly 1¼in. wide. The two inner edges of the rails are lipped downwards, so as to let the water drip from them, rather than run round in the inner surface of the conduit. The

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rails are laid in 33ft. lengths, and the bearing surfaces on the chairs are tested with a 30-ton load. The inside dimensions of the conduit are as follows: width, 12½in.; depth, 19in. The conductors consist of I sectional iron, the upper surface being somewhat rounded where the contact is made. These rails are carried by insulators placed about 16ft. 6in. apart. The rails are supplied in 33ft. lengths, so that one insulator is placed at the centre of each, and others at the ends. All the joints in these contact rails are accessible from traps by the side of the rails. At every third or fourth joint a pit is constructed, as shown in Fig. 2, to receive the mud and water which collect in the conduit. These pits are connected to the city sewers. The mud which remains in the pits collects in the bucket seen in the plan, and is removed during the night when necessary. The traps and manholes are closed by iron covers, the lids of which are filled in with wood paving blocks.

The steel bolts carrying the conductor rails are insulated by vulcanite, and the insulation is placed both between the bolt and attachments. A vulcanite mushroom on the bolt near the top prevents water from getting on to the insulation lower down. The rail carriers come on to the lower end of the bolts, as can be seen. The conducting rails are bonded by bundles of thin copper strip, attached to the rails in the usual way by means of thimbles and plugs. These bonds allow the necessary flexibility when expansion or contraction takes place. The position of the contact rails in the conduit precludes them from being seen from the street. The rails are divided at intervals by sectional insulators in the same way as is adopted in overhead work. The contact rails are discontinued at crossings and sidings, and the impetus of the car is relied on to carry it over such places. The ploughs on the car are carried on a cast-iron frame between the two wheels. In this, contact ploughs (Fig. 3), placed one on each side of the car, move up and down. The contact with the conductors is made by means of flaps, which revolve round on horizontal arms at the lower end of each plough. The flaps in the normal position rest obliquely on the rails, and are pressed against them by springs. These flaps give, so as to allow of the ploughs being inserted into the slots. The contacts themselves are made of an aluminium alloy. The roller at the lower end of the plough runs up an inclined plane at the end of the line, and lifts the plough out of the slot automatically. From the above details it will be seen that the system is well thought out.

HIGH-EFFICIENCY LAMPS.

We understand that the Edison and Swan United Electric Light Company, Limited, are now placing on the market a new type of high-efficiency incandescent lamp. The lamp in question is designed to take only 2¾ watts per candle-power, thus saving at least 25 per cent. in the electric lighting bill of the consumer. Lamps of this efficiency have often been promised us from many sources, but it has not been easy to secure a uniformly good article. The average life of the new lamp is, of course, a matter yet to be exactly determined, and also is somewhat a function of the regularity of the supply given. A life of 500 hours is, however, to be expected under the most disadvantageous conditions. Allowing for only 25 per cent. saving in power, this would in 500 hours amount with a 16-c.p. lamp to 7½ Board of Trade units, which at 6d. would cost 3s. 6d. With this saving there is an ample margin after providing for the cost of the new lamp. In cases where the lights are supplied from isolated plants, which are now overloaded, this lamp will render it possible to give a much greater output of light. The efficiency figures given above apply equally for 100 and 220 volt lamps. The illustration Fig. 1 shows the form of the high-voltage lamp, in which great stability of filament is obtained. The illustration is full scale. The other illustration (Fig. 2) is of a new attachment between the lamp and socket, in which no plaster is used. The brass cap on the top of the lamp is cemented on to the glass by some special cement, while the cap is attached to the socket by screws. The top of the socket containing the contact plates is made of vitrite, and a raised bridge between the contact plates guards against a short-circuit. The lamp so made is intended specially for colliery work, where the prevailing moisture seriously affects the usual plaster attachment. The lamps will also find a field in many other damp places.

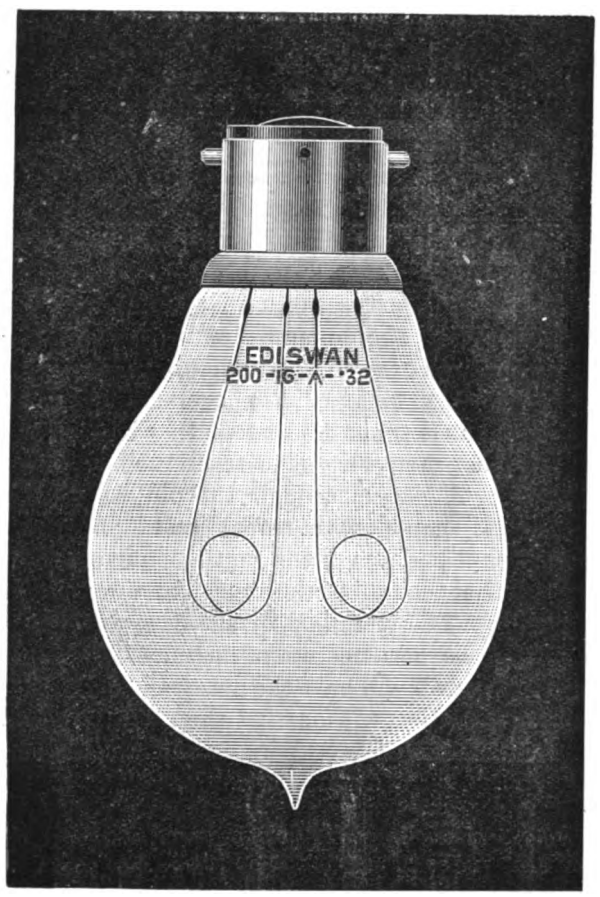

FIG. 1.

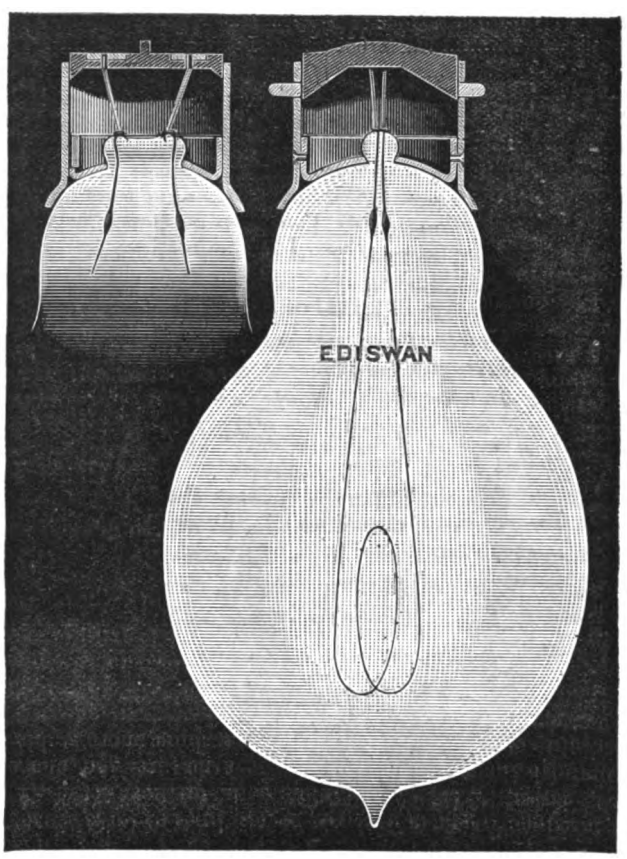

FIG. 2.

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THE

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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Vol. XIX. of new series of "THE ELECTRICAL ENGINEER" can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.

PROFESSIONAL ETIQUETTE.

"An electrical engineer again wrote offering to apply for a provisional order and prepare a preliminary report on the installation of an electric lighting system for a fee of twenty pounds." We regret to note the recurrence of such paragraphs in the agendas of town councils, as they are an index of the method of obtaining work used by certain would-be consulting engineers. In civil engineering the consulting engineer conforms to a high standard of professional etiquette in which touting is not allowed, and we had hoped to see a similar course adopted by the electrical profession. The routine of serving in a consulting engineer's office and of working up to a good position by actually carrying out works, is, however, too slow for some of our younger electrical men. They will not wait until their reputations lead clients to consult them, but prefer instead to circularise town councils generally. Such professional gentlemen give certain advice gratis as to what the towns should do, and as to the extremely high value of their own advice in the course they advise. We even heard of a letter of the above order in which a town council who have had an order for years, and who have established a preliminary station, were advised that they should apply at once for a provisional order. To such gentlemen who wish to rise like rockets we can also tender gratuitous advice, and that is that they should take note of the careers of other men who have tried their methods before them. A glance through the old volumes of any electrical paper will reveal cases in point, and the present position of the gentlemen in question will show that self-advertisement did not pay in the long run. The true facts of the case are these: the man whose experience warrants him starting as a consulting engineer will have the necessary connection and obtain practice without touting. Conversely, no touting will provide experience in engineering matters. To the town councils, we would add that the 5 per cent. paid to a thoroughly capable consulting electrical engineer will be saved three times over in the course of the erection of an electric lighting works, but that they had better put themselves unreservedly in the hands of a good contractor than trust to an unqualified consulting engineer.

ENGINES.

It is, we believe, a fact that Glasgow is going to America for engines, and thus is to obtain the whole of its traction plant from the same quarter. This is hardly to be wondered at when the history of the case is considered. Yet we cannot but deplore the fact, and urge that English builders can certainly, if matters could be properly put before them, build engines, dynamos, and motors in all respects better than those obtained abroad. Unfortunately, in almost all that pertains to electrical traction matters, we have been followers, and not initiators. The people who have had the most experience in traction matters say, We want this kind of engine and not that kind; but English builders go on persistently

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offering them the kind they won't have. The English builders may be perfectly right in their contention, but so long as the electrical equipment of tramway lines is upon modified or actual American types, so long will the controlling engineers have engines of the type found to work in well with their standard equipment. Our memory in this matter may serve us an ill turn, but we have an idea that Mr. Crompton or some equally reputable English engineer complained that the English firms had had to take a back seat, because in traction matters they were restricted to directions they did not approve. They can with much confidence point to several lines which have an entire English equipment, and have been eminently successful. It is therefore somewhat disappointing to find large orders going to America. Still, if we cannot effectually compete, and are beaten in fair competition, the fact should rather be an incentive to energetic improvement than to supine acquiescence. The demands upon the various items of a traction installation are pretty well known, and there ought to be no difficulty in providing for these demands. At any rate, if other makers can do it, why not those at home?

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

LEGAL.

SIR,—With reference to the recent case Stanley *v.* the Magnolia Anti-Friction Metal Company of Great Britain, heard at the Manchester Assizes before Mr, Justice Bruce and a special jury, and which was decided on November 13 in the plaintiff's favour, would you allow me to point out, to prevent a natural misconstruction, that the defendant company was a partnership, composed of John Sugden, John Lulham Pound, and Max Wagner, which has been dissolved as long since as July, 1896. The action was not against the Magnolia Anti-Friction Metal Company of Great Britain, *Limited*, with whom I am now connected, and *who only* are empowered to supply the original and only genuine magnolia metal. As the similarity in the firms' titles might do the latter company an injury, will you kindly mark the distinction by publishing this letter.—Yours, etc., ERNEST F. STANLEY.

ELECTRIC GOVERNORS.

SIR,—I had not time before leaving London last week to reply to Mr. John Richardson's letter, which appeared in your issue of the 5th inst., relative to my governor described and illustrated in your issue of October 29, but shall be obliged if you will be good enough to afford me space in your next number for the following observations on Mr. Richardson's criticisms.

I was quite aware of the existence of the various patents he refers to, and also of his paper read before the Institution of Civil Engineers in 1895, and while fully admitting that the patents in question suggest apparatus based on the same ideas, in some respects, as mine, I cannot admit for a moment that Mr. Richardson's allegation, that there is nothing essentially novel in my arrangements, is correct. My patents have been very carefully considered by eminent scientific gentlemen of standing quite equal to that of Prof. Silvanus Thompson, referred to by your correspondent. These gentlemen have had before them full and complete information as to all that has been done or suggested in this connection, and they have expressed very clear and decided opinions that my governors possess essentially novel features which tend to make them more efficient and trustworthy than any other hitherto introduced.

I will not occupy your valuable space by entering into the details of the various differences between my governors and those shown and described in the patents referred to by your correspondent; suffice it to say, with reference to the electric governor, that in my safety stop mechanism a spring suddenly draws up the solenoid core when the current is interrupted, and is thereby itself detached from a hook so as to allow the throttle valve to be closed by the weight of the solenoid core. In Patent No. 288, of 1881, there is no spring, but an electromagnet is held up by its own attractive force against the cast-iron valve chest until the current is interrupted, and then falls and acts as a weight to close the throttle valve, an arrangement which it must be admitted is entirely different from mine.

Your correspondent himself says that Mr. Willans used hydraulic pressure to work his relay; I use compressed air for that purpose, and that is undoubtedly a very important difference, because compressed air acts promptly, whereas a liquid, such as water or oil, acts slowly and sluggishly.

Richardson and Nevile's Patent No. 5,028, of 1888, is only adapted to move the trip gear of a steam-engine, an operation which requires comparatively little power, and, therefore, no relay is necessary; but for operating large throttle valves, relays are absolutely necessary, and I have every reason to believe, from practical experience, that my system is more efficient than any other yet employed.—Yours, etc., EDWARD THUNDERBOLT.

REVIEWS.

Light Visible and Invisible. By SILVANUS P. THOMPSON, D.Sc., F.R.S., M.R.I. Macmillan and Co. 6s.

This book is the outcome of the Christmas lectures on optics delivered by the author last year at the Royal Institution. The audiences before whom the lectures were delivered required that plenty of experiments should be shown them, and the Royal Institution naturally desire that, in spite of this, the actual progress of the science treated of should not be slurred over. To fulfil these two requirements no better lecturer could have been chosen, as the reproduced account of these lectures now before us shows. The chapters of the book deal respectively with the six lectures, in which the following subjects were treated: "Light and Shadows," "The Visible Spectrum and the Eye," "Polarisation of Light, "The Invisible Spectrum (Ultra-Violet Part)," "The Invisible Spectrum (Infra-Red Part)," and, finally, "The Röntgen Light. In each case the chapters consist mainly of descriptive matter, but appendices have been added to all the chapters, in which more exact scientific information is given. Thus, while in the first lecture the wave nature of light is ignored and matters proceed pleasantly on the old lines, the appendix provides for the reader a heavier dose of matter on the general modern methods of geometrical optics. This appendix would be an effectual disperser of a lecturer's Christmas audience, but is a valuable addition to the book now before us. A similar course is adopted in the following appendices; and we can recommend this little volume both to the general reader and to the student who wishes to get a true grasp of the ascertained facts about light.

FORTHCOMING EVENTS.

The following are some of the announcements for the forthcoming week:

MONDAY, NOVEMBER 22.—Imperial Institute, 8.30 p.m. ("Electric Balloon Signalling applied to Scientific Exploration in Arctic and Antarctic Expeditions," by Mr. E. S. Bruce, M.A, fully illustrated by working models and experiments).

TUESDAY, NOVEMBER 23.—Institution of Civil Engineers' ordinary meeting, 8 p.m. ("Central-Station Electric Coal-Mining Plant in Pennsylvania," by Mr. W. S. Gresley, A.M.I.C.E.).

WEDNESDAY, NOVEMBER 24.—Society of Arts, 8 p.m. ("Progress of Metallurgy and Metal Mining in America during the Last Half Century," by Prof. James Douglas).

THURSDAY, NOVEMBER 25.—Institution of Electrical Engineers meeting at Institution of Civil Engineers, Great George street, 8 p.m. ("Accumulator Traction on Rails and Ordinary Roads," by Mr. L. Epstein; continuation of discussion)—Finsbury City and Guilds Technical College, Leonard-street, City-road, E.C., 8 p.m. (Mr. Philip Dawson on "Electric Traction").

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QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. The answers to any question should be sent within 10 days after the question has appeared. Questions may be sent at any time. In the first question this week certain assumptions have to be made by those answering, and we trust that these will be based as far as possible on conditions known to exist in a given electric lighting station. In answer to the second question, sketches are desirable.

QUESTIONS.

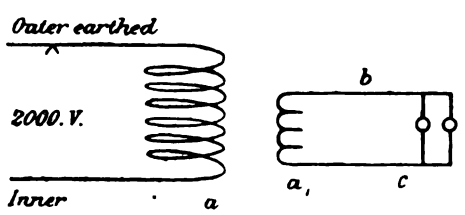
12. Detail the various losses of electric energy which occur between the 'bus bars in a central station and the consumer's meter with the various systems of supply. How can these losses be reduced, and how far is one wrong in considering the maximum loss as an indication of the disadvantage of any system?—H. M.

13. The armatures of Mordey alternators are sometimes connected with half the coils in series, the two halves being in parallel, and an equaliser is used. What is the object of this equaliser, and how is it constructed?

ANSWERS.

Question No. 8.—In an alternating-current system using concentric feeders with the outer earthed at the generating station and with switches on the inner only, is it advisable to use switches and fuses on both poles of the transformers feeding on to the low-tension network?

Best Answer to Question No. 8 (*awarded* 10*s.*).—The question is hardly as clear as it might be, and is open to two interpretations. I presume that the low-tension side of the transformer is the only one considered. On the high-tension side, one pole would be quite sufficient for switches and fuses in the transformer chamber, as there could be no serious potential on the earthed pole to earth. The low-tension circuit must be considered as entirely distinct from the high-tension as regards potential differences to earth, and therefore it is equally important to have fuses and switches on both poles of the secondary of the transformer, whether one pole of the high-tension circuit be earthed or not. In fact, from one point of view, it is more important to "fuse" both poles of the secondary when one pole of the primary is earthed than when it is not. A sketch is



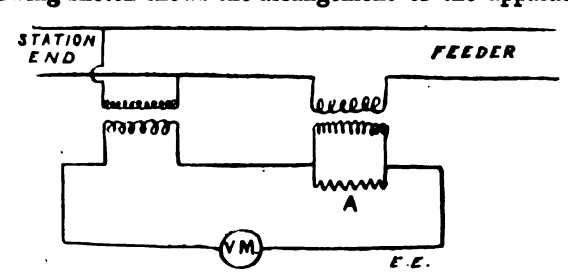
necessary to explain the matter clearly. If a becomes connected to a^1, owing to a fault, the difference of potential between the low tension and earth will be 2,000 volts. If now there is an earth, or one is made by an earthing device at, say, b, a current of many hundred amperes will flow from the inner high tension through a to a^1, to b, and back through earth to the outer high tension. If there is no fuse on the "b" side of the low tension, damage may be done. The same will occur if the earth is on the c side. It is, therefore, advisable to have fuses on both low-tension poles. The placing of a permanent and substantial earth on one of the low-tension poles permanently will not entirely relieve the other pole, as an accidental earth *may* occur on it, and there will still be a large current through the cable; it will, however, prevent any danger of shock, etc. With regard to the switches on both poles, of course they are necessary, as the transformer should be entirely disconnected from the mains when finished with, otherwise it will be permanently at a difference of potential from earth equal to that of the conductor to which it is left connected. If one pole is earthed, the switch need not be on that pole. It will be well not to rely on earthing devices to produce an earth on one pole when required unless they are of a *very* reliable character. Of course, they are advisable from the "shock" point of view.—W. FENNELL, A.I.E.E.

Answer No. 8.—For the very same reason that it is advisable to use switches and fuses only on the inner conductor of a concentric feeder, is it desirable to use only a switch and fuse on the inner pole of the secondary side of a transformer when the secondary mains are of the concentric type. In a concentric main the outer conductor, even if not earthed, is practically very little above earth's potential, owing to its having a greater electric capacity than the inner. It is very important with concentric cables that under no circumstance shall the outer become disconnected from the source of supply before the inner conductor, as an abnormally high potential is liable to be set up on the outer, sufficient in some cases to pierce the insulation of the cable. Fuses are dangerous on the outer conductor, and it is desirable to use instead of a switch some sort of mechanical connection which can be easily disconnected for testing of the mains, etc. In a three-wire network the "middle wire" should be mechanically connected to the transformer so as to allow for disconnection when necessary, and the two "outers" should each be provided with switch and cut-out. The most scientific arrangement of the conductors in a triple concentric cable is to make the "middle wire" the outer of the cable, but this is not always done, on account of its smaller relative area. If the network is a two-wire system, and composed of single conductors, it is best to use switches and cut-outs on both poles. The fact of the outers of the feeders being earthed at the station, does not affect the question as to the advisability of having switches and fuses on both poles of the secondaries of the transformers.—JOHN PILLING.

Answer No. 8.—As the outer conductor of the high-pressure feeders is permanently earthed at the generating station, the difference of potential between the outer and earth at the transformers will be only that due to the drop in the feeder, and when the inner conductor of the feeder is disconnected from the transformer, then the *whole* of the primary winding is practically at earth potential, and in consequence harmless. It is therefore not necessary to use switches and (or) fuses on both poles of the primaries, neither is it advisable, for if by any reason the outer conductor switch or fuse be opened before the inner, then the whole of the primary will be raised to the full potential above earth, and an unnecessary stress put upon the insulation. The use of switches and fuses on the low-pressure distributors from the transformers is also subject to the same reasoning. It is neither necessary nor advisable to use them on any conductor which is permanently connected to earth. Of course, to entirely free a transformer, both primary and secondary switches must be opened.—L. R.

Question No. 9.—Is there any reliable method of indicating at the central station the E.M.F. at the farthest end of a long alternating-current feeder without the use of pilot wires? If so, give details of the method.

Best Answer to No. 9 (*awarded* 10*s.*).—There is really no absolutely accurate method of indicating at the central station the E.M.F. at the farthest end of an alternating-current feeder, except by the use of pilot wires and electrostatic voltmeter. Another method, though not much in vogue in this country, is the use of a compound transformer. It is a combination of two transformers, in which the secondary pressures are opposed to each other. The primary winding of one of the transformers is in shunt across the two mains, and therefore the secondary E.M.F. is proportional to the 'bus bar pressure. The primary winding of the other transformer is in series with the feeder, and consequently the secondary E.M.F. is proportional to the current passing through the feeder. The following sketch shows the arrangement of the apparatus:



The secondary of the series transformer is closed through

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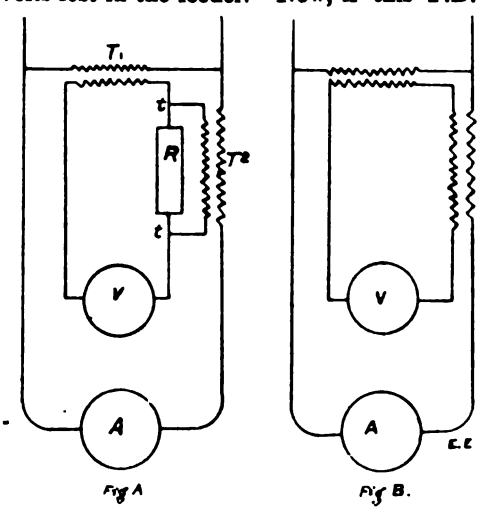
an adjustable non-inductive resistance, A, in order to bring the two secondary pressures opposite, as they would otherwise be one-quarter period out of opposite phase. This adjustable resistance may also be varied to suit the length and size of the feeder. This method is fairly good when the virtual resistance is practically constant or varies according to a known law, but it does not take any account of the induction in the feeder or of capacity when the feeder is concentric, both of which affect the E.M.F. at the far end of the feeder. Then there is the arbitrary method of marking on the feeder meter the E M.F. required at the station, and for any particular current passing in the feeder to overcome the virtual resistance of the cable. We cannot call this a method of indicating, but merely of calculating.—A. D. MARKLAND.

Answer No. 9.—A simple method of finding the pressure at the far end of a feeder is to put a second scale on the feeder ammeter, calibrated to show the volts lost in the feeder (and transformers) current. Then, if this value be subtracted from the station pressure at that instant, the voltage at the far end will be ascertained. This second scale may be in a different colour to distinguish it from the ampere-scale. Another method is by using two transformers, with the voltmeter in series with their secondaries, Fig. A. The primary of one transformer, T_1, is connected across the mains, and that of the other, T_2, is in series with the mains. The secondary of this transformer is shunted by an adjustable resistance, R, which is regulated according to the size and length of the feeder. It will thus give a P.D. at the terminals, *t t*, which may be a particular fraction of the volts lost in the feeder. Now, if this P.D. is made



to oppose the P.D. of the secondary of the transformer which is across the mains, the reading on the voltmeter will be an indication of the actual pressure at the far end of the feeder. Dr. Fleming shows a method in his book on transformers of "compounding" the feeder voltmeter, as in Fig. B. He says that the E.M.F.'s oppose one another; but this can only be the case when the secondary of that transformer which is in series with the mains is shunted, as in Fig. A. Because the secondary E.M.F. of the transformer which is across the mains is in opposite phase to the primary volts, and the secondary E.M.F. of the series transformer is about one-quarter of a period behind the main current, these two E.M.F.'s cannot *op ose* one another, and their sum must be greater than one of them.—T. A. LOCKE.

Answer No. 9.—A method which has been used in practice is to have a transformer with three windings, two of them being primary windings, like the windings in a compound-wound dynamo differentially wound. The high-resistance winding is placed between the feeders, whilst the main current flows through the low resistance. When the current in the feeder increases, the low-resistance winding, being designed with the right number of turns, introduces into the secondary circuit a back E.M.F. proportional to the drop of potential in the feeders. The greater the current in the feeders, the greater the drop of potential, and proportionately greater this back E.M.F., thus keeping the E.M.F. at the terminals of the secondary proportional to that at the extremity of the feeder. The potential indicator is placed in secondary circuit, which, being wound with comparatively few turns, the indicator does not measure the actual volts, but a proportional number. This enables a low-reading voltmeter to be used even though it is a high-potential distribution. By proper calibrating, the potential indicator can be made to read the E.M.F. directly in volts.—P. G. MOORE.

ELECTRICITY SUPPLY FROM CENTRAL STATIONS.

The following is an abstract of a paper read last Friday by Mr. J. T. Baron, the resident engineer of the St. Pancras station, before the London Association of Parochial Engineers. The paper was naturally of a general and descriptive character, rather than one dealing with special items. Mr. Baron commenced by reviewing the advantages of electricity for lighting purposes, such as the reduction of fire risk, greater cleanliness, less depreciation of decorations, and finally the general adaptability of the light to harmonise with its surroundings. The author then remarked the great progress made by the electric light, and claimed that the favour it had found in the eyes of municipal authorities proved conclusively that it had passed the experimental stage. There were now some 38 municipal authorities owning their own electricity works, and, as Mr. Baron caustically remarked, "some 33 companies have acquired rights to supply owing to the dilatory and procrastinating nature of some of our municipal authorities." The author then proceeded to explain to his audience the elementary principles and facts concerning electric lighting and the various units used in measuring electrical quantities. At the same time, the historical development of the dynamo was briefly reviewed. The need for graduated sizes of units was explained as follows: In central stations of large size the units of plant are graduated so as to ensure economical running. Thus during the lightly loaded part of the day a 60-kw. or 80-kw. set might be run, while as the load increased, 150-kw., 300-kw., or 500-kw. sets would be introduced. Each unit should be kept as fully loaded up to its maximum capacity as possible. Mr. Baron then described the different systems of supply. He recommended, in connection with the continuous-current system, the use of accumulators to assist at the period of heavy load. They also were a large factor in securing economical running and in reducing working costs. Thus in several provincial stations one shift per day was all that was required in the summer, as the batteries could take the rest of the demand. After describing at length the details of the London Electric Supply Company's system, Mr. Baron referred to the old fight between the exponents of the direct and alternate current systems. There was no doubt, he said, that each system had a large field in which it was specially advantageous. The continuous-current system, however, had the advantage as far as motors were concerned. The questions of cheap coal and abundant water supply were of great moment in the economical working of electric lighting works, but the author pointed out that the London generating stations were, with few exceptions, placed in busy parts away from the river. Hence several of these stations have lately taken up evaporative condensers as a means of reducing their charges for fuel. Mr. Baron then touched on the other features of economical working, such as the employment of feed-water heaters, which also tend to keep the boilers clean, and the Green's economiser. From this point, taking them under three headings—the boilers, engines and dynamos, and mains—the author briefly ran over the salient features of the electric lighting plants of the present day. In dealing with the mains, he recommended the placing of either creosoted boards or bricks over armoured cable when laid direct in the ground to prevent navvies from injuring the cable afterwards. In a further section of the paper, devoted to methods of lighting, the author referred to the change made in the capacity of distributing systems due to the introduction of the 200-volt lamp. The paper was concluded by details of the various methods of charging and of the various purposes for which electric motors were now being employed.

In the subsequent discussion, Mr. W. Durtnall, A.I.E.E., the electrical engineer of the Cannon-street Hotel, and Mr. Higgins, the electrical engineer of Messrs. Strode and Co., referred to several interesting questions concerning the most economical supply from the consumers' point of view, both agreeing that the 100-volt at present in use was more satisfactory, from a financial point of view, than the 200-volt lately brought into use by a few of the supply companies.

A vote of thanks was passed to Mr. Baron for his paper.

Motorcar Meet.—The annual meet of the Motorcar Club will take place at the Hôtel Métropole, at 11 o'clock on the 29th inst. The cars will run to Richmond, and in the evening the club will dine at the Whitehall Rooms.

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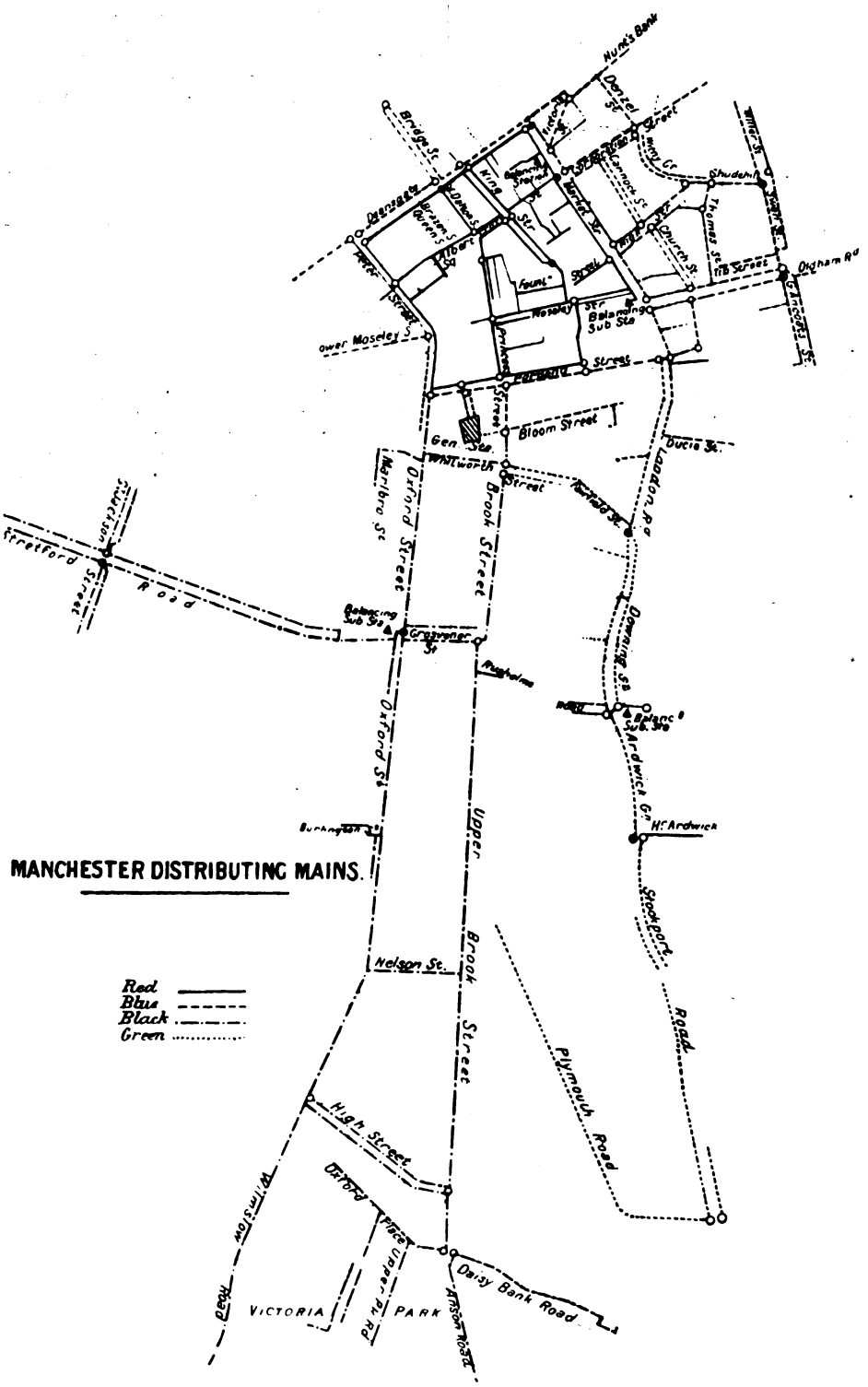
THE DISTRIBUTION OF ELECTRICAL ENERGY.*

BY C. H. WORDINGHAM, A.M.I.C.E., M.I.M.E., M.I.E.E, CITY ELECTRICAL ENGINEER, MANCHESTER.

(Continued from page 631.)

In connection with the burning out of faults, it may be interesting to note that a cable is seldom burned out by fusion through excess of current. What really happens in the case of a short-circuit is that an arc is established between conductors of opposite polarity, and this arc melts the conductors. If these are so enclosed that a supply of air cannot be kept up, the arc is soon choked out; the current required to burn out the fault is thus very much less than would be necessary if the cable were heated by the simple passage of current through it. With a network so connected up, it is essential that means should be provided for conveniently, quickly, and safely disconnecting any section while alive, either for testing purposes or for isolating a faulty main. The author has devised a piece of apparatus for this purpose, called a pillar distributor, which appears to fulfil the necessary conditions. A description of this will be found in an appendix to this paper. One of these pillars is in the room, and can be inspected by members. There are at the present time about 60 in use on the Manchester network, and the results have been extremely satisfactory. Their position is indicated on the diagram of the mains, which shows clearly the circumstances under which they are used. Connections and disconnections are frequently made with these pillars while the current is on, but there has never been a short-circuit or mishap with them, although in one case 1,700 amperes at 200 volts was broken, and in another the current flowing at a pressure of 150 volts through a dead short-circuit was also successfully broken. The author's opinion is that in the case of a large city there should be only one network, but that this should be subdivided into a number of smaller network connected together at certain definite points. At these points should be fixed either automatic switches, or, perhaps preferably, switches operated electrically from the generating station, which in the event of a fault on any one section would immediately isolate it, leaving it however connected to the generating station, so that it is left to the discretion of the engineer in charge as to whether the supply shall be cut of from this section or not.



* Paper read before the Northern Society of Electrical Engineers.

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works, coloured respectively black, red, green, and blue. Three of these networks are already connected direct to the generating station, while the fourth will shortly be so connected. The various networks are all united together at a fair number of points. These points will ultimately be somewhat reduced in number, and if satisfactory switches can be devised, they will be fixed at these points for use in the manner described above. Each network can be split up, and every length of main isolated by means of pillars shown by circles on the diagram. The present feeding points are shown by larger circles with crosses. In connection with the question of balancing, there are at present four sub-stations with balancing motor-generators. These also are indicated on the diagram. The determination of the size of conductors to be put down is one of the most difficult problems which has to be faced. It must be recognised at once that, contrary to the case of feeders, mathematical calculation is of no avail, and the engineer has to fall back on his experience and judgment entirely; in fact, the probable demand for electrical energy in a given street, like many another engineering problem, is a matter of pure guess-work. The best practical rule in the author's experience is to settle upon certain standard sizes of main; in his own case these are 1-16th square inch, ⅛ square inch, ¼ square inch, and ½ square inch, and after a careful inspection of the street in which mains are to be laid, to decide upon one or other of these, bearing in mind that it is safer to rather over-estimate than under-estimate, the demand for new developments of the uses of electrical energy are likely to lead to increased consumption, and, in a flourishing city, property tends to improve. Moreover, distributors once laid should never require to be increased in section. In multiple-wire networks, the usual practice is to make the outer conductors larger than the intermediate, but the author prefers to keep all the same size. If this be done, and the above principle be followed, and if the network be well cross-connected, as suggested earlier in this paper, it should be possible to deal with all future demands by adding to the number and section of the feeders. Of course it will be necessary to settle upon a current density at which to aim, and the author considers 600 amperes per square inch to be suitable for the average conditions of supply.

Summarising what has gone before, we may take it that we have determined to establish a distributing network on the three-wire system, with five wires in certain streets, and to give a supply of continuous current at a pressure of 200 and 400 volts, and also in special streets when there are five conductors at 100 and 300 volts. The next point to determine is the system of mains to be employed. Several able papers on the relative merits of different systems of mains have already been brought before this society, and the author therefore begs the indulgence of members if, in stating his own experience and opinions, he traverses ground already familiar to them. What are the conditions which are to be fulfilled? In the first place, it is important that the mains should be so arranged that they can be tapped at any point along their length. They should not require that connecting boxes be laid down at predetermined points, for many of these will certainly be wasted, and many will be found to be in inconvenient positions, necessitating either the entrance of the service line at an unsuitable point in the building, or the running of unnecessarily long connections. Jointing on of service lines should be easy, quickly effected, and should not require highly trained men or special contrivances. While low first cost is highly desirable, it is of greater importance that the mains should be of durable materials, and should be unlikely to fail; for the failure of a distributing main is of much greater importance than the failure of a feeder, since it is easy and comparatively not costly to provide reserve feeders, while it is out of the question to duplicate distributing mains. Further than this, the feeders can be readily withdrawn, while a distributor cannot be renewed without serious interruption of the supply, and excessive labour for rejointing. The insulation of conductors should be permanent and steady; it need not be extremely high. The system of distributors should be as flexible as possible, since it is always preferable to lay them under the footways and near the buildings, and many obstacles to a straight course are in consequence met with. The mains should afford security against fire, explosion, or other damage to person or property, and they should interfere as little as possible with the surface of the street or pathway. They should be unaffected by the soil, as well as by rats or other vermin.

Mains fall broadly into two systems—drawing-in and built-in. The drawing-in system is very attractive in theory, and in practice is under certain circumstances to be preferred for feeders, but for distributors the title is a misnomer, for every drawing-in system becomes a built-in system as soon as T-joints are made to connect consumers to the conductors. It is impossible to draw the conductors out without cutting all the branch wires, and to draw in additional cables on the top of old ones is to court certain disaster, for they will assuredly damage both the branch connections and the main conductors. If a drawing-in system be employed, each cable should be in a separate duct, otherwise, should there be an earth on one cable, and the insulating covering be damaged, the fault will almost inevitably develop from an earth into a short-circuit, whereas, if the cables are held apart in separate ducts, this will not take place, and the fault may be found before disaster ensues. A drawback to these separate ducts is that they are of necessity close together, and when the main is broken into to make a branch connection, these cables are held so rigidly and so close together that it is a difficult matter to make a satisfactory joint.

Turning now to the built-in system, the conductors may either be insulated throughout with a solid dielectric or with a solid and a fluid dielectric intimately mixed, or else with a fluid and a solid at intervals. In the former case there will be a certain leak all along the conductor; in the latter, if the fluid be air, the insulation will be perfect, except at the solid points of support. In the first class are included solid materials such as vulcanised indiarubber, vulcanised bitumen, diatrine, etc., and mixtures such as paper or other fibrous material impregnated with air or light or heavy oil. In the second class there is less variety, the conductor usually being supported on porcelain, the chief difference in detail being in the method of support, the conductor either merely resting on the supports, or else being tightly strained at intervals.

There is one important essential difference between the two classes: in the first the insulation resistance is usually high, but the thickness of dielectric is very small, and if the material is defective, or is injured at any point, there is almost certain to be established a considerable leak to earth; while in the second class the insulation is much lower, but the conductor, instead of being liable to leakage throughout its length, can only come in connection with earth at intervals—*i.e.*, at the supports; and the supports are of such a size that the actual distance of the conductor from earth is considerable, and even if an insulator entirely fails, there is a good chance that it may not come in contact with earth. Taking the first class of insulation, it would not be profitable to discuss in detail each dielectric available. When solid insulation only is employed, the dielectric is usually waterproof in itself, but when fluids are intermixed with the solids it becomes necessary to enclose the material in an impervious envelope to exclude moisture, and to retain the fluid if the fluid be a liquid. In the author's opinion a waterproof solid is preferable to the mixture, partly because it is less likely to allow water to enter, whether during jointing or if slight damage be done to the outside of the cable, and partly because the impervious envelope is usually lead, which, being very heavy, increases the labour of laying, and when laid requires a plumber to be employed whenever a joint has to be made, unless expensive and otherwise objectionable joint-boxes be employed. Further than this, the lead being a good conductor, the effects of a fault are often transferred to points at a considerable distance from the original seat of the mischief.

To be continued.)

INSTITUTION OF ELECTRICAL ENGINEERS, Nov. 11.

Accumulator Traction on Rails and Ordinary Roads.

BY L. EPSTEIN, MEMBER.

(Concluded from page 623.)

In the interests of economy the formerly much-recommended overcharging must not be too freely indulged in. Such overcharging can easily be guarded against by using recording instruments, or by other suitable means, while when charging at constant potential the battery will itself guard against overfeeding by effectively opposing, at the proper time, the charging current. The recommendation to overcharge the cells occasionally may, however, be followed with advantage, the beneficial result consisting not so much as was formerly supposed in the actual improvement of the electrodes, but in the thorough mixing of the electrolyte, which is liable to vary in S.G., being densest at the bottom of the cell and decreasing towards the surface, thus leading to unequal action in different parts of the plate. Another device for equalising the action over the whole surface consists in making the electrodes taper towards the bottom, with the object of compensating for the higher density and better conductivity of the electrolyte there by increasing the distance between electrodes of opposite polarity.

We are now, however, confronted with the all-important question of the cost of depreciation of the batteries. If we consider a battery in a car for 52 passengers, with an average running weight of about 12 tons, and an average mileage of 100 per day, equal to 1,200 ton-miles per day, we find that at the rate of 80 watt-hours per ton-mile the daily electrical expenditure is 96 units, or, if working at 400 volts, 240 ampere-hours. It is, of course, immaterial for our calculation what the voltage is, as the cost of renewal of either a

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small number of large electrodes or a large number of small electrodes will be practically the same for the same watt-hour capacity. The cost of renewing the positive section of a cell of such capacity should not exceed, including manufacturer's profits, 10s., and, assuming two discharges or their equivalent a day, we may reasonably expect a useful lifetime extending over 1,500 discharges. The battery doing work, therefore, during 750 days and covering 75,000 car miles, the cost of renewing the positive sections in 220 cells will amount to £110, or ·35d. per car mile. That this estimate errs on the safe side is borne out by the experience gained in Hanover, although it seems that the batteries used there are of greater weight than is necessary. Given a good battery and having adopted a system best suited to the conditions of a given line, and in any case obviating the necessity for handling the batteries, we should arrive at a working cost approximately the same as on the trolley system—the extra expenditure caused by the greater weight of the self-contained car being balanced, as is shown in Hanover, by corresponding advantages gained.

While on tramlines accumulator traction must prove its superiority over rival systems in order to be adopted, there is another large field in which the use of batteries is a matter of necessity. I refer, of course, to traction on ordinary roads. The tractive force on ordinary roads is naturally subject to much greater variations than that on rails. I think, however, that on good roads paved with asphalte or wood and in fairly good condition, the tractive force of vehicles as hitherto built should, on the level, not exceed 60lb. The weight of an electrical vehicle to carry from two to four passengers, with motor and battery complete, will be about 30cwt., which includes a battery with a weight of 9cwt. A battery of such weight ought to be sufficient to supply current for a four to five hours' run, at an average speed of eight miles on the level and four miles up a gradient of 1 in 24. The power on the driving axle will be about two effective horse-power in the former case, and about three effective horse-power in the latter, and, assuming a combined efficiency of motor and gearing of 65 per cent., the battery will have to furnish discharges at the rate of 2,206 watts and 2,812 watts respectively. With a battery efficiency of 70 per cent. the charge to supply one hour's actual run requires about three units, which, at an estimated cost of 2d. per unit (a sum that should certainly not be exceeded, whether the current be generated at the company's own stations or taken from a public supply) corresponds with a cost of ¾d. per mile. It may therefore be anticipated that electric carriages plying for public hire should be able successfully to compete with horse-drawn vehicles for a similar purpose, provided that the wear and tear of the accumulators is not excessive. The favourable financial results would not be impaired even if the cost of maintaining the accumulators should exceed the rate of 10 per cent. per year, said to be quoted by some manufacturers. The time during which such accumulators have been at work is probably too short to prove whether the batteries can be maintained at such a remarkably low rate. Reliability of the battery, obviating the necessity for frequent examinations and tests and for remedying partial defects, is again of much higher importance than (within reasonable limits) the lifetime of the whole battery, as will become evident from the following consideration. Assuming the average mileage made with one charge to be 40, and estimating the cost of renewing the positive section at 10s. per cell, or £20 per battery of 40 cells, the cost of renewal per mile run would be as follows: If renewed in 8 months=240 days, after 9,600 miles, ·5d. per cab mile. If renewed in 12 months=360 days, after 14,400 miles, ·33d. per cab mile. If renewed in 16 months=480 days, after 19,200 miles, ·25d. per cab mile. If renewed in 24 months=720 days, after 28,800 miles, ·166d. per cab mile.

If the average cost of a battery be £60, and if it should become necessary to renew all the positive sections, even after as short a time as 12 months after having run 14,400 miles, it is true that the cost of renewals (£20) will equal 33⅓ per cent. of the first cost, but this only equals one-third of a penny per cab mile. On the other hand, even with batteries having a longer life but necessitating supervision and slight repairs, the wages incurred and the cost of material would, judging from the experience gained in tramway work, certainly amount to a much larger sum than the cost incurred in renewing the positive sections, even in a comparatively short time. Besides, in such case, more sets of batteries per car would become necessary, increasing not only the first outlay but the charge for interest and depreciation, and thus considerably swelling the total cost.

Lightness of batteries for ordinary roads is of much more importance than it is on tramlines, not only on account of the heavier energy expenditure which is necessary to propel a given weight, but the more so as the battery will represent a larger portion of the total weight of the vehicle as compared with tramcars. In large towns it would be an advantage to use batteries which are interchangeable, and to make arrangements with public supply companies to charge the batteries and always keep a number ready for use. The drivers would then be able to exchange the batteries at the nearest station, instead of being compelled to return to the one station, which may be a long distance off; time would thus be saved, and the earning capacity of the electric carriages increased.

The figures relating to tramways contained in this paper are the results of my own tests; but such is not the case with those having reference to traction on ordinary roads. I should have preferred to submit data, based on personal observations on a motorcar which I am making, and which I think embodies several improvements tending to reduce the necessary tractive force. But, unfortunately, as is often the case with new constructions, the completion of that car has taken longer than anticipated, and, although I endeavoured to postpone my paper until I should be in a position to bring something which might have the charm of novelty before this Institution, yet, wisely or otherwise, I gave way to the request to read a paper on electric traction at the beginning of the session. If, as I fear, I have failed to bring anything very original or interesting before you, this must be my excuse.

Discussion.

Mr. E. Manby, in commencing the discussion, said he could give a few figures in connection with a new accumulator which had been used for the last few months on the Dresden tramways with considerable success—he referred to the Marshall accumulator. The patent consisted in the fact that the paste consisted of the ordinary salts of lead incorporated with copper, and they acquired a wonderful degree of hardness. This paste had been subjected to very severe tests in Dresden, and it showed a great degree of electrical activity and that it never cracked or broke up. The plates of the cells used on the Dresden tramways were 11cm. by 27cm. There were 13 plates to each cell, weighing in all 13½ kilos. With this small surface they had given a very high efficiency. They worked at a normal rate of discharge of 65 amperes, and on emergency had risen to 120 amperes, without the slightest deformation of the electrodes. They had run the Dresden tramway cars for a whole working day of 17 hours for a distance of 130 miles without recharging. The cells had stood very severe tests, and in only one case had there been an accident. The whole of the force of the town current—500 volts—was, through the mistake of the foreman superintending the charging, all let through the cells in car, which caused an explosion and set fire to the car. After the fire was put out, two of the cells were removed and the car was run for several hours, which was a test which, perhaps, very few batteries could stand. After a seven months' trial the Dresden Tramways Company was so satisfied with this accumulator that they had decided to equip the whole of their cars with it. The maximum normal discharge per kilo of plate was nearly nine amperes. The normal discharge was one ampere for about 6½ or 7 square inches of positive plate. The maximum discharge was one ampere for 4·6 square inches of positive plate, which he thought might be considered to have exceeded anything previously done in that line. The results of this battery had made a considerable sensation on the Continent; they had been adopted in Belgium, and they would shortly be adopted in France.

Mr. R. E. Crompton said the subject was one of extreme interest to them all. He thought it was quite possible that they were on the verge of having traction of both kinds, both on the rails and on the road, carried out to a considerable extent by accumulators. He thought they were tremendously interested in the success of the very bold experiments which had been carried out by the Electrical Cab Company, and he was sure if they went on as they had begun they would know more in a few months' time of the possibilities of driving by accumulators than they thought they were likely to do a short time ago, because they at once came face to face with the most difficult problem when they exposed the plates to the jolting of the common roads. There was an American invention which had been explained to him, devised for the purpose of getting over the great difficulty which they had experienced even with fixed cells, and that was the difficulty of preventing the active material from crumbling away and becoming detached. That constituted the greatest difficulty of all that they had had, and with the vibration of the road and the vibration of the machinery they were sure to have that falling away increased very much. The American inventor had tackled the difficulty by encasing the whole of the plate with vulcanised rubber, not of the hard vulcanite form, but a quite soft and elastic form. Each of the positive plates was covered with a thick diaphragm of this rubber, which was pierced at regular intervals by properly formed apertures which gave the electrolyte free access to the surface of the plate, but at the same time allowed elastic support to the surface of the plate. That was to say, he applied a diaphragm to the surface of the plate which was sufficiently porous to allow free action of the electrolyte, and at the same time held the active material up to its backing. Some device of that kind seemed to be what they wanted before they submitted the ordinary accumulator to the vibration of tractive apparatus. If that could be done, they would have made a great step in advance. He thought the figures which Mr. Epstein gave as to road traction were rather startling at first sight; but when they came to check them over, they could see they were warranted. At the first sight a tractive force of 60lb. per vehicle appeared to be a very small figure, but when they came to work it out they would find it was a correct figure. He thought, when the figures of the electric cab came to be worked out, it would be found that the tractive force was under 60lb. A good many experiments carried out by Mr. Ravenshaw and others had

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shown that the road friction of pneumatic-tyred vehicles properly constructed need not exceed 28lb. per ton, and if a vehicle could be brought under 30cwt. they might really run it at 10 miles an hour for one actual horse-power. He thought there was very little doubt they could make the machinery so efficient that with 1,400 watts they could drive such a cab at 10 miles an hour on the level. He thought those figures were very encouraging, because it was evident that as they increased the efficiency and decreased the horse-power required to be got out of the accumulators, they also decreased the weight of the accumulators, the weight of the framing, and the weight of everything that had to carry them. He wished Mr. Manville's company well in every way. It had been very interesting and gratifying to see that the electric motor-car was about the only one that had worked with any success on the road.

General Webber said they were very much indebted to Mr. Epstein for the paper. When it came before the Council prior to the meeting, he felt great regret that Mr. Epstein had not referred in any way to his own experience with his own accumulators on the Birmingham tramway line which was in existence some six years ago, and which was the only example of such form of electric traction in the United Kingdom. At that time he made a very careful examination of that system with Mr. Snell, now the engineer to the Sunderland electric light works, and the conclusion they came to was that the use of accumulators in the system had been very much disparaged because of circumstances to which Mr. Epstein alluded in his paper. When he spoke of the system of charging and moving the cells, he had little doubt that he had in his mind the arrangements that were made for handling the accumulators used on the Birmingham line. He (General Webber) had proved distinctly that the system did not have fair play, because at least 60 per cent. of the electricity that was generated was lost on its road to the cells, owing to various circumstances of faulty arrangement. He was surprised that those faults had not been brought to light and used as conditions to be avoided, and that owners of tramways in the United Kingdom had not been induced to use accumulators with the experience gained at Birmingham. If they had done so, they would have had by now as good results as they had had in Hanover and in Paris. He hoped Mr. Epstein would tell them if his ideal cell did exist, and, if so, where it was procurable. The means of reducing the necessary tractive force was almost a subject for a paper by itself, and it pointed of course to the question of the wheel. He referred to the experiments made with an omnibus manufactured by the Electrical Power Storage Company from the invention of Mr. Frank King two or three years ago, which was shown on the Victoria-embankment, and which even carried three Cabinet ministers, till one of the wheels exploded. The elastic part of the wheels was entirely formed of rubber, and when the omnibus was still the rubber of course flattened out, the area of support being a rectangle, which was a very great element of resistance to the tractive force, and was probably the chief factor of the discontinuance of the experiments in that direction. Great pains had since been taken with the wheel, which he thought would be one of the solutions of the difficulty. He knew of one which consisted of a hollow steel casing holding an indiarubber tube, to be expanded like a bicycle tyre. A solid rubber wheel tyre was let into the casing with overlapping edges, so that when the inner tyre was inflated it would keep the outer tyre in its place, and thus reduce the resistance to the tractive force very considerably. He wished Mr. Epstein had given them a great deal more of his experience, and he hoped in his reply he would be able to tell them much more, particularly as regards traction on tramways, which was a question that had not been sufficiently thrashed out in public, considering the objections that the municipalities had to overhead wires and the extremely strong objection there was on the ground of expense to the slot system. For these two reasons the question had a double interest in the United Kingdom, and he trusted that this paper was only the beginning of the unravelling of the subject, and that as it was being worked out in Dresden, and elsewhere, it would also be worked out in this country.

Mr. E. Manville thought Mr. Epstein was deserving of their warmest thanks for his paper, and he entirely agreed with his views. As regards the Birmingham Central Tramway accumulator system, he had the fortune or the misfortune to have the responsibility of running it for the two latter years of its life. He thought the accidents were due almost entirely to the rapid deterioration of the accumulator plates, largely on account of carrying accumulators in cars and the handling of the cells themselves. Ever since he had anything to do with that company he came to the same conclusion as Mr. Epstein, that the cells should certainly be carried independently of the cars. A system equipped in that way would have more chance of success than the Birmingham trams. They were also led to believe at one time that the deterioration was incurred by the vibration in carrying the accumulators about, but lately he had made a number of tests on cells of all descriptions. In each type of battery a stationary cell was used, as well as one which was violently vibrated all the time during its discharge. Some of these cells proved to be good, and some to be bad, and there were a large number of them altogether. One fact was established, and that was that none of the cells that were vibrated were any worse than the corresponding cells which were still. This was a very important fact. He did not believe that vibration was the cause of the deterioration of cells, but he believed that the deterioration was due to the very stringent electrical conditions under which they were used. That brought them to the difference between a tramcar and a light vehicle, both driven by accumulators. It was quite possible to put a much heavier weight of accumulators on a car, and hence to increase the ratio of accumulator weight to total weight to about 1 to 2¾. That meant a corresponding difference in the maximum duty which the cell was called upon to perform, and he believed that difference would have a very considerable effect on the life of the cells used in that way. Mr. Epstein had pointed out that with a combined trolley and accumulator system a good plan would be to have the cells on separate trucks, and to connect these trucks to the cars where the trolley line ended. This plan had the advantage that it would materially improve the regularity of the trolley line and decrease the cost of the feeders. As to the traction of vehicles on rubber tyres on roads, he agreed with Mr. Epstein that on hard London roads it was not so much a question of smoothness as of hardness. On country roads, which were often very soft and with a thick layer of dust or mud, the traction resistance did not exceed 60lb. per ton, and he thought they would be nearer in putting it at 40lb. per ton.

Prof. Ayrton asked Mr. Manville if he could give them some actual figures about electric cabs. What was the motor? Was it 1 h.p. or 5 h.p.? What was the average power that the cells actually gave out, and what was the maximum power they were called upon to give out? What kind of cells were they which he tested; were they pasted or non-pasted, and what kind of vibration did he give them?

Mr. Manville replied that the motors were capable of taking an input of 3 kw., say 4 h.p., as a maximum. The motors had double-wound armatures and fields, which were connected together in different combinations to produce different speeds. The accumulators were always left in a series as a battery. There were 40 cells used, and from his own experience in one cab the current taken on level wooden pavements was 30 amperes at 80 volts, and it increased to 40 or 45 amperes on the roughest kind of hard road. The maximum variation, he thought, sent the current as high as 120 amperes going up a steep hill—the Savoy hill in the Strand. The cells he used in his tests were those which could be bought in the market—both Planté cells and pasted. The vibration was caused by the cells being suspended on eccentrics worked from two countershafts in the same plane.

Prof. Perry: That isn't severe enough. That doesn't represent the joltings of the common road.

Mr. Tremlett Carter asked whether Mr. Epstein would recommend, in the case of small motorcars using a series-parallel device for the cells themselves, whether it was possible to have those combinations of electromotive force from the battery that would enable them to get different voltages to give them different speeds, or must they adopt some differential form of gearing, which, he thought, was not at all satisfactory. If they were to have vehicles with only one single motor on them, might they use the batteries in series for the high speed in parallel for starting?

The discussion was then adjourned till the next meeting on November 25.

The **President** reminded the members that the annual dinner will be held on November 24.

CLEVELAND INSTITUTION OF ENGINEERS.

ELECTRIC POWER WORK IN IRONWORKS, SHIPYARDS, AND ENGINEERING ESTABLISHMENTS.

The thirty-third annual meeting of the Cleveland Institution of Engineers was held at Middlesbrough on Monday evening, Mr. T. Westgarth (of Sir Christopher Furness, Westgarth, and Co., Limited, marine engineers, Middlesbrough) in the chair. The following new members were elected: Mr. Bernard Stephenson, engineer; Sir Christopher Furness; and Mr. Chas. F. H. Bolckow, assistant engineer. The council reported that Mr. Westgarth, the president, had been re-elected, and the retiring members of the council had also been reappointed. Mr. Westgarth then gave a description, profusely illustrated with lantern photographs, of

The Electrical Driving Plant at the New Works of Sir Christopher Furness, Westgarth, and Co., Limited, Middlesbrough.

Mr. WESTGARTH stated that when his firm decided to extend their business they acquired a site in Commercial-street, Middlesbrough, which appeared to be advantageous, except that it is divided into four parts by streets. Before they bought the site they considered carefully the question of motive power, because it was evident that it would be very expensive if a separate source of power had to be provided in each of the four sections of the works, but it was seen that the difficulty could be effectually overcome by the use of electricity. They arranged with Messrs. D. Selby Bigge and Co., of Newcastle-on-Tyne, to design the electrical details of the installation. A set of vertical triple-expansion condensing engines to work with steam at 200lb. pressure was erected. The cylinders are 14in., 23½in., and 39in. diameter by 24in. stroke, arranged to indicate 400 h.p. at 100 revolutions per minute. A Proell automatic expansion valve with high-speed governor is fitted, and a heavy flywheel is placed at each end of the crankshaft, each wheel driving one of the main dynamos. They decided to have a comparatively slow-running engine and to drive the dynamos with belts, because they thought that this

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arrangement would be the most serviceable for continuous work, and least likely to cause stoppage for repairs, which advantages they considered would more than balance the loss of power by the use of belts. The air-pump, which is on Edwards's patent principle, and the feed pumps are worked by levers from the centre engine, and a separate feed pumping engine is also fitted. The boiler is of the ordinary marine type, 10ft. diameter by 10ft. long, fitted with Howden's system of forced draught. The power station is so placed that the main machine shops, in which the heaviest work is done, can be driven by ropes directly from the engines, without the interposition of electricity. In addition to the main engines a vertical compound tandem engine with 50-horse dynamo is fitted in the engine-room for nightwork, or for use in case of breakdown. The two main dynamos are of the ordinary continuous type, working in parallel, each capable of giving out 150 h.p. at 450 revolutions. The dynamos, as well as most of the motors, were made by the General Electric Company of Liège, and have proved to be very satisfactory. The voltage is 240. Separate motors are fitted to only a few of the larger machines standing in such a position that driving belts would be an obstruction; otherwise the machinery is divided into groups of from four to a dozen, according to size, each group being worked from a main shaft driven by its own motor. This arrangement has been found in practice to work very satisfactorily; the average power exerted by each motor driving a group of machines being much less than would be required if each machine had a separate motor, in addition to which the first cost is materially reduced. In regard to electric gear for the travelling cranes, they adopted the use of one motor to each crane. The work is transmitted from the motor by a belt or ropes, which form an elastic medium connecting the machines, and is found to work very satisfactorily. The works are lighted from the same dynamos, with a separate system of wires from the switchboard. There are 52 arc lights and about 400 incandescent lamps on the works. Mr. Westgarth remarked that he could not give any definite figures as to results, because the plant was just completed when the present strike of engineers commenced; but so far as they can judge, the economy of fuel and working expenses is likely to be even greater than they anticipated. During the last few months their average indicated horse-power has been 307, and the average consumption of fuel (costing 7s. 6d. a ton) 541lb. per hour, but the boiler, in addition to supplying steam for the engines, has supplied one and sometimes two steam hammers. The average weight of water evaporated has been 5,110lb. per hour, so that the evaporation has been 10·1lb. of water per pound of coal burned. The average cost of coal has been 1s. 9½d. per hour, and the average cost of water 1⅝d. per hour. They have been employing about 480 men, and, judging from what the firm were doing before the strike, it appears that when they are employing 800 men the cost of fuel and water will really be very little more than the figures quoted above. These costs include the lighting as well as provision of power. The cost of maintenance is going to be very light. The total cost of the installation, including the motive power, has been about £10,000, and although this is a very large sum, the figures quoted above are quite sufficient to justify the outlay.

A paper was then read by Mr. D. Selby Bigge, of Newcastle-on-Tyne, on

Modern Practice in Electric Power Work and Recent Developments on the North-East Coast.

Mr. Selby Bigge remarked that in May, 1894, he read a paper before the Cleveland Institution of Engineers on the subject of the application of electricity as a motive power for various industrial purposes, dealing chiefly with its application to the driving of works' machinery. Since then great strides have been made, and electrical driving has passed out of its experimental and probationary stages and become a reliable system, to which every engineer can turn when contemplating the remodelling of old works or the laying down of new ones. In no part of the country has the progress made in electric driving been so marked and rapid as upon the North-East Coast—in fact, it may be said that the engineers of the Middlesbrough, Hartlepool, and North-East Coast districts have to a very large extent been the pioneers of the system in this country. Five years ago there was little to show in this country in the shape of driving works electrically, but North Country engineers were induced to visit the Continent to see for themselves installations, and to judge of the practical advantages of electric driving. The initiative in the North was taken in a small way at the works of Messrs. Dorman, Long, and Co., Limited, Middlesbrough; the system proved a success, was rapidly extended and developed, and found its way into the neighbouring works in the district. The following are the chief firms who have adopted the system of electric driving in the North of England: Dorman, Long, and Co., Limited, Britannia and West Marsh Iron and Steel Works, Middlesbrough; Charles Dorman and Co., Bedson Wireworks, Middlesbrough; Bell Bros., Limited, Clarence Ironworks, Middlesbrough, and Lumpsey Mines, Brotton; Carlin How Mines, Carlin How, Brotton; Sir Raylton Dixon and Co., Limited, shipbuilders, Cleveland Dockyards, Middlesbrough; R. Craggs and Sons, Tees-side Shipyard, Middlesbrough; Anderston Foundry Company, Limited, Port Clarence, Middlesbrough; Sir Christopher Furness, Westgarth, and Co., Limited, Tees-side Engine Works, Middlesbrough; North-Eastern Steel Company, Limited, Middlesbrough; Skinningrove Iron Company, Limited, Skinningrove Ironworks, near Loftus-in-Cleveland; Furness, Withy, and Co., Limited, Middleton Shipyard, Hartlepool; William Gray and Co., Limited, shipbuilders, West Hartlepool; Thomas Richardson and Sons, Limited, Hartlepool Engine Works, Hartlepool; Irvine's Shipbuilding and Dry Docks Company, Limited, Harbour Dockyard, West Hartlepool; Short Bros., shipbuilders, Pallion, Sunderland; R. and W. Hawthorn, Leslie, and Co., Limited, Hebburn Shipyard, Hebburn-on-Tyne; Tees-side Bridge and Engineering Company, Limited, Middlesbrough; Palmer's Shipbuilding and Iron Company, Limited, Jarrow-on-Tyne; C. S. Swan and Hunter, Limited, shipbuilders, Wallsend-on-Tyne; North-Eastern Marine Engineering Company, Limited; Sunderland Forge Company, Limited. Numerous installations have been started in other parts of the country. No more forcible instance of the application of electricity can be found than in those cases where it has been applied to the driving of shipyards or iron and steel works, which contain a number of scattered engines. Such machines as these are frequently very uneconomically driven, and it seems almost paradoxical to find marine engineers and shipbuilders who manufacture or employ engines of the highest efficiency known, and lay such stress upon low coal consumption, employing the most uneconomical methods possible in the driving of their own works. In many cases the ramification of steam-pipes alone form, as it were, a huge condenser, in which the greater portion of the steam is condensed before ever reaching the engines it is intended to drive. In some cases the total coal consumption has been found to be as great as 15lb. to 20lb., and frequently 10lb. of coal per horse-power of actual work done by the various machines throughout the works. From a central power station of modern design, the same power can be given out by the machines in any part of the works for an expenditure of 2½lb. to 3lb. of coal per actual horse-power of work done, inclusive of all losses in engines, dynamos, cables, switching gear, and motors. In the case of an ordinary sized works the loss in the transmission of power through the cables should not exceed 3 or 4 per cent. One of the most important and remarkable features of electric power installations is the very low cost of the annual upkeep. When once the plant is laid down, the maintenance over a number of years is exceedingly small—2 or 3 per cent. on the original cost of the plant. The repairs to the motors can almost invariably be carried out at the works. The results which have been obtained in the running of the different shipyards have been most encouraging and satisfactory. The first shipyard in this country to have been exclusively driven by means of electricity was that of Messrs. Furness, Withy, and Co., Limited, Hartlepool. The wear and tear on the machine tools themselves has been considerably decreased, owing to the very steady running of the motors driving the tools, the constant vibration of the steam-engines, which were previously driving these tools, having caused deterioration to the machinery. Taking a shipyard, it has been found that the greatest economy is obtained when the whole of the driving power is concentrated in one central plant, consisting of one, two, or three units, as the case may be. The average-sized shipyard can be driven electrically, exclusive of lighting, by an engine indicating no more than 200 h.p. to 300 h.p. When this power is concentrated in a triple-expansion engine using not more than 1½lb. to 2lb. of coal per indicated horse-power hour the economy derived is very great, as the majority of shipyards are necessarily most uneconomically driven, owing to the large number of scattered engines. Every machine in a shipbuilding yard can be driven electrically, with the exception of the steam-hammers in the forge. These hammers are a source of great waste. In the case of hydraulic machinery for driving jib cranes, riveters, manhole punches, etc., it has been found advisable to drive the electric pumps with a motor, leaving the hydraulic system alone as it exists. The power absorbed by the use of hydraulic pumps in connection with shipyards usually amounts to 40 h.p. or 50 h.p., and ample margin should be allowed for in the motors driving this class of machinery. Special electric winches have been designed for shipyard use, and have proved very serviceable. They are, as a rule, provided with 7-h.p. to 8-h.p. motors, and are capable of doing all that the steam-winches did before them, and in a very much more economical manner. The steam winches in a shipyard are generally a source of great waste of steam, as the pipes have to be usually laid underground, where it is hard to maintain them in good condition and avoid leakages of steam. All the outlying punches, shears, and this class of machinery can be very simply and quickly adapted from steam to electric driving. The sizes of motors usually employed are 5 h.p., 7 h.p., or 10 h.p. A noticeable point about the introduction of electric driving

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in shipyard work, is that the whole of the yard can be changed from steam to electricity without any real stoppage to a single machine in the yard. The motors are placed on their respective foundations, the wires laid to them, and switching gear and registering instruments fixed up, and at the dinner-hour the belt is removed, or the connecting rod of the engine taken off, and the motor is set to work. All that is necessary can usually be arranged to be done in the dinner-hour or at night-time. It may be taken that 300 e.h.p. is capable of driving at least 450 h.p. of motors in connection with regular shipyard work, and much the same proportion may be taken for installations of a similar nature. The author then gave a list of the various powers absorbed by shipyard and other machine tools when running light and heavy—*e.g.*, the double punch, large plate-bending rolls, punch and shear, angle squeezer, riveting machine, plate-planing machine, angle-cutting machine, countersinking machine, woodworking machinery, stern-frame boring, winch, cold saw, portable drill, etc. In iron and steel works the powers must be somewhat heavier, and the size of the plant necessary for driving of the works more powerful. In addition to the ordinary outlying machinery, shops, hydraulic plant, all the small live-roller gear engines, skid engines, capstans, winches, etc., can be advantageously replaced by electric motors. Plate rolls, angle rolls, and other similar machines are easily adapted for electric driving. In the case of purely engineering works, consisting of engine and boiler shops, the power is generally subdivided up into the driving of the various line shafts, large machine tools, blowers, overhead cranes, jib cranes, etc., while the electric lighting is always embodied in the power plant. As to the economical means of producing electricity where waste gases are available, boilers should be laid down to be driven off these gases. In ordinary cases, either compound or triple-expansion plants, working at high pressure of steam, and provided with the best condensing arrangements, should be made use of, otherwise half the advantages accruing from electric driving are lost. Above certain powers, say 150 h.p., direct compound plants running at moderately slow speeds are most suitable for electric driving. During the past year a fresh development has taken place in this country by the introduction of polyphase machinery, where the motors and generators are devoid of commutators and brushes, with the exception of small starting rings used only in the starting of the motors. There are many special advantages in connection with the use of polyphase machinery, as in the case of having to run machines a long distance off, the pressure being raised to any extent. In long-distance transmission, high-tension currents are made use of and transformed down again for use in the motors driving the works. In the case of works of limited area the voltage is practically no higher than that which is usually used with continuous-current machinery, and no danger to the workmen is possible. At Messrs. Thomas Richardson and Sons' engineering works at Hartlepool is one of the first installations on any large scale which has been laid down in this country upon this new system. The polyphase system has also been adopted in the North of England by the North-Eastern Steel Company, Middlesbrough; Messrs. R. and W. Hawthorn, Leslie, and Co., Hebburn-on-Tyne; and Palmer's Shipbuilding and Ironworks, at Jarrow. The field for electric power applications is opening up in all directions, and a large and increasing industry is being developed.

[Mr. Bigge's paper was illustrated by a large number of lantern slides, showing photos of existing machinery.]

DISCUSSION.

Mr. Westgarth, the president, said that the schedule of powers given by Mr. Bigge was very valuable and useful, just the sort of information that was needed, but which was hard to get. It would be of great use to those contemplating the putting in of installations. The questions to be taken into account were—first, the advantages of adopting electricity for distributing power in any works; next, whether the generating plant should be driven directly or by belts (he favoured the latter), and whether polyphase machinery should be put down.

Mr. R. J. Worth, of Stockton, considered the installations at Mr. Westgarth's works had been carried out in a most economical manner. He agreed that where large machines were concerned, each should have a separate motor. He could not, however, have adopted belt driving and allowed the driving of the whole works to depend upon the main belt. Belting was most expensive in its upkeep. He agreed with Mr. Selby Bigge that direct driving was preferable for large machines. With regard to the results mentioned by Mr. Westgarth relative to evaporation, they were very good, but certainly not better than were got with the Lancashire or Galloway boilers, which were much more easily got at and cleaned. As to electrical driving of foundry cranes, he had found that there was only one successful way of driving them—by means of an engine on the top. He would like to know whether the crane could work efficiently when electrically driven.

Mr. W. H. Panton (of Messrs. Dorman, Long, and Co., Middlesbrough) thought Mr. Bigge was right in saying that with large powers—anything over 200 h.p.—direct driving should be the rule. At Messrs. Dorman's works they had had two and a half years' experience, and nothing had gone wrong with the machinery, while its upkeep was very slight indeed.

Mr. Henry Withy (of Messrs. Furness, Withy, and Co., shipbuilders, Hartlepool) said they had had nearly three years' experience. The question of belt driving had occupied much of their attention. He was much in favour of it, because it enabled one to have a slow-running engine and a fast-running dynamo. The latter were smaller and cost less. At this yard last year, while they spent as much money as previously in producing power, they got 50 per cent. more work. That was the percentage of saving in electric driving.

Mr. E. H. Craggs, shipbuilder, Middlesbrough, mentioned that they had found electric driving very satisfactory, and he held that those who had not adopted it must come to it, and the sooner they did so the better.

A **Speaker** asked if there was much trouble with regard to sparking. He considered that electricity was very successful for putting in not readily accessible places—in coal-mines, for instance. He knew of pits which would have been flooded to this day if it had not been for electrical pumping machinery.

Mr. Charles Wood, Tees Ironworks, Middlesbrough, thought that the question of working foundry cranes by electricity had been satisfactorily worked out by Mr. Selby Bigge and the president. They provided a larger power than was generally necessary so as to have enough at starting.

Mr. F. H. Marshall desired to know whether electricity could be applied to the working of wharf cranes, which were costly to work, as steam had always to be kept on them, and there was a great deal of idle time.

Mr. Selby Bigge, in replying, said that with respect to foundry cranes there was not the slightest difficulty in working them by electricity. The only machine they had not succeeded in driving was the steam-hammer. It would be a great economy if wharf cranes were worked electrically, as they could be, because power need not be got up until the vessel arrived. He mentioned that gas-engines were used for providing the electric power not only at Messrs. Craggs and Son's at Middlesbrough, but also at Sir Raylton Dixon and Co.'s, and at Messrs. Short's, at Sunderland, where gas could be obtained very cheaply. Gas-engines had several advantages for producing power, but were not very suitable for electric lighting.

Mr. Westgarth said they had no trouble with sparking at the dynamos.

LEGAL INTELLIGENCE.

NICHOLSON AND TYLER v. LAWRENCE.

High-Efficiency Lamps and E.P.S. Accumulators.

This trial, which was commenced on Monday, the 2nd inst, before the official referee, Mr. Verey, and continued on the 8th and 12th inst., was a claim by Messrs. Nicholson and Tyler for £206. 5s. 6d., balance of a sum of £605 5s. 6d., the cost of an installation of electric light at the defendant's house at Kenley, Surrey. The defendant is the chairman of the Linotype Company.

Mr. Rufus D. Isaacs, instructed by Mr. Frederic Hudson (C. J. Smith and Hudson), appeared for the plaintiffs, and Mr. Noad, instructed by Mr. P. G. C. Shaw, appeared for the defendant.

Mr. E. Charrington and **Mr. G. L. Addenbrooke** gave evidence on the plaintiffs' behalf that the installation was a high class one in all respects, and that the system of high-efficiency lamps was an economical and advisable one where cost of current had to be considered.

Evidence was given on behalf of the plaintiffs that the number of lamps and their candle-power had been greatly increased beyond that mentioned in the specification, and that the defendant had increased the draught on the accumulators by substituting low-efficiency lamps for high-efficiency ones.

On behalf of the defendant, **Mr. E. W. Timmis**, **Mr. A. H. Preece**, and **Mr. Gorham** gave evidence that though the system of high-efficiency lamps was economical, it was not advisable, as the lamps commonly proved bad, and in their opinion the original accumulator supplied was not sufficiently large for the installation. As regards the rest of the work, they agreed that it was up to the specification and of high quality.

The **Referee** held that by the contract the plaintiffs were bound to provide an installation as therein specified. As to the question of the high-efficiency lamps, Mr. Charrington and Mr. Addenbrooke thought that reasonable care had been used, and that there was no fault on the part of the plaintiffs. The defendant's experts differed, but the Referee found that there was no evidence that the plaintiffs were wanting in skill, even assuming that they had to use their skill as electrical engineers and not merely as contractors. He was satisfied that the installation and accumulators would do the work they were originally specified to do, and that the extra accumulator and work were ordered by the defendant. As regards the other items, the only evidence that had been given on behalf of the defendant was that of Mr. Timmis, whose opinion seemed entirely to rest on the information supplied to him by Mr. Lawrence. Under these circumstances, he found for the plaintiffs for the full amount claimed, with costs on the claim, and also for the plaintiffs on the counterclaim, with costs. Judgment was entered accordingly.

SOUTH LONDON ELECTRIC SUPPLY CORPORATION.

Mr. Justice Channell had before him on Friday, in the Queen's Bench Division, an action brought by Mr. Tayler, a stockbroker, as assignee of a Mr. Goma, against Mr. Charles William Sax,

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electrical engineer, of 2, Woburn-square, W.C., for the sum of £500, the value of certain shares in the South London Electric Supply Corporation, in consideration for services rendered.

For plaintiff it was stated that in 1892 the Vestry of Lambeth had obtained a provisional electric lighting order, which, however, they were not desirous of carrying out. The defendant negotiated with them to obtain a transfer of the order, to form a company to take over and work the whole concern. Mr. Goma was in a position, as the defendant thought, to give assistance in the matter, and an agreement was entered into in January, 1896, in which defendant undertook to pay Goma £500 in shares, in consideration of his doing his best for him. Mr. Goma did all he could, and in December, 1896, the South London Electric Supply Corporation, Limited, was formed, the object being to obtain, by purchase, and work the Lambeth electric lighting order. The formal transfer of the provisional order was duly made direct from the Lambeth Vestry to the electric lighting company, the shares of which were now quoted on the Stock Exchange at from 1⅞ to 2⅛.

The defence was that the basis of the arrangement was that the defendant should get the direct transfer, and that he never did get. The agreement was also stated to be a mere anticipatory one, which was never entered into. The whole of the transfer arrangements were refused by the Board of Trade to the defendant, who, in consequence, ceased to have any interest in the matter.

Mr. C. W. Sax, the defendant, was called, and said the Lambeth Vestry agreed with him as to the transfer of the provisional order to the Vestry, subject to the approval of the Board of Trade. Subsequently he heard from the Vestry that the application to transfer had been refused. He had not received one single share, or one single penny. Cross-examined: He had associated himself with a Mr. Jacob Atherton in the promotion of the company to take over the electric lighting order. His original scheme had fallen through. He was aware that Mr. Atherton received a certain sum for doing what he did to promote the company, but he had never received anything from Mr. Atherton.

At this point his **Lordship** intimated that he did not see how the plaintiff could hope to succeed in establishing his claim, and he gave judgment for defendant with costs.—*Financial Times.*

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Londonderry.—The Corporation invite tenders for the supply of carbons for one year from January 1, 1898, particulars of which appear in our advertising columns.

Canterbury.—The Electric Lighting Committee of the Corporation are prepared to receive tenders for the supply and erection of plant, particulars of which appear in our advertising columns.

Dundee.—The Gas Commissioners are prepared to receive tenders for an economiser to be delivered and erected at the Electric Lighting Station, Dudhope-crescent-road, Dundee, particulars of which appear in our advertising columns.

London, W.C.—The Metropolitan Asylums Board invite tenders for the execution of certain additions and alterations to the electric fire alarm system at the South-Eastern Fever Hospital, Hatfield-street, New Cross-road, S.E., particulars of which appear in our advertising columns.

Hackney.—The Joint Public Health and Electric Lighting Committee of the Vestry are considering the question of lighting Hackney by electricity, either combined with a dust destructor or without, and are prepared to consider any scheme for this purpose from parties in a position to carry it out, particulars of which appear in our advertising columns.

Bishop Auckland.—The Guardians are prepared to receive tenders for the provision of telephonic communication between the several blocks of buildings at the Workhouse, Bishop Auckland. Full particulars can be ascertained on application to Mr. Wyld, master of the workhouse. Sealed tenders, properly endorsed, to be sent to Mr. Sam Adams, clerk, Bishop Auckland, by November 24.

Madrid.—The Government Telegraph Department invite tenders for 25,000 insulators. The estimated maximum cost is one peseta per piece, and the deposit required is 5 per cent. preliminary, 10 per cent. final. Particulars may be obtained and models seen, at the Offices of the Department (Office No. 7), at Madrid; or at the Civil Government Offices at Barcelona and Leon. Tenders by November 21.

York.—The North-Eastern Railway Company invite tenders for the following articles in such quantities as they may require, during six months ending June 30, 1898, delivered carriage paid at the telegraph stores at York: (1) telegraph apparatus; (2) telegraph wires and line stores. Payment for each month's delivery will be made at the end of three clear months, or in cash, less 2½ per cent. discount. Forms of tender may be obtained on application to Mr. Graves, Telegraph Department, York, and tenders must be sent to the Secretary at York, sealed and marked "Tender for Telegraph Stores," by noon on 22nd inst.

Blackburn.—The Blackburn Corporation Tramways Company are prepared to receive tenders for eight tramcar bodies, with trucks, motors, controllers, trolley poles, etc. Specification, general conditions, and form of tender may be had on payment of £2. 2s., returnable on receipt of a bona fide tender upon the prescribed form and within the stated time. Drawings and plans of route may be inspected at the office of Mr. E. M. Lacey, engineer, 10, Delahay-street, Westminster. Sealed tenders, addressed to Mr. J. W. Baker, secretary, Blackburn Corporation Tramway Company, Railway-road, Blackburn, and endorsed "Electric Tramcars," to be delivered to him by 12 noon on 27th inst.

Leicester.—The Sanitary Committee invite designs and tenders for motor vehicles for the collection of house refuse. The motive power, capacity, and all other particulars are to be described in a full specification, accompanied by drawings and delivered at the office of Mr. E. George Mawbey, C.E., borough engineer and surveyor, Town Hall, Leicester, addressed to the Chairman of the Sanitary Committee, by January 31. The loaded wagons would have to ascend an incline of 1 in 20, turn in a limited space, back and tip over a beam about 14in. high by 12in. in width, and when empty descend a road having a gradient of 1 in 15. The Committee do not bind themselves to accept any proposal, and firms tendering must do so at their own cost, no fees being allowed for the preparation of drawings, etc.

Blackpool.—The Corporation are prepared to receive tenders for the following works required in the conversion of their present system of electric traction: (Section A) steel columns, brackets, and straining posts; (B) trolleys, trolley wire, and insulators; (C) controllers, motors, and gearing; (D) main and section fuses. Tenders will be received for one or more sections, but not for part of a section. Specification, general conditions, and form of tender may be had on application to Mr. Robt. C. Quin, borough electrical and tramway engineer, Corporation Electricity Works, Blackpool, on prepayment of £2. 2s., which will be returned on receipt of a bona fide tender upon the prescribed form, and within the stated time. Drawings and plan of route may be inspected at the office of the Borough Electrical Engineer during the usual office hours. Sealed tenders, addressed to the Chairman of the Electric Lighting and Tramways Committee, and endorsed "Tender for Traction Material, Section —," to be delivered to the Borough Electrical Engineer by 10 a.m. on November 22.

Madras.—Tenders are invited for the utilisation of water flowing from the Periyár Lake for purposes other than irrigation and not incompatible with the use of the water for drinking. The irrigating season extends over nine to ten months, during which time the discharge is likely to be from 1,100 to about 500 cubic feet a second, according to the demands for irrigation and the available quantity in the lake. Subject to the risk of interruption by accident or drought, supply can be given throughout the irrigation season. No supply can be guaranteed at other times, but, so long as water is available, the Government will be prepared to issue it in such daily quantities as may seem to it advisable with reference to the time which is likely to elapse before the supply is replenished by the setting in of the rains. The fall from the tunnel to the foot of the hills is approximately 900ft., and the distance measured along the course of the stream about 6,800ft. One cubic foot per second falling 900ft. is estimated to produce over 60 effective horse-power. Intending lessees should state the quantity of water required in cubic feet per second and the annual rent offered for each cubic foot per second. No rent will be charged for the first year from the date of the concession; for the second year the charge will be one-fifth, and an additional charge of one-fifth will be made every year until the full rent is reached. The whole or part of the concession may be surrendered on a year's notice being given. Lessees will construct at their own expense, on plans to be approved by Government, all the weirs and other works required to divert the water from the river below the tunnel. For further information, application may be made to the Chief Engineer for Irrigation, Madras, by whom tenders will be received up to July 1, 1898.

RESULTS OF TENDERS.

Cheddleton.—The Staffordshire County Council have accepted the following tenders: Mavor and Coulson, Limited, Glasgow, electric generating and storage plant, £6,240; Walsall Electrical Company, electric wiring and fittings, £3,195. 16s. 6d.; Tangyes and Co., sets of pumps to deep well, £690.

BUSINESS NOTES.

Blackpool.—The Tradesmen's Executive have appointed a deputation to ask the Electric Lighting Committee for a reduction in their scale of charges.

Perthshire.—It is understood that the plans of the proposed light railway from Strathord to Bankfoot have been passed by the committee of the County Council of Perthshire.

Willans and Robinson.—The registers of debenture stockholders and of transfers will be closed prior to the payment of interest from to-day to 29th inst., both days inclusive.

Dover.—The railway company intends to apply for powers to close a dangerous crossing known as the Crosswall. To carry out this scheme a portion of the electrical tramline will have to be diverted.

Luton.—The following gentlemen have been elected members of the Electric Lighting Committee for the ensuing year: Messrs. Hucklesby, Smith, Cumberland, Garrard, Rayner, Ellery, Harman, and Wilkinson.

Middleton.—Mr. S. V. Clirehugh, M.I.E.E., of Manchester, has been requested by the Council to prepare a report on the electric lighting of the boroughs of Middleton (Lancashire) and St. Annes-on-Sea.

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Monmouth.—The corporate seal has been fixed to the lease of the electricity supply station from the Marquis of Worcester to the Corporation. The lease is for 99 years at a rental of £80.

Branch Office.—The General Electric Company, of London and Manchester, have opened a branch in Dublin, under the management of Mr. Fletcher, who has had some years' experience with the company in London.

New Firm.—We are informed that Messrs. Ball, Wylde, and Co. have just started in business at 9-10, Fenchurch-street, E.C., as import and export merchants and agents for all electrical supplies and machinery.

Radcliffe.—At a meeting of the Electric Lighting Committee it was resolved that the committee visit the Shoreditch and Leyton electric lighting works at the same time as the Sewage Committee visit the Hendon sewage works.

Eccles.—The following gentlemen have been elected members of the Electric Lighting Committee for the ensuing year: Alderman Kendall; Councillors Broughton, Corner, Hindley, Mort, Oldfield, Pearson, and Plews.

Musselburgh.—We hear that a company is being promoted in Musselburgh whose object will be to produce an electric light supply for the town. Water power will be obtained from the mill lade, which runs through the burgh.

Bedford.—The sanction of the Local Government Board has been obtained to borrow the further sum of £19,650 for electric lighting purposes, such sum to be repaid within a period of 25 years from the date of borrowing the same.

Glasgow. — We understand that the Tramway Committee fixed a visit to Dublin to inspect the electricity works on Saturday last. The committee decided on the 15th inst. to order engines of the McIntosh and Seymour type.

Bristol.—The following gentlemen have been elected members of the Electric Lighting Committee for the ensuing year: the Mayor; Aldermen Pethick and Hall; Councillors Tryon, Hughes, Lloyd, Pearson, Elkins, Billing, Harris, Moore, and Lowe.

Brighton.—The Lighting Committee for the ensuing year is constituted as follows: Aldermen Botting, Sir J. Ewart, and Moon; and Councillors Briant, Broadbridge, Butt-Thompson, Galliers, Halliwell, Holloway, Inskip, Richards, and Stafford.

Lancaster. — The following gentlemen have been elected members of the Electric Lighting Committee for the ensuing year: Aldermen Kitchen, Smith, and Bell; Councillors Preston, Hall, Storey, Leeming, Heald, Warriner, Little, and Huntington.

Dublin.—The Dublin United Tramway Company's extension of their electric system between Annesley Bridge and Dollymount was opened for traffic on the 11th inst. The public can now travel from Nelson's Pillar to Dollymount for 2d.—a reduction of 1d. on the old fare.

Morley.—The following gentlemen have been elected members of the Electric Lighting Committee for the ensuing year: the Mayor; Aldermen Stockdale, Johnson, and Armitage; Councillors Watson, Rhodes, Horsfall, Glover, Haigh, Hirst, Craven, Jowett, and Scholes.

Wakefield. — The following gentlemen have been elected members of the Electric Lighting Committee for the ensuing year: Alderman Sherwood; Councillors Bolton, Clapham, Cookson, Cradock, Fallas, Harrison, Ianson, Nicholson, Rhodes, Smith, and Wigham.

Catalogues.—No. 12 of the "General Electrical Progress," issued by the General Electric Company, contains particulars of heating apparatus, a motor for desk fans for continuous current, a short Solar arc lamp for use where headroom is limited, telephones for church use, etc.

Stonehouse.—It is proposed that the electric lines should be laid in the first instance in the following streets: Union, Edgcumbe, Chapel, Durnford, Barrack-place, Caroline-place, Victoria-place, Millbay-road, Buckingham-place, Phœnix, Manor, and High streets.

Coventry.—The following gentlemen have been elected members of the Electric Lighting Committee for the ensuing year: Aldermen Banks, Hill, and Tomson; Councillors Armishaw, Booth, Calcott, Drinkwater, Johnson, Morton, Robinson, Statham, Turrall, and West.

Burton.—A resolution has been passed by the Town Council respecting the declaration of a standard pressure of electrical energy for the distributing mains and the constant pressure at customers' terminals. It was decided to adopt the present pressure as standard.

Norwegian Mica Company.—We are informed that this Company, which is working mines of mica in Norway, has opened offices in Christiania, Norway. Johan H. L. Vogt, professor of mineralogy at the University of Christiania, and Mr. Henry E. Mohn, C.E., are the directors.

Plymouth. — The following gentlemen have been elected members of the Electric Lighting Committee for the ensuing year: Messrs. Radford, Bray, James, Jinkin, Coumbe, Elliott, Williams, Debnam, Edgcumbe, Vickery, Marshall, Stanbury, Woollcombe, Geake, and Hilson.

Gloucester.—The following gentlemen have been elected members of the Electric Lighting Committee for the ensuing year: the Mayor, *ex-officio*; the Deputy-Mayor; Aldermen Trevor Powell and Mousell; and Councillors Karn, Clutterbuck, Allen, J. Clarke, King, Woodward, Ford, and Radford.

Fowler-Waring Cables Company, Limited.—We are informed that Mr. H. F. Harris, 40, Merrion-avenue, Blackrock, Dublin, has been appointed as the agent in Ireland for the supply of all types of both lead-covered and rubber-covered electric light and tramway cables made by this Company.

Barrow.—The following gentlemen have been elected members of the Electric Lighting Committee for the ensuing year: Aldermen Fish, Townson, and Wansbrough; Councillors Ashburner, Atkinson, Bell, Bradshaw, Chapman, Cox, Hardy, W. Hewetson, Jos. Huartson, Lee, Smith, Wright, and Young.

Southport. — The following gentlemen have been elected members of the Electric Lighting Committee for the ensuing year: the Mayor; Aldermen Hacking, Vaughan, and Wood; Councillors Ashton Barlow, Bradshaw, Foggitt, Hayward, Hesford, Hulme, Jones, W. Jones, Travis, and Watson.

New Books.—We have received a book, entitled "Steam-Boilers," from Messrs. Yates and Thom, being their illustrated catalogue of boilers. The work was written and compiled by Mr. H. Fowler.—We have also to acknowledge the receipt of the "'Mechanical World' Pocket Diary and Year Book for 1898."

St. Mary Abbotts (Kensington)—Notices and plans having been received from the Notting Hill Electric Light Company, and the House-to-House Electric Light Supply, relative to extensions of their mains in this parish, the Vestry have given permission for the works being proceeded with subject to the usual conditions.

Manchester. — The following gentlemen have been elected members of the Electric Lighting Committee for the ensuing year: the Lord Mayor; Aldermen Griffin, Higginbottom, and King; Councillors Arrandale, Bax, Bishop, Saxon, Dreyfus, Jennison, Lambert, Lloyd, Mainwaring, J. Phythian, Saxon, and M. Wells.

Middlesbrough.—At the first meeting of the newly-elected Streets Committee, permission was granted to the Imperial Tramways Company to lay a double line at the high end of Newport upon conditions that they enter into an agreement that they would remove the same if found unworkable or inconvenient to traffic after seven years.

Walsall.—The Electric Lighting Committee recommend that, with a view to meet the increasing demand for electric current, the necessary additional plant, including engine, dynamo, transformers, and cables, be provided at a total cost of £7,000 and that application be made to the Local Government Board for their sanction to a loan for that amount.

"Rhodesia."—This is the title of a new African sixpenny weekly, published in the City by the Rhodesia Publishing Syndicate, Limited, under the editorship of Mr. Alexander Davis. In the opening leader the editor states that having an absolutely free hand he will be fearless in criticism, whether directed against Government measures, financial groups, or individuals.

Penarth.—A meeting of the Parliamentary Committee of the Penarth District Council was held on the 15th inst. for the purpose of considering the proposed Bill for the electric tramway between Grangetown and Penarth. A sub-committee was appointed to go minutely into the clauses of the Bill and report at another meeting of the Parliamentary Committee to be held next week.

Huddersfield.—The following gentlemen have been elected members of the Electric Lighting Committee for the ensuing year: the Mayor; Aldermen Calvert, Haigh, Hellawell, and Kendall; Councillors Armytage, Firth, Hesketh, Holroyd, Longbottom, Marshall, Marsland, T. Mellor, Robinson, Roebuck, Sterry, Whitehead, Whittell, Woolven, Shaw, Joel, Crosland, and Cartwright.

Rawmarsh.—The monthly meeting of the Rawmarsh Urban District Council was held on the 17th inst., when there was considerable discussion relative to the question of electric lighting, the Council having already decided to take steps to obtain a provisional order. In answer to a question whether any further action had been taken, the Chairman said that a deputation had gone that day to Sheffield to glean information.

Appointment Vacant.—The States of Guernsey require a thoroughly competent telephone foreman to superintend construction of the Guernsey exchange, at a commencing wage of 45s. per week. Permanent and improving position is offered to a good man. It is stated that applications, which will be treated as strictly confidential, are to be made to Mr. A. R. Bennett, 44, Manor Park-road, Harlesden, London.

Glasgow.—A meeting of the Electricity Committee of Glasgow Corporation was held on the 16th inst. to consider the applications sent in for the post of chief electrical engineer, rendered vacant by the resignation of Mr. Arnot. Altogether 33 applications have been received, including some from distinguished men in London. A sub-committee was appointed to draw up a short list. The salary attached to the office is not less than £800 a year.

General Power Distributing Company.—The formation of a company is contemplated with the object to erect a central station at the coalfields for the production of electricity direct at a much smaller cost than has hitherto obtained. We understand that the British Thomson-Houston Company is interested in the matter. Among the towns included in the area are Derby, Nottingham, Ilkeston, Newark, Mansfield, Lincoln, Gainsborough, Retford, Worksop, Doncaster, Chesterfield, Sheffield, and Rotherham.

Leeds.—The new line of tramway, running from Call-lane, on the Marsh-lane system, by York-street and Burmantofts-street to Beckett-street, and thereby affording an alternative route to Roundhay Park, was formally opened on the 13th inst., when a car containing Councillor Hannam (chairman of the Highways Committee), Councillors Smith and Batley, Mr. T. A Prince, and Mr. Wharem, made a successful trial run over the whole route.

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Maidenhead.—The Town Council have adopted the first report of their Electric Lighting Committee, which states: "It being necessary to define an area in which the Council will be under the obligation of laying distributing mains within a period of two years after the commencement of the provisional order, the committee recommend that High-street and Queen-street shall comprise this area." The area is specified as above in the advertised notice of the order.

Harrogate.—The electrical engineer's report has been adopted by the Council, and it has been resolved that the tenders for additional plant be opened by the mayor, town clerk, and electrical engineer, and tabulated for the committee. The engineer has submitted an application from Mr. Wm. Ingham, Harlow Heath, Otley-road, for electrical energy, and it has been resolved that the main be extended from the end of Beech Grove to Harlow Heath at an estimated cost of £44.

Hove.—The intention of the British Electric Traction Company to apply to the Light Railway Commissioners for an order authorising the construction of light railways in Brighton and Hove has been discussed by the Hove Urban District Council. The company have projected three routes, one of them being the line ascending the hill from North-street to the Dyke-road. The Legal and Parliamentary Committee's decision to oppose the application at all stages was unanimously confirmed.

West Bromwich.—A special meeting of the Town Council was held recently for the purpose of considerating the advisability of applying to the Board of Trade for a provisional order for the supply of electricity for public or private purposes in the borough. It was decided that the area of supply should be from Roebuck-street to Wednesbury Bridge, and from Carter's Green to the borough boundary at Great Bridge. The further consideration of the matter was left to the Gas Committee. The estimated cost of adopting the scheme is £20,000.

Bangor.—The following gentlemen have been elected members of the Electric Lighting Committee for the ensuing year: Aldermen Langford Jones, Thomas Lewis, and D. Cameron; Councillors Grey Edwards, T. G. Williams, John Williams, Edward Jones, Richard Davies, W. T. Roberts, W. Bayne, and J. E. Roberts.—Application is to be made to the Local Government Board for sanction to borrow £400 for the completion of the purchase of a site for the electricity station.

Stockport.—The following gentlemen have been elected members of the Gas and Electric Lighting Committee for the ensuing year: Aldermen Sir Joseph Leigh, J.P., Henry Turner, J.P., Joseph Worrall, James Whittaker; Councillors J. T. Barnett, John R. Clarke, W. H. Gradwell, J. G. Johnson, J.P., William Johnson, Richard Lievesley, William Lister, Hyde Marriott, George Pollitt, Robert Redfern, F. R. Robinson, J.P., R. Shuttleworth, John Turner, J.P., Thomas Trayner, Thomas Webb.

Rhyl.—At an adjourned meeting of the Urban District Council the Road Committee reported that the chairman had introduced the question of supplying electric light for the sea-front of the town, and submitted an estimate of the cost by Mr. Hall of £4,250, the annual loan charged on which would be £170. It was resolved to request Mr. Hall to prepare an estimate for supplying the lake grounds only as an experiment. The question of proceeding to the Board of Trade for a provisional order for electric lighting this year was confirmed by the Council.

Dingwall.—A meeting of the Provisional Committee of Dingwall and Strathpeffer Electric Lighting Company was held on the 15th inst., when a number of preliminary details connected with the joint schemes was considered. The electrical engineer is Mr. Yorke, Glasgow, and the agent for the proposed company is Mr. E. J. Gunn, solicitor, Dingwall. Sir W. J. Bell of Scatwell, LL.D., presided at the meeting, and the capital of the company is understood to be fixed at £12,000, but it is said that not more than £10,000 will be at present issued.

Self-Propelled Traffic Association.—The Liverpool and district centre of this body have issued particulars of a competition for motor vehicles for heavy traffic they intend holding from Tuesday, May 24, 1898, until the following Friday. The chief object of the trials is to arrive at a type of heavy motor-wagon suitable for trade requirements in Liverpool and neighbourhood, which shall be capable of economically taking the place of horse haulage and of competing with the existing railway rates, in the transport of heavy loads of goods over considerable distances.

O. Berend and Co.—We have received from the above firm a copy of their new trade price-list of switches, cut-outs, resistances, and general accessories for electrical installations. The catalogue is well got up and illustrated, and shows that the firm are carefully standardising their manufactures. We object, however, to the dimensions of the switches being given in millimetres instead of in inches. The value of the switch itself is not changed by this fact, but in some quarters the defect may cause mistakes. The high-tension switches and automatic gear are worthy of special notice.

Bradford.—The following gentlemen have been elected members of the Electric Lighting Committee for the ensuing year: the Mayor; Aldermen J. Cowgill, W. Lister, C. L. Robinson, W. Moulson, Priestley, and J. Whitley; Councillors W. Armitage, J. Arnold, W. E. Aykroyd, W. H. Barker, W. E. Booth, T. Crossland, W. Moulson, W. C. Dixon, E. Dobson, C. E. Dowson, J. Freeman, H. Gray, J. Hayhurst, W. Jennings, W. Knight, J. M. Peel, W. E. B. Priestley, H. B. Ratcliffe, G. H. Robinson, T. H. Shaw, J. H. Stott, J. S. Toothill, D. Wade, J. Whittingham, T. A. Williamson, and H. S. Wright.

Limehouse.—At a previous meeting the Board of Works decided to refer the question of electric lighting to the Works Committee, with an instruction to the committee to enquire of the Shoreditch Vestry the cost of working, etc. The Shoreditch Vestry have now written stating that no return of the expense of working the dust destructor and electric lighting plant had been prepared, but when it was they would forward a copy to the Board. At the last meeting the Board of Works agreed that the subject remain in abeyance until the return was received.

Guildford.—The Town Council have decided to replace the present modern clock dials (which are opaque glass, and are illuminated from the inside by means of eight gas lights) with the original dials. These are very ancient, and have a solid copper framework, which is to be gilt-relieved. The lighting will now be by means of electricity from the outside of the clock face. Four powerful lights will be placed on each side of the dials. These will be controlled from switches in the town hall. The contract for the work has been placed in the hands of Messrs. H. Fentum Phillips and Co., of the Guildford Electrical Works.

Colwyn Bay.—The Light Railway Commissioners, Lord Jersey and Colonel Boughey, held an enquiry at Colwyn Bay, on the 11th inst., into an application made by the Light Railway and General Construction Company for an order from the Board of Trade conferring powers to lay down a light railway between Colwyn Bay and Llandudno. There was considerable opposition, and it was ultimately decided to suspend the decision *sine die* pending the result of the application of the Llandudno Council for a provisional order, Mr. Lloyd, on behalf of the landowners, reserving the right to re-enter the protest at a future date if necessary.

Aberdeen.—At the meeting of the Town Council on the 12th inst., the draft order to be presented in the next session of Parliament, authorising the Council to purchase and acquire the tramway system at present owned by the Aberdeen District Tramways Company, was approved, and orders were given that it should be published.—The estimated annual cost of the electric lighting of the quays, taking the current from the Corporation, will be £1,700, but towards this the Town Council will give an annual contribution of £250 in respect of the lighting of the pavements, which reduces the net cost to the Harbour Commissioners to £1,450.

Sandgate.—At the last ordinary monthly meeting of the Urban District Council Mr. F. Hall, of Folkestone, solicitor to Mr. Fraser, engineer of the Folkestone Electric Tramway Company, attended with a view to obtaining the approval of the Council to the general principles of the scheme. After some discussion, the report of the General Purposes Committee recommending the Council to approve the scheme was read, and after the explanation of a number of technical details, the report of the committee approving of the principles of the scheme, together with the clauses and conditions drawn up by Mr. Hall for the protection of the Council, was adopted.

Dudley.—The Earl of Jersey and Colonel Boughey, Light Railway Commissioners, held an enquiry on the 13th inst. into the application of the British Electric Traction Company for an order to construct light railways in the district of Dudley and the neighbouring townships. The scheme extends over eight miles, and the construction of electric tramways on the overhead-wire system is proposed. The only opposition was from the Dudley Town Council, and after a very long enquiry a portion of the tramway was allowed, but the decision was reserved, with a recommendation for a mutual arrangement between the Town Council and the promoters.

Applications for Orders.—Within the last few days notice has been given of the intention on the part of seven local authorities to make application to the Board of Trade, under the Electric Lighting Acts of 1882 and 1888, for provisional orders to supply electricity for public and private purposes. These authorities are the Urban District Council of Barnes, the Vestry of the parish of Bermondsey, the Corporation of Maidenhead, the Urban District Council of Willesden, the Urban District Council of East Ham, the Urban District Council of Aldershot, and the Corporation of St. Albans. Mr. James de Lara Cohen, of Acton, has given notice also of his intention to apply for a provisional order for the area known as the Friars-place Estate, Acton.

Taunton.—The following gentlemen have been elected members of the Electric Lighting Committee for the ensuing year: Aldermen Potter, Fowler, and Goodland; Councillors Gibbs, Hammett, Kite, Lewis, Norman, Price, Sibley, and West.—Mr. Ed. B. Thornhill, electrical engineer, has reported to the Town Council that the Babcock boiler, which they had permission to order in April last, had been erected, and had been running satisfactorily with the other boilers. They had been running the small engine and alternator during the day for the past month, and had had a very fair demand for light. During the past quarter there had been a very satisfactory increase in the lamp connection, the equivalent of 83 16-c.p. lamps having been joined up.

Weston-super-Mare.—At the last monthly meeting of the Town Council it was proposed, according to notice given, "That the following resolution, passed by the committee of the whole Council on October 11 last, and subsequently confirmed by the Council, be rescinded—viz., 'That scheme No. 2 be adopted, subject to such modifications (if any) as may be considered desirable, and that an early interview be arranged with Mr. Hawtayne, to discuss with him what modifications (if any) should be made in the scheme, before applying to the Local Government Board for such sum of money as may be required for carrying out such portions of the scheme as may be decided upon.'" A lengthy discussion followed, after which the motion was defeated by 10 votes to 8.

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Bootle.—At the first meeting of the new Council a letter was received from the town clerk of Liverpool, intimating that the provisional order proposed to be obtained by the Corporation of Liverpool in the ensuing session will not include any new tramways in Bootle, or any connecting lines between proposed tramways in Bootle and the existing tramway system. It was then decided that the resolutions of the Council on October 13 and 27 last, directing that steps be taken to obtain, in the ensuing session of Parliament, a provisional order authorising the construction of new tramways be rescinded, and that the General Purposes Committee bring up a further report upon the matter in due course.

Personal.—The *Dunstable Borough Gazette* publishes a biography of the newly-elected mayor, Alderman Frederick Turner Garrett, from which we quote: "Very early in life Alderman Garrett took up the study of electricity, and this explains his great enthusiasm in that direction. He has been engaged in all the principal electric lighting work executed in the neighbourhood, and is at present giving us the first example of electric lighting in business premises in Dunstable by installing a plant in his own place. He is a partner in the firm of F. T. and A. Garrett and Co., of 41, Gold-street, Northampton, who are at the present time carrying out extensive electric lighting and other work at Harefield Grove, near Uxbridge, at Byfield and Brackby in Northamptonshire, and at other places."

Poole.—The Streets and Highways Committee have reported to the Town Council that a letter was received from the Bournemouth, Boscombe, and Westbourne Omnibus Company, Limited, stating the intention of the company to apply for powers to construct a tramway from Poole to Bournemouth, and asking the assent of the Council to their scheme. A letter was also received from Messrs. Burt and Haviland, on behalf of another syndicate, stating that they were proposing to apply for parliamentary powers to lay down an electric railway between Poole and Bournemouth. It has been resolved that the town clerk be instructed to reply that the committee will be prepared to meet the promoters and engineers of both schemes in consultation, and will then give the matter their consideration.

Ashton.—The Town Council have written to the British Electric Traction Company, suggesting an extension of the time prescribed by the agreement between the Corporation and the company within which the sanction of the Local Government Board to the borrowing of money was to be obtained. It was stated at a Council meeting that, owing to the engineers' strike, the work of proceeding with the laying of the apparatus for lighting the town with electricity could not be proceeded with. The wires were laid, the building erected, and the scheme was there at a standstill.—The new Electric Lighting Committee consists of the Mayor; Aldermen Heginbottom, Hilton, Siddall, and Wilson; Councillors W. Andrew, Catlow, Hall, Hallam, Kelsall, A. E. Mellor (chairman), Newton, Phillips (deputy-chairman), A. Shaw, and E. Shaw.

Ealing.—The District Council have received a number of communications from the British Electric Traction Company with reference to its application to the Light Railway Commissioners for an order authorising the company to construct a light railway along the Uxbridge-road from Acton through Ealing to Hanwell. The company stated that the line would be laid in the manner usually employed in tramway construction, and would be worked by electricity on the overhead system. At the meeting held to consider these the Vice-Chairman said the matter had been before the Highways Committee of the Middlesex County Council, and it had been decided to refer it to the county surveyor, and also to ask the opinions of the district councils affected. He moved that the clerk enter notice of dissent to the proposal, and take all necessary steps to oppose it. The proposition was carried unanimously.

Yarmouth.—At its last meeting the Council resolved to apply for leave to borrow the further sum of £1,200, making £12,000 in all, for the purpose of erecting the destructor as designed, the balance, after providing for two items connected therewith, being for contingencies. The monthly financial statement relative to the electric lighting supply showed that the income was £411. 5s., while the expenditure for production was £203. 11s. 2d. The cost of capital and sundry charges amounts to £190 per month. The total expenditure for building and machinery was £19,337. 11s. 8d. Messrs. W. J. Crompton and Co. wrote submitting a scheme under which the Corporation might carry out the work of wiring and fitting-up houses, shops, works, offices, etc., under an agreement with the firm. The town clerk was directed to convene a special meeting to consider this. The Electric Lighting Committee have decided not to provide motors and other plant on hire at present, as the length of time allowed for repayment of loans was too short to permit of a sufficient return to warrant outlay for such an undertaking.

Sydney.—The Commissioners of Railways of New South Wales (Mr. Charles Oliver and Mr. W. M. Fehon) in their report for the year ending June 30, 1897, state, referring to the proposed city railway extension now under co sideration by the Public Works Committee: "The proposed extension of the railway into the city is a matter which demands some mention in this report, in consequence of the absolute necessity for a decision in the matter. The time has arrived when it must be emphatically stated that the passenger business by steam trams cannot longer be conducted at Redfern with reasonable convenience to the public, or without unnecessary risk. The accommodation is inadequate, and consequently there is, notwithstanding the exercise of the utmost care and the use of all modern appliances for safe working, an element of danger which would not attach to a terminal station arranged to meet traffic requirements. For the daily business the accommodation is below what is required, and for holiday or exceptional traffic it is very deficient. We trust that the question of the extension of the railway into the city will be finally dealt with on an early date."

Proposed Light Railway on Tyneside.—At a special meeting of the Whitley and Monkseaton Urban District Council held last week for the purpose of considering the Tynemouth and District Light Tramways Order, the following resolutions were adopted: (1) "That the Council dissent from the property of the Urban District Council being taken by the British Electric Traction Company, Limited, for the purpose of the North Shields, Tynemouth, and District Light Railway, on the ground that, in the opinion of this Council, there is no necessity for a light railway in this district, and on the further ground that the promoters propose to lay down what is, in fact, a street tramway, for which powers ought to be obtained under the Tramways Act, 1870, and that the seal of the Council be affixed to the form of dissent." "(2) That the Council oppose the granting of an order by the Light Railway Commissioners to the British Electric Traction Company, Limited, for the construction of the North Shields, Tynemouth, and District Light Railways, and that the clerk be authorised to take the most efficient steps to defeat the action of the British Electric Traction Company."

Morley.—The following report has been adopted by the Town Council: "That the town clerk be instructed to prepare an agreement with Mr. Scatcherd *re* sub-station in South Nelson-street, and that any alterations to same which may be required when the street is paved be made by the Corporation; that the engineer report on the wiring of the town hall, and state probable cost of any alterations and repairs that may be required, and that the present arc lamps be changed for two 300-c.p. incandescent lamps; that Mr. Drewitt be appointed as improver, to be taken on as assistant on January 1, or, should the works be started prior to that date, from date of first supply; the chairman reported that Mr. George Tucker had been engaged as a fitter, from the 29th inst., at £2 per week; the committee considered the manner in which the various contracts were being carried out, and, as it appeared that the chief delay rested with the Electric Construction Company, it was resolved that the chairman and engineer go to Wolverhampton and point out to the company the great inconvenience caused by the delay, and endeavour to arrange for immediate delivery."

Ayr.—The report by Mr. Fuller, the engineer of the Ayr burgh electricity works, which was adopted by the Council, states that during the last month the laying of two high tension feeders has been completed. Advertisements have been inserted in this week's papers inviting tenders from firms willing to undertake the free wiring. These tenders will be laid before the committee as soon as they arrive. As the dynamo makers are not nearly ready, while the engines are, it is thought very advisable to take immediate delivery of the engines. In order to meet the demand for current in the Newton district, arrangements have been made for the fitting-up of a sub-station. Another transformer and box will be laid down at the junction of Wallace-street and George-street connected by a high-tension feeder from Main-street. A report by Mr. Robert Hammond on the progress made by contractors on the plans in course of construction for the electricity works has also been submitted, and the committee have instructed the town clerk to intimate to Mr. Hammond that, in their opinion, he should have a representative on the ground to superintend the work, particularly from the time when the engines come until they are completed.

Derby.—The following gentlemen have been elected members of the Electric Lighting Committee for the ensuing year: Aldermen Bennett and Woodiwiss; Councillors Butterworth, A. Ottewell, Eaton, Fletcher, Foster, Haslam, Laurie, Stone, and Wilkins. The Electric Lighting Committee have reported to the Council that tenders for transformer boxes, etc., and dynamo and engine, in connection with the extensions had been invited, and the contracts as under awarded: Messrs. Crompton and Co., £867. 5s., transformer boxes, etc.; Messrs. Ferranti, Limited, £7,132. 10s., dynamo and engine, as noted in our last issue. The electric lighting station, by permission of the Watch Committee, had been connected with the fire-station system of telephones. The assistant engineer (Mr. Moss) had been allowed £15 per annum in lieu of apartments at the electric light station. The wages of J. Thexton (stoker) had been raised from 25s. 1d. to 26s. 1d. per week. An extra man had been engaged for the winter months at 25s. 1d. per week, and a draughtsman had been engaged for three months at 25s. per week. A feed-water softener had been purchased from Messrs. Macphail and Simpson at a cost of £316, inclusive of pipe connections. The above accounts are included in the sum of £20,000 granted by the Council in April last. The report has been adopted.

London County Council.—At its last meeting applications from the House-to-House Electric Light Supply Company, of intention to lay low-tension mains were granted on the usual conditions; also an application from the Charing Cross and Strand Electricity Supply Corporation of intention to lay conduits for 10 mains. The cables are to be laid in bitumen in cast-iron troughs, with an armoured pilot wire. The Highways Committee expressed the opinion that the laying of the mains in Wellington-street and the Strand should, when commenced, be carried on without cessation by day and by night until completed. An application by the County of London and Brush Provincial Electric Lighting Company to lay low-tension mains was approved of on the usual conditions. Referring to four notices from Messrs. Kincaid, Waller, and Manville on behalf of the South London Electric Supply Corporation, under the Lambeth Electric Lighting Order, 1892, of

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intention to lay various high and low tension mains, the committee reported that the order was originally granted to the Vestry, and subsequently transferred by agreement to the company, and contains no provision enabling the Council to approve or disapprove the works. In a similar way a notice given by the Vestry of Hampstead, under the Hampstead Order, 1892, of intention to lay certain mains could not be dealt with, because the Vestry is the undertaker under the order, and the Council has no power of approval or disapproval of the works.

Colchester.—The Electric Light Works Committee have reported to the Town Council that having considered the contract for the erection of station buildings and a proposed addition by the contractors, they have resolved that the deed must be entered into as originally drawn. Having considered the correspondence as to the draft contract by the Electric Construction Company, Limited, for the establishment of works, etc., and it having been ascertained that the assumption that the company now decline to undertake the works was correct, the committee had considered a communication from Messrs. Siemens and Co., Limited. This stated that Messrs. Siemens now found that by deducting the estimated cost of street work and modifying the engines and dynamos as suggested by Mr. Massey, the amount of their original tender could be reduced to about £10,800. They would be willing to carry on the work now on the terms of the draft memorandum of agreement, provided the necessary guarantees could be arranged with the engine-makers. They were prepared to hand over to the Corporation one-half of the net profits of the first two years' working, provided that in the improbable event of there being any loss they should be repaid the amount out of the first profits made by the Corporation after they had taken the running of the electric light works into their own hands. The committee now unanimously recommended that as the Electric Construction Company had declined to undertake the works unless a general arbitration clause was inserted in the contract deed, the Council accept Messrs. Siemens's offer, the amount of their reduced tender being only £34. 13s. in excess of that of the Electric Construction Company, and that the contract with Messrs Siemens be sealed accordingly. The report has been adopted.

Wolverhampton.—The electric light extensions previously reported are still making satisfactory progress. During the past few weeks the department has been busy connecting new consumers and extending the installations of other consumers. The total number of private lamps (equivalent 8 c.p.) connected on October 31 was 12,248, being an increase of 3,393, or 28 per cent.—over October, 1896. The number of consumers have increased in the same period from 125 to 187, or an increase of 49 per cent. The Electric Construction Corporation, Limited, Bushbury, near Wolverhampton, have now commenced the extension of their already large premises. The contract has been secured by Mr. Henry Gough, builder, Wolverhampton, and 30 men are busily engaged on the work. The site of the operations is at the rear of the main building, on the north side of the Stafford and Birmingham Canal, and in close proximity to the London and North-Western Railway main line. Altogether, several acres of meadow land, now used as the works' yard, will, in course of time, be utilised for additional shopping and other necessary buildings relative to the manufacture and construction of all kinds of electrical fittings, machinery, and appliances. Extra machine tools are also to be brought into use to meet the constant increase of orders and the great demand for electrical goods. In order to cope with the immediate pressure of business, a new wing of the main bay of the factory is to receive first attention. It will stand out prominently southwards, and supplement the other five existing bays, as well as the principal one. It has also been found necessary to enlarge the drawing office, and alter and rearrange the general offices. At the present time between 700 and 800 hands are regularly employed at these works, and it is the intention of the company to raise the number of operatives to 1,000 as soon as the room and accommodation has been completed.

Crieff.—Some time ago, says the *Scotsman*, the Crieff Town Council remitted to Mr. W. Arnot, late electrical engineer for Glasgow Corporation, to report on the water power of the Barvick and Turret Falls (some three miles to the north-west of Crieff), as a source of power for supplying electricity to the town, and which had been offered free by Sir Patrick Keith Murray, Bart., of Ochtertyre, the proprietor. Mr. Arnot's report has now been received. To utilise these falls, he says, it would be necessary to form a large reservoir near the Barvick. In that reservoir the Barvick water would be naturally stored, and the water of the Turret could be conveyed to the same reservoir by means of a lade from a dam on the Turret. After referring to the erection of the turbine-house and high-tension dynamos to generate the current for transmission, Mr. Arnot says that the poles from there to Crieff would be placed at a distance of 60 yards apart, carrying two cables insulated for high tension. In Crieff these lines would terminate in a sub-station, where motor-generators would be erected, and the current distributed on the continuous low-pressure system. Mr. Arnot goes on to state that to erect the necessary works for the Barvick alone, they could not count on the cost being less than £4,000, and that depended upon the nature of the ground forming the bottom of the reservoir. As to the question of electrical equipment, that could not be satisfactorily done under £4,000. Assuming that they would be able to sell 66,576 units per annum, working expenses would amount to £1,418, allowing for interest on capital at 4 per cent., depreciation at 3 per cent., wages, etc., and rates and taxes. To meet that expenditure the Council would require to charge 6d. per unit, which would bring in £1,664. Mr. Arnot thinks the safest and the cheapest way to light Crieff with electricity would be to do so by steam power. They could erect in Crieff steam electrical plant that would give them the same output as the Barvick Falls for £6,000. The working expenses per annum would amount to £1,276, allowing for interest on capital at 4 per cent., depreciation at 3 per cent., fuel, wages, etc. This would be met by charging the same number of units as above at 5d., leaving a balance of £111.

Cheltenham.—A Local Government Board enquiry was held on the 11th inst. by Colonel A. C. Smith, R.E., into an application by the Council for sanction to borrow £18,385 for the purposes of extending the electric lighting. The Corporation was represented by the town clerk (Mr. E. T. Bridges). Mr. Kilgour (electrical engineer), Mr. Hall (borough surveyor), Alderman Norman (chairman of the Electric Lighting Committee), and others. The Town Clerk said the Lighting Committee had borrowed £47,485, and spent £41,137, leaving an unexpended capital of £6,348. Alderman Norman stated that their first complete year ended on March 21 last. Their total net revenue for that 12 months for private supply was £1.760. A contract to supply the public library brought in £40, making a total of £1 800; and street-lighting realised £146, making a total revenue of £1,946. Their expenses for that year's working were £1,890. This year, from March, 1897, to March, 1898, assuming that the proportionate increase on the whole year would not be larger than the increase in the June quarter, their receipts would be £3,150 from private lighting, £40 from contract, and £1,010 from street-lighting, making a total of £4,200 for the year, so that the balance on the year's working would be £1,700, and after paying interest and depreciation, leave them with a balance of £300 to £600. On the first 10 months, the working deficit was £1,800. on the first complete year it was £1,150, but this year, as he had said, the net profit would be from £300 to £600. They had the equivalent in 8-c.p. lamps connected of 12,002, and they had waiting for connection 13,068. They had 195 private customers, and 22 waiting for supply. They were supplying the public lamps at 1½d. per unit, which is not very profitable. There were 63 of these lamps connected at present. A statement of the details of the loan asked for having been presented, Mr. Bridges said the loan was absolutely necessary for extensions during the coming winter, and in no case did they contemplate extensions for which there was no prospect of a profitable return. The demand for the light was going up by leaps and bounds, and 45 per cent. of their total outlay was outlay on their mains and groundwork. For the first time they had no appearance of opposition. Mr. Kilgour, in explaining the plans to the inspector, stated that there were 40 miles of mains, the high-pressure being 2,000 and the low varying from 200. More transformers were needed for the sub-stations.

Huddersfield.—The following figures show the progress made in the electric lighting of the district during the four years of its installation:—

The number of consumers connected—		
November, 1894	199	Increase.
,, 1895	252	53
,, 1896	356	104
,, 1897	544	188
Lamps connected—		
November, 1894	14,460	Increase.
,, 1895	18,500	4,040
,, 1896	27,000	8,500
,, 1897	38,600	11,600
Units of electricity sold for the year ending		
November, 1895	216,341	Increase.
,, 1896	285,566	69,225
,, 1897	417,740	132,174

On account of the increase, which is larger this year than in any previous year, it was found necessary to make considerable additions to the works in the form of new steam-boilers and generating plant. Owing to the engineers' strike this plant is not yet completely fixed, but it is hoped that by the end of the month it will be in working order. This will be of sufficient size to supply 10,000 8-c.p. lamps in use at the same time. The demand for current is, however, increasing so rapidly that another generating plant must be fixed in time for the next season's demand. The large increase has helped considerably to reduce the average cost of generating the unit of electrical energy, which it is satisfactory to find is considerably below the figure obtained in other towns. The increase also enabled the department to show last year a small balance of income over expenditure, which it is expected will this year be increased, notwithstanding the fact that the committee have revised the scale of charges and are allowing larger discounts to consumers, which will reduce the charges for energy very considerably. Many new mains have been laid during the year, representing an increase of 5,760 yards of high-pressure mains and 3,820 yards of low-pressure mains. Fifteen transforming stations have been constructed. The consumers connected during the year 1895 had an average of 76 lamps each, and for 1896 an average of 81 lamps each, while those connected during the last year have an average of 61 lamps each. This proves conclusively that the owners of the smaller shops and houses are appreciating the supply and becoming aware of its many advantages. During the year several electric motors have been connected to the mains, varying in size from $\frac{1}{10}$ h.p. to 6 h.p., and the demand for electrical energy for cooking and heating purposes is steadily increasing.

Cardiff.—The system of electric tramways for the construction of which the Corporation of Cardiff will seek parliamentary powers next session, says the *Western Mail*, is a very comprehensive one. If an enlargement of the boundaries be sanctioned, the Town

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Council propose to further extend the system now mapped out to Penarth, Llandaff, Whitchurch, and the northern section of Roath Park. The Parliamentary Committee have been empowered to give an undertaking to the local authorities in the districts interested to the effect that, if the scheme now proposed for enlarging the boundaries be sanctioned by Parliament, the Corporation will in the succeeding session apply for powers to make the extensions to which we have referred. One of the principal routes to be included in the Bill will be from James-street, at the docks, through Corporation-road, Clare-road, Clare-street, Lower Cathedral-road, and Cathedral-road to a point a little short of Pontcanna. From this trunk line there will be branches through Tudor-road and Wood-street into St. Mary-street, and from Despenser-gardens along Neville-street to Cowbridge-road. A second line will be run along Park-place and Colum-road to a point where the latter thoroughfare forms a junction with North-road. In the eastern end of the town a circular route has been adopted as far as circumstances would permit. Starting from Clifton-street, a line will be laid down Copper-street and Planet-street, Glossop-road, Castle-road, Albany-road, and Broadway, back to the first-named street. A branch will be laid from Albany-road, through Wellfield-road, to the north-eastern end of Ninian-road, while another route will commence at Clifton-street, through Splott-road, Walker-road, and down to the south-western end of Portmanmoor-road, opposite the Dowlais Works. From this latter point to the new pier, which will be erected opposite the centre of the Roath Dock, there will be only a short distance to traverse. This, briefly, is the scheme as it is now projected, but provision has been made, as will be seen by reference to the plan, to make junctions with the existing tramways at the northern end of Neville-street, between Park-place and Queen-street, and between Glossop-road and Adam-street, while the line which now terminates at the lower end of Crwys-road will be continued along that road and Whitchurch-road to a point where the latter forms a junction with North-road. If Penarth be brought into the borough, then power will be sought to make an electric tramway from the western end of Clare-road to the top of Windsor-road at Penarth, and then along Stanwell and Plymouth roads to the Taff Vale Railway Station. The scheme, as far as it is mapped out at present, will provide much-needed accommodation in several parts of the town, and will work in with existing tramways when those are acquired by the Corporation and electricity is employed as a motive power; but the usefulness of the system will be greatly enhanced if the extensions which are dependent upon the enlargement of the borough can be effected. With the exception of short lengths, the lines now proposed will be double, and delays at passing-places will thus be avoided.

Camberwell.—The General Purposes Committee have had under consideration a statutory notice from the London Electric Supply Corporation of its intention to lay mains in the Camberwell-road. The following report has been received from the vestry clerk on the subject: "Gentlemen,—The London Electric Supply Corporation, Limited, obtained a provisional order in 1890. The area of supply was so much of the parish of Camberwell as lies to the north of a line running along Camberwell New-road and Denmark-hill to its junction with the London, Chatham, and Dover Railway Company's South London Railway, then along that railway to Queen's-road, and along Queen's-road to the eastern boundary of the parish, but including both sides of the streets named. The following is the list of streets throughout which the undertakers were to lay distributing mains within a period of two years after the commencement of the order: Camberwell-road, High-street, Queen's-road, Church-street, Peckham-road, and Rye-lane. This had been agreed to by the Vestry in June, 1890. The same company had obtained power to light the following localities: portion of St. Martin-in-the-Fields; portion of St. Margaret and St. John, Westminster; St. James's, Westminster; St. George, Hanover-square; Chelsea, Greenwich, Rotherhithe, Bermondsey, St. Olave, St. Saviour, Christ Church, and portion of Lambeth lying north of Westminster Bridge-road The Vestry on November 8, 1893, applied to the Board of Trade to revoke this order in pursuance of Section 25 of the order granted to the London Electric Supply Corporation, as this corporation had failed to lay mains through the portion of the parish included in the order during the prescribed two years. The Board of Trade did not, however, accede to this request. On December 5, 1895, when the Vestry was considering the question of electric lighting, the London Electric Supply Corporation wrote that notwithstanding that every effort had been made to obtain business by canvassing, and by reducing the price of the current, it had not been able to obtain a single customer in that part of this district in which it had powers; that it had plant and machinery of very large capacity ready and waiting to supply electricity in the district as soon as customers could be found to take it. The corporation is now serving statutory notice of its intention to lay distributing mains in Camberwell-road, about 150 yards, as far as this parish is concerned. The local authority can of course disapprove of this, and the undertakers have then an appeal against such disapproval to the Board of Trade. The Crystal Palace District Electric Supply Company, Limited, obtained an order in 1894 for a small number of roads in this parish, near the Crystal Palace—viz., Sydenham-hill, Crescent Wood-road, College road (part of), Crystal Palace-parade, Farquhar-road, etc. The House-to-House Electric Supply Company gave statutory notice of intention to apply for a provisional order in July, 1890, and the Capital and Counties Electricity Supply Company in July, 1895, but proceeded no further. The Camberwell and Islington Electric Light and Power Supply Company obtained an order in January, 1891, having powers in nearly all the parish except that served by the Crystal Palace District Electric Supply Company, but this was revoked by the Board of Trade in August, 1892. The County of London and Brush Provincial Company obtained an order in July, 1895. The area of supply is all the parish of Camberwell, except that supplied by the Crystal Palace District Electric Supply Company, and the following streets are included in the compulsory area: Camberwell Green, Camberwell-road, Old Kent-road, Denmark-hill, Albany-road, High-street, Church-street, Queen's-road, Camberwell New-road, Rye-lane, Peckham-road, Lordship-lane, East Dulwich-road, Peckham Rye (west side), from Rye-lane to East Dulwich-road. In the case of this company the Vestry has had special clauses inserted in the order as to purchase.—C. WILLIAM TAGG, vestry clerk." As will be seen from the report, the London Electric Supply Corporation obtained the provisional order in 1890, and nothing whatever has been done in this parish up to this time. At the Vestry meeting held yesterday it was resolved that the Board of Trade be asked to refuse its consent to the laying of such mains, and to revoke the order in pursuance of Section 25 of the order.

TRAFFIC RECEIPTS.

Bristol Tramways.—The traffic returns for the week ending November 12 were £2,498. 2s. 11d., compared with £1,875. 6s. 3d. for the corresponding period of last year, being an increase of £622. 16s. 8d.

Dover Tramways.—The traffic receipts for the week ending November 13 were £98. 8s. 0d. The total receipts up to the same date were £1,238. 17s. 7d. The mileage open at present is only two miles.

Birmingham Tramways.—The traffic receipts for the week ending November 13 were £3,602. 18s. 2d., as compared with £3,037. 12s. 6d. in the corresponding week in 1896, being an increase of £565. 5s. 8d.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended November 14 amounted to £1,283, as compared with £1,143 in the corresponding week of the previous year, being an increase of £140.

City and South London Railway.—The returns for the week ended November 14 were £1,081, compared with £1,078 for the corresponding period of last year, being an increase of £3. The total receipts for the half-year 1897 amounted to £18,661, compared with £18,825 for the corresponding period last year, being a decrease of £164.

South Staffordshire Tramways.—The traffic returns for the week ending November 12 were £597. 19s. 3d., as compared with £557. 2s. 6d. in the corresponding week of the previous year. The aggregate receipts so far this year were £28,729. 10s. 11d., as compared with £27,813. 15s. 7d. in the corresponding period in 1896.

S.D. Tramways, Dublin.—The traffic receipts for the week ending November 12 were £412. 12s. 5d., as compared with £408. 1s. 11d. in the corresponding week in the previous year, being an increase of £4. 10s. 6d. The number of passengers carried was 69,385 in 1897 and 61,443 in 1896. The aggregate returns up to date are £13,168. 19s. 5d., as compared with £13,724. 2s. 1d. last year, being a decrease of £555. 2s. 8d. The mileage open is the same as last year—viz., eight miles.

PROVISIONAL PATENTS, 1897.

NOVEMBER 8.

25872. Improvements in induction motors. Frank Michael Lewis, 111, Gloucester-road, Brighton.

25877. An improved glow lamp. Leonard Gunn, 17, Lambs Conduit-street, London.

25883. Improvements in apparatus for measuring a supply of electricity. William Arthur Price, Teign House, Westcombe Park-road, Blackheath, London.

25889. An improved cell or box suitable for accumulator or other electric batteries. Frederick Charles Geary and John Henry Robottom, 338, Shobnall-street, Burton-on-Trent.

25890. Improvements in or connected with electrolytic cells. George Bell and George William Bell, 15, Water-street, Liverpool.

25896. Improvements in electrical switches. John Henry Tucker, 16, Oozells-street, Birmingham.

25906. Improvement in incandescent electric lamps or vacuum tubes for advertising. Frederick James Jones and James Francis Stevenson, 26, Frodsham-street, Chester.

25941. Improved construction of electrical transformers. Charles Boritschewsky, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

NOVEMBER 9.

25970. Improvements in the method and in or in connection with the means of operating electric railways. Willis Nelson Stewart, 30, Park-row, Leeds.

25998. Improvements in automatic circuit breakers. Wallace Fairweather, 62, St. Vincent-street, Glasgow. (The Crocker-Wheeler Electric Company, United States.) (Complete specification.)

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25993. **Improvements in electric arc lamps.** Maurice Provin Gatte, 8, Rue des Princes, Brussels.

26023. **Electrical instrument.** Charles Arthur Allison, 52, Chancery-lane, London. (William Charles Banks, United States.) (Complete specification.)

26026. **Improvements in the covers or domes of the switches of electrical glow lamps, which improvements are also applicable to other electrical switches.** Richard George Evered, 7, Staple-inn, London.

26040. **Improvements in the construction of electrical transformers for use in three-wire systems.** The British Thomson-Houston Company, Limited, and Henry Metcalf Hobart, 70, Chancery-lane, London. (Complete specification.)

26057. **Improvements in or connected with porous cells or receptacles for galvanic batteries.** Michael Martin Bair, 45, Southampton-buildings, Chancery lane, London.

26057. **Improvements in electrolytical apparatus.** Francis Edward Elmore, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Partly communicated by John Oliver Surtees Elmore, India.)

26089. **Improvement in terminal and connection screws and contact-pieces for electrical purposes.** Desmond Gerald Fitz-Gerald, 53, Chancery-lane, London.

26097. **Improvements in or relating to galvanic batteries.** Richard Joseph Crowley, Charles Edwin Monkhouse, and Albert Smith, 46 Lincoln's-inn-fields, London.

26102. **An improved process for the production of pliable and elastic bodies by electrolysis.** Anna Krüger, 18, Southampton-buildings, Chancery-lane, London.

NOVEMBER 10.

26118. **A conduit and aerial electro-locomotor primarily for laying or drawing-in electric mains or other cables for any service.** Edgar Lionel Benjamin, 48, Sutherland-avenue, Maida Vale, London.

26187. **Improvements in and in the manufacture of filaments for incandescent electric lamps.** Arthur Francis Woodley, 31, Southampton-buildings, Chancery-lane, London.

26199. **Improvements in electric igniting devices for gas-burners.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Charles Poilibert Joseph Clément and Hans von Krohn, Belgium.)

NOVEMBER 11.

26244. **Improvements in the lighting of miners' safety lamps and the like by electricity.** Tom Ingham and Henry Davis, All Saints' Works, Derby.

26296. **Improvements in holders for incandescent electric lamps.** Archibald Campbell, 168, Fleet-street, London.

26306. **Improvements in switching gear for transformers, reactance coils, storage batteries, and the like.** The British Thomson-Houston Company, Limited, and Henry Metcalf Hobart, 70, Chancery-lane, London. (Complete specification.)

26332. **Improvements in and relating to the jointing of electrical cables.** Henri Emile Menier, 60, Queen Victoria-street, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, May 11, 1897, being date of application in France.)

26333. **Improvements in and relating to the transmission of telegraphic messages.** Joseph Arthur Lovel Dearlove, 323, High Holborn, London.

26343. **Improved methods of and apparatus for manufacturing filaments of electric lamps.** Hiram Stevens Maxim, 45, Southampton-buildings, Chancery-lane, London.

NOVEMBER 12.

26367. **Improvements connected with electrical illumination.** Henry Cooney, 15, Water-street, Liverpool.

26373. **A pneumatic brush for dynamos, motors, or any machine for the production or use of electric current by rotary armatures.** Francis Joseph Taylor, Springvale, Doagh, Belfast.

26399. **Improvements in electrical measuring instruments.** George Keith Buller Elphinstone and Arthur Cecil Heap, 101, St. Martin's-lane, London.

26411. **Improvements in or relating to trolley standards and poles for electric cars.** George Henshaw, 70, Chancery-lane, London.

26412. **Improvements in electrical transformers.** The British Thomson-Houston Company, Limited, and Henry Metcalf Hobart, 70, Chancery-lane, London. (Complete specification.)

26441. **Improvements in the preparation of accumulator plates.** Carl August Bennert, 322, High Holborn, London. (Complete specification.)

26448. **An improvement in electric cables.** George Sutton, 53, Chancery-lane, London.

26455. **Method of and means or apparatus for detecting and indicating variations in the condition of circuits traversed by alternating currents, applicable also for the measurement of the inductance resistance or capacity of electric apparatus for the transmission of orders, and for other purposes.** Alfred Upton Alcock, 46, Lincoln's-inn-fields, London.

NOVEMBER 13.

26496. **Improvements in watertight electric fittings.** Henry Davis and Lancelot Walter de Grave, All Saints' Works, Derby.

26514. **Improvements in and relating to grids and supports forming part of accumulator plates.** Arthur Edwin Greville, 2, Staple-inn, London. (Complete specification.)

26526. **Improvements in apparatus for heating buildings and the like by means of hot fluids or electricity.** Joseph Alfred Dargue, Ernest Griffiths, and Clarence Hutton Wright, 6, Lord-street, Liverpool.

26543. **Improvements in apparatus for the generation and electrolytic application of electric currents.** Francis Edward Elmore, Birkbeck-chambers, Southampton-buildings, Chancery-lane, London. (Partly by John Oliver Surtees Elmore, India.)

SPECIFICATIONS PUBLISHED.

1896.

22996. **Appliances for the intercommunication of telephones.** Andrews.

23334. **Displaying prices and the like in shop-windows and other places by electric illumination.** Craig.

24766. **Switches for electric currents.** Rawlings and Rawlings.

25061. **Electric current or pressure regulating device.** Holsten.

25070. **Electric cables particularly suitable for telephone circuits.** Hawkins.

25158. **Ammeters.** Siemens Bros. and Co., Limited, and Nebel.

25347. **Ceiling roses for electrical purposes.** Theermann.

25511. **Manufacture of electric accumulators or secondary batteries.** Lucas.

29115. **Electric storage or secondary batteries.** King.

1897.

1887. **Incandescent electric lamps.** The British Incandescent Electric Lamp Company, Limited, and Moul.

6695. **Electric tramways and railways on the sectional conductor system.** Lake. (Arno and Caramagna.)

10439. **Secondary batteries.** Lee.

14033. **Electric regulators.** Gartland.

20444. **Telephones.** Junge. (Kraft, Huber, and Exner.)

21055. **Electric cars and surface-contact railways.** The British Thomson-Houston Company, Limited. (Hewlett.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	11½
Brush Company, Ordinary	8	11-11½
—— Non. Cum., 6 per cent. Pref.	2	1½-2½
—— 4½ per cent. Debenture Stock	100	107-111
—— 4½ per cent. 2nd Debenture Stock	100	98-102
Callender's Cable Company, Debentures	100	108-112
—— Ordinary	5	7-8
Central London Railway, Ordinary	10	9½-10½
——	6	5½-6
Charing Cross and Strand	5	12-13
Chelsea Electricity Company	5	10½-10¾
—— 4½ per cent. Debentures	100	112-115
City of London, Ordinary	10	27-28
—— 6 per cent. Cumulative Pref.	10	17-18
—— 5 per cent. Debenture Stock	100	131-136
City and South London Railway, Consolidated Ordinary	100	69-71
—— 4 per cent. Debenture Stock	100	138-140
—— 5 per cent. Pref. Shares	10	15½-15¾
County of London and Brush Provincial Co., Ordinary	10	13¾-14
—— 6 per cent. Cum. Pref.	10	15½-15¾
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1½ 2
—— 5 per cent. Debentures	—	89-94
Edison and Swan United Ordinary	3	2½-2¾
—— 5 per cent. Debentures	5	4-5
Electric Construction, Limited	2	2-2½
—— 7 per cent. Cumulative Pref.	2	3½-3¾
Elmore's Copper Depositing	1	¾-1
Elmore's Wire Company	2	1-1¼
W. T. Henley's Telegraph Works, Ordinary	10	20-21
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	9½-9¾
—— 7 per cent. Preference	5	11-11½
India Rubber and Gutta Percha Works	10	21½-22½
—— 4½ per cent. Debentures	100	103-107
Kensington and Knightsbridge Ordinary	5	14½-15½
—— 6 per cent. Pref.	5	8-8½
London Electric Supply, Ordinary	5	2-2½
Metropolitan Electric Supply	10	17½-18½
—— 4½ per cent. First Mortgage Debenture Stock	100	119-123
National Telephone, Ordinary	5	6¾-6¾
—— 6 per cent. Cum. First Pref.	10	16-17
—— 6 per cent. Cum. Second Pref.	10	14-16
—— 5 per cent. Non. Cum. Third Pref.	5	6-6½
—— 3½ per cent. Deb. Stock	100	104-109
Notting Hill Company	10	15½-16½
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	3½-3¾
—— £4½ shares	4½	7½-7¾
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	104-106
South London Electric Supply, Ordinary	2	2-2½
St. James's and Pall Mall, Ordinary	5	16½-17½
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	13	36-39
—— 5 per cent. Bonds	100	103-105
Waterloo and City Railway, Ordinary	8	12½-13
Westminster Electric Supply, Ordinary	5	14½-15½
Yorkshire House-to-House	5	8-8½

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NOTES.

The Brussels Exhibition.—The British Thomson-Houston Company, Limited, inform us that the Thomson recording wattmeter has obtained the diploma of honour at the Brussels Exhibition, being the only meter that has received such a distinction.

"**Cassier's Magazine.**"—We have received the November number of this magazine, which contains many articles of great value on engineering subjects, together with a portrait and biographical sketch of Mr. Alfred F. Yarrow, of shipbuilding fame. The illustrations and letter-press throughout are, as usual, excellent.

"**Kurvey Linear Discussion on Corn.**"—Some amusement was caused at the meeting of the Camera Club on Monday evening when the honorary secretary, Mr. J. Wallis Godfrey, M.A., stated that Prof. H. E. Armstrong, D.Sc., F.R.S., was to read a paper at last night's (Thursday) meeting on "Kurvey Linear Discussion on Corn," and that the professor would not tell him or anyone else what the subject was about. The title certainly did not give any clue.

"**The English Illustrated Magazine.**"—We have received a copy of the Christmas number of this magazine, and can heartily recommend it. The numerous stories are interesting, and several articles are worthy of special note. Amongst these is one of a series on "The Great Adventurer," being studies and sketches of the First Napoleon. The article in this issue deals with his *début* as a general. The illustrations in this Christmas number are excellent in detail.

Institution of Engineers and Shipbuilders in Scotland.—We have received a copy of Part I. of vol. xli. of the *Transactions* of this society. It contains the presidential address by Mr. George Russell, and papers by Mr. Hermann Kühm on the Proell-Corliss engine and the Proell valve diagram, and by Mr. F. J. Rowan on water-tube boilers. There are eight tables and five plates to illustrate the latter. At the first general meeting on the 26th ult., when the above papers were read, Mr. F. P. Purvis showed several models of work in ship carpentry and ship joinery which have been executed (most of them at Hull) for the annual examination of the City and Guilds Institute.

Protection in Fog.—A correspondent, writing to the *City Press*, suggests that fixed point constables should, in foggy weather, wear an electric lamp in their helmets or belts. This, for obvious reasons, he says, would be a great advantage to drivers and pedestrians, to whom such lights would be beacons: and last, but not least, to Robert himself. He was induced to write this through having seen a policeman accidentally knocked down by a cab horse a few nights since in the Strand. It is not quite clear that electric lamps will act as a charm to protect policemen's lives and limbs from the carelessness of cabdrivers, and on a foggy day the "beacon" would be lost among the myriads of shop and street lamps alight. The "beacon" could only be a small lamp at the best.

New Electric Lighting Schemes.—Up to the end of last week statutory notice had been given by 17 local authorities and others of their intention to apply to the Board of Trade for provisional orders under the Electric Lighting Acts, 1882 and 1888, for power to produce and supply electricity for lighting purposes. Since then similar notice has been given by 12 other authorities to a similar effect—namely, the Rural District Council of Chelmsford, the Vestry of the parish of Marylebone, the Midland Electric Light and Power Company, Limited (for the borough of Royal Leamington Spa), the Hastings Corporation, the Haworth Urban District Council, the Weston-super-Mare Electric Light and Power Syndicate, the Crewe Corporation, the Lewes Corporation, the Gravesend Corporation, the Dartford Urban District Council, the Aston Manor Urban District Council, and the Batley Corporation.

Guttapercha from Leaves.—The statement that a certain quality of guttapercha can be made from the leaves of the tree which yields the gum has been corroborated by a communication from the Singapore Botanic Gardens, sent to the *Kew Bulletin*. Describing a visit to the factory of Mr. Arnand, the writer says that the leaves are imported in sacks dry from Borneo and Jahore. Most of the trees are overcut in Singapore, and there are few leaves left. The leaves and twigs cost 4½dol. per picul (133lb.). They are put, damped with hot water, into a rolling machine, which grinds them to powder. The powder is thrown into tanks of water and shaken about. The gutta floats in the form of a green mealy-looking stuff, is lifted out by fine copper gauze nets, put into warm water, and pressed into moulds. The writer is doubtful that this source of obtaining guttapercha may not last very long, owing to the difficulty of obtaining the leaves.

Replacing Insulators on a 10,000-Volt Circuit. We notice in the *Electrical Review* of New York a description by Mr. W. B. Jackson of a method used by him in changing broken insulators on a 10,000-volt transmission line without interrupting the supply. The ladder used by the linemen in going up to the insulator to be repaired is placed on a small platform insulated from the ground by four insulators. Before the wire attached to the defective insulator is handled an earth wire is hooked on to it, and this earth wire is relied on to protect the workmen in completing the required alteration. A 3ft. stick boiled in paraffin is used in first attaching the earth wire to the line. Mr. Jackson assures us that this method is actually used on a system in which he is interested, and that numerous repairs have been effected by it. As regards the safety of the method to the operator we have no doubt, but the advisability of connecting a dead earth to the 10,000-volt line wires must be a severe strain on the insulation of the machinery at the central station.

Electricity Defined.—The lately-deceased scientist, Galileo Ferraris, according to the *Elektrotechnischer Anzeiger*, in answer to a young lady's request, inscribed in her album the following definition of electricity: "Since Maxwell has demonstrated that the vibrations of light might consist of periodical changes of electromagnetic forces, and as Hertz has given Maxwell's theory an experimental basis with his proof of the similarity existing between electromagnetic waves and light waves, the belief becomes more and more firmly established that this light-conveying ether and the medium in which the electric and magnetic forces act are identical. Therefore, I may well reply to the question, O! studious and charming maiden, 'What is electricity?' that it is not only the fearful agent which at times lights up the heavens suddenly and startles thy soul with its loud clapping of thunder, but also the life-giving and the life-awakening cause, which as light and heat brings forth the magic of colour and the breath of life, which transmits to thy heart the pulsations of the universe and awakens in thy soul the charm of glance and smiles."

Street Motors in Paris.—The correspondents in Paris of one or two of the English papers appear to have seen a perfect nightmare of dangers in the Parisian streets since the introduction of motorcars. The streets of Paris used to be dangerous enough in all conscience up till a short time ago, even when the dangers were the privileged perquisites of horses and bicycles. There was no rule of the road (there might have been one once, but probably it

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got mislaid in the last revolution), and each *cocher* drove his *fiacre* or *voiture* wherever he could and wherever he wanted to. The street was his own, and if he was strongly enough equipped, his progress through the busy parts of the city reminded one of the triumphal race of a Roman charioteer, who overcame all obstacles to reach his goal. We were in Paris on two occasions recently, and we could not help being struck with the change which had been made in controlling the traffic. There was an unaccustomed air of novelty about, it is true, but instead of the perilous confusion spoken of by the writers whom we have alluded to, it was possible to cross the streets without experiencing more trouble and danger than one does in London. And as for horses taking fright and bolting when they met electric tramcars and motorcars, the epidemic must have ceased temporarily while we were there, for there was no such excitement.

A German Commercial Association.—The British Consul at Stettin, in a report which has just been published, describes an interesting commercial association which was established at that place, soon after the conclusion of the Franco-German War, for the purpose of extending and improving the maritime trade of the port and assisting it to compete with Hamburg and Bremen. The original members, at their first meeting in December, 1871, decided that the better education of clerks and young men who took up commerce as a profession was necessary. For this purpose evening classes were instituted, at which all branches of commercial education were taught. Further, young men were to be sent abroad to the British Colonies, America, and elsewhere to improve their knowledge of business and to work in the interests of Stettin trade. Each was to get £75 to cover travelling expenses and living for three months at the destination. This sum was a free gift; but repayment, when the donee was able to do so, was treated as a matter of honour. Very few have failed to repay the money, the failures being mostly due to death. The German Consul is advised of the student's arrival, and gives him assistance in carrying out the aim of his journey. Valuable reports on a great variety of commercial subjects have been sent in to the association by the students, and many of them have been printed and circulated amongst the members. Since 1872, 50 of these young men have been sent abroad to South and Central America, Singapore, Rangoon, Java, Hong Kong, the Transvaal, and other places, but mostly to the republics of Spanish America.

Institution of Junior Engineers.—On Saturday afternoon, November 20, a large number of the members availed themselves of the opportunity for visiting the electricity works of the Islington Vestry at Eden-grove, Holloway. They were shown over by Mr. Albert Gay and Mr. C. H. Yeaman. The station was opened in March of last year, and we published a full description of it in our issue of March 6, 1896. It will be remembered that the design includes many novel features. Labour-saving devices have been introduced wherever practicable, a notable instance of which was observed in the coaling arrangements. The wagons are run from the collieries right into the boiler-house and there emptied by means of special gear into the coal-bunkers. The main boilers are of the Lancashire type, but there are two water-tube boilers to meet unexpected demands arising from fogs. Meldrum's furnaces and forced-draught apparatus are fitted to all the boilers. The steam-piping system also presents some unusual features, which have been adopted with the object of retaining the advantages of the "ring" method whilst obviating many of its drawbacks. All the engines are of the horizontal high-pressure compound non-condensing type, the latest form of Wheelock valve gear being applied. There are rope-driven alternators of the Lowrie-Hall form, the field magnets forming the rotating part, and also direct-driven alternators in which the magnets are mounted on the engine flywheel. Each of the rectifiers is capable of supplying 30 12-ampere lamps. Since the station was opened it has been necessary, to meet increasing demands for current, to increase the plant by the addition of four Lancashire boilers, two slow-speed horizontal engines, each of 500 i.h.p., direct coupled to alternators, each of 300 kw.

British and Foreign Patents.—At the end of last week a deputation from the Manchester Chamber of Commerce was received privately by Mr. Ritchie at the Board of Trade with reference to certain disadvantages under which British industries are now carried on in consequence of important differences between British and foreign patents. The deputation consisted of Mr. W. H. Holland, president of the Manchester Chamber, Mr. Ivan Levinstein, Mr. Harry Grimshaw, and Mr. Helm, secretary. The following report was communicated to the Press, and it will be interesting to read this in connection with the note which appeared in our last issue on Mr. Fairfax's paper before the Society of Patent Agents: The principal point to which Mr. Ritchie's attention was drawn was the fact that patent rights were granted to foreign subjects in this country for inventions which cannot be patented in their own. It was stated that very serious injury was inflicted upon British industrial interests in consequence of this inequality, and it was asked that the Patents Act of 1883 should be amended so as to remove the inequality, and that the duration of any British patent granted to a foreigner should not exceed the term of his patent in his own country. The deputation also desired that, as complementary to this amendment, the British representatives at the forthcoming congress of the international convention for the protection of industrial property, to be held in Brussels next month, should be instructed to support the propositions for the alteration of the rules of the convention, which would permit the amending legislation in question. Mr. Ritchie, in reply, stated that, although he had considerable sympathy with the desires of the deputation, the matter was by no means free from difficulty. He would, however, give careful attention to the facts and arguments put before him.

Michael Faraday.—Mr. John W. Faraday, of Hayle, Cornwall, writing to the *Standard* to correct one or two points in the editorial published by that paper, gives an interesting little bit of ancestral history which may interest some of our readers. We learn from this authoritative source that one Robert Faraday married Elizabeth Dean, the owner of Clapham Wood Hall, in Yorkshire. This hall, it is said, was of some beauty, and of a style peculiar to that part of the country; architecturally, it was very effective. This Robert Faraday was the great scientist's grandfather, his own father, Barnabas, being born at the hall. He was one of a large family, the members of which had to shift for themselves when they left the parental abode. This they did, but in no instance was their condition in life anything approaching that of a "day labourer," a class of men whose position at that period was peculiarly miserable and degraded. Faraday's own father was verger and sexton of the village church, and leader of the choir, and he was a shoemaker by trade. Faraday's own uncle was the owner of a neighbouring quarry, and employed a number of "day labourers," and was noted for his kindness to his employés. Faraday's father, James, formed an attachment to Margaret Hastwell, whose father was a farmer, and also

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an employer of day labourers. The lady's father was averse to the match, being ambitious for his daughter to marry someone who had more cash than a youth who came from Clapham Wood Hall was likely to have. Thereupon, James, who followed the calling of a blacksmith, went to London. Eventually he returned and married Margaret, and took her back to London. There James had to fight his own battle, and, like many another, found it hard enough. Hence, Michael's earlier years were years of struggle against a poverty which at one time pinched the family sorely.

Seismograms and Telegrams.—A lecture under this heading was given at the Camera Club on Thursday evening of last week by Prof. Milne, who demonstrated the connection between photography, seismography, and telegraphy by pointing out that in the instruments which are used for recording earthquake movements the necessary records are obtained by photographic methods on bromide paper. In this connection Prof. Milne had but little to say about the telegram ordinary beyond pointing out that the difference between it and a seismogram was that, while the latter was the story of an earthquake told by itself, the telegram told it later in a more or less modified form. The seismogram was ahead of ordinary telegrams, for it could give information from anywhere in about 16 minutes. He could now give them the dates of some earthquakes which would be verified by-and-by when the telegrams came. There was one which, he judged from the nature of the disturbance, had taken place in Borneo. On August 4 there was one in Japan, but they only received a seismogram about that because they never sent telegrams about earthquakes in Japan unless about 300 people were killed. Generally speaking, they could tell how far away the place was at which the disturbance took place, but not the place itself, though it was possible to judge approximately. The instruments he used in the Isle of Wight for recording distant earthquakes were not sensitive to anything rapid, and very different from what he would use near the scene of the disturbance. Seventy-five per cent. of earthquakes came from under water in the neighbourhood of coasts. They were also frequent where the land for a great distance sloped down steeply to the sea, and in mountainous regions. Prof. Milne illustrated his lecture by a number of lantern slides, which dealt mainly with the effects of earthquakes in Japan, and the results of experience gained in consequence of a systematic observation of their movements.

The Engineering Dispute.—It is with a distinct sensation of relief that we read of the peaceful opening of the conference, arranged through the mediation of the Board of Trade, between the employers and the men. The following is the official list of the 28 representatives of both sides: (on behalf of the employers) Colonel Dyer (of Sir W. G. Armstrong and Co., Newcastle), Sir Benjamin Brown (Messrs. R. and W. Hawthorn, Newcastle), Sir B. Dobson (Dobson and Co., Limited, Bolton), Mr. C. E. Allan (Messrs. Workman, Clark, and Co., Limited, Belfast), Mr. G. Clark (Messrs. Clark, Limited, Sunderland), Mr. Donaldson (Messrs. Thornycroft, Chiswick), Mr. W. H. Ellis (Messrs. John Brown and Co., Sheffield), Mr. A. P. Henderson (Messrs. D. and W. Henderson and Co., Glasgow), Mr. G. Jessop (Messrs. Jessop and Appleby Bros., Leicester), Mr. J. Hawthorn Kitson (Messrs. Kitson and Co., Leeds), Mr. J. Laird (Messrs. Laird Bros., Birkenhead), Mr. S. R. Platt (Messrs. Platt Bros. and Co., Oldham), Mr. R S. Scott (Greenock Foundry Company, Greenock), Mr. Alexander Siemens (Messrs. Siemens Bros. and Co., Westminster), Mr. T. Biggart and Mr. J. Robinson, secretaries to the Federated Employers; Major A. Hope, secretary Iron Trade Employers' Association, and Mr. Leslie Field, secretary London Engineering Employers' Association. On behalf of the Affiliated Societies: Mr. A. Sellicks, Mr. W. Golightly, Mr. Joseph Hooson, Mr. A. Taylor, Mr. F. H. Rose, Mr. J. Ratcliffe, Mr. John Whittaker, Mr. George Ferguson, Mr. G. N. Barnes (general secretary) as representing the Amalgamated Society of Engineers; Messrs. Craven, Shae, and Bigby as representing the Joint Committee; Mr. J. Swift, representing the Steam-Engine Makers' Society; and Mr. Arrandale, of the United Machine Workers' Association. Colonel Dyer acted as chairman of the employers' representatives, and Mr. Sellicks as chairman of the Affiliated Societies' representatives. The first subject considered was that of employers' freedom of management, and the fact that this one point was not settled at the end of the first day's proceedings indicates that the conference is likely to prove very lengthy. The conference re assembled yesterday (Thursday) at 11.

Electric Balloon Signalling.—In the lecture-room of the Imperial Institute on Monday night Mr. Eric S. Bruce delivered a lecture, fully illustrated by experiments and working models, on "Electric Balloon Signalling Applied to Scientific Exploration in Arctic and Antarctic Expeditions." The lecturer remarked that he had invented a system of electric balloon signalling which was independent of the configuration of the country. Signalling from the car of an ordinary captive balloon required the use of a balloon of considerable size, and also presupposed calm weather, but if the signals were made by electric flashes the operator could remain on the ground with the apparatus, and the balloon would be portable and quickly inflated. A difficulty he had had to overcome was in constructing the key, as the Morse key contacts would not stand the heavy currents necessary for lighting. He now used a specially improved key worked by carbon contacts. For military purposes he used balloons of varnished cambric, and they were now employed by Great Britain, Belgium, and Italy. He had also used goldbeater skin, which was very light, as an 18in. balloon of that material filled with coal-gas would lift itself. On the other hand, it would require a balloon 7ft. diameter in cambric to lift itself. The lights he used were placed in ladder form, and were incandescent, and the cable was very flexible, being of strands of copper. For Arctic work he would recommend a balloon of 7ft., which would lift 500ft. of cable, with a cubic capacity of 150ft. To fill that, the explorer would have to take out a steel tube of compressed hydrogen about 8ft. long. He placed his lamps inside the balloon, although he lost illuminating power, because experience had shown that was best. When incandescent lamps were flashed the filament remained red hot for a moment, and in the open that would be visible and connect the flashes, whereas in the balloon the afterglow was not seen. Of course, in foggy weather it was better to have the lights outside, and then the fog acted as would the goldbeater skin, obviating the afterglow. There was no danger in the lamps being inside a balloon filled with coal-gas or hydrogen.

Photo-Electric Phenomena.—Mr. H. Luggin has been making experiments in connection with photo-electric phenomena and photographic processes, and has embodied the results of those experiments in a paper, of which the following abstract has been published in the *Journal* of the Chemical Society. The author exposed to light a sensitive electrode similar to that previously described by him in 1894, but which could be raised to any definite potential above that of the liquid. The current produced, or the photo-current, was measured, and it was found that an intimate connection exists between the strength of the photo-current and the depth of the darkening of the

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sensitive electrode. As the potential of the electrode is increased, however, the photo-current decreases, and ultimately a potential is reached where the current becomes zero, and by increased exposure may pass over to a current of opposite sign. Where the action of the current is to remove the halogen, and hence cause darkening of the electrode, the current is called normal or positive, currents which act in the reverse sense being known as solarisation current, and experiments show that both kinds of current may be produced with the same electrode, according to its potential and the light intensity. The solarisation current, in the case of silver chloride electrodes, more readily occurs with yellow light, whilst, on the other hand, blue light favours the production of the normal current, which, in contradistinction to the solarisation current, is coterminous with the exposure. The potential at which no normal current is produced is known as the equilibrium potential, and a linear equation is found to hold for the relation of the photo-current to the defect from the equilibrium potential, and in the equation the constant is probably dependent on the dissociation of the silver salt. The author endeavours to connect these results with the purely photographic phenomena, and considers that solarisation appearances are intimately and causally connected with the solarisation current, and at any rate with printing out papers the connection between the photo-electric and photographic phenomena is, in the author's opinion, established. The applicability of the halogen salts appears also to be connected with the value of the equilibrium potential, and the author finally discusses at some length the production of images by development.

A Novel Railway.—Some people are never satisfied. For untold centuries men were content with animal traction of various descriptions. Then came the new-fangled steam locomotive with lumbering wheels, noisy machinery, rattling frames, and sky-scraping funnels, which bears about the same resemblance to the modern railway locomotive as a foal bears to its mother; and of more recent date still, we have electric traction. We take no count of the various side shows, consisting of cable traction and gas and oil motors. When electricity came we safely thought we might rest awhile and await developments of that system; but no, we are to be hurried along by an inventor named Halford, who, curiously enough, brings us face to face with a very old friend in a very new garb—namely, the force of gravity. By this invention the cars are, as it were, always running down hill. This result is achieved by making the permanent way in sections, whose length is to be determined by engineering considerations, hinged together and supported at each end on hydraulic rams. As the train reaches the junction of two sections, it puts the hydraulic machinery in action, so that the ram rises, lifting the end of the section together with the cars that are upon it. The train thus has a decline, down which it runs by its own weight, and as the same process is repeated with each section, it is practically always running down a falling gradient, continuous, though of varying steepness. The necessary hydraulic power is conveyed through a pipe laid beneath the rails, and the admission of water to the cylinders of the rams is controlled either by electrical means from the cars, or by the weight of the train depressing the section it is about to leave, and thus actuating the supply valve. In the model built by the inventor the rails are raised on columns and the cars suspended on either side below the track, but the system is claimed to be equally applicable to trains running above the rails in the ordinary way, though in that case it is considered that the limit of speed consistent with safety would be much reduced. With a full-size railway the stroke of the rams necessary to produce a high speed would not be very long, and the passenger would experience little, if any, of the switchback motion which might at first sight appear inevitable. In our little judgment we should feel inclined to criticise the somewhat ludicrous and eccentric motion of the train, together with its moral effect on a nation of staid and sober citizens, and leave the mechanical and commercial sides of the affair to take care of themselves. We are still reserving our faculties to appreciate the revolving stations on the Underground, and when that is accomplished we may have enough intellect left to enjoy the delights of a modified switchback ride to York and compare it with the way Dick Turpin used to do it.

Liverpool and Self-Propelled Traffic.—The *Newcastle Daily Chronicle* says that the Liverpool and District Centre of the Self-Propelled Traffic Association have arranged to hold trials of motor vehicles for heavy traffic, somewhat after the plan of the competition just held in France by the Auto-mobile Club. The trials will be held in May next, and as Sir David Salomons (the president of the central association) and the Earl of Derby (the president of the Liverpool centre) are taking great interest in them, they bid fair to be of great importance. In no part of England, out of London, is the heavy traffic in the carriage of goods over roads so considerable as that in and around Liverpool, and the only apprehensions which can be entertained for the success of the proposed competition are that the requirements of Liverpool are so much more exacting than those of any other provincial town, especially considering the railway and canal competition, and that the development of the motorcar has not yet reached such a pitch of perfection as to render it likely that its undertaking of the heavy traffic of a busy commercial centre and populous city like Liverpool will be unattended by drawbacks, some of which, through the experiment being tried prematurely and consequently failing, might stand in the way of the successful adoption of this method of traction at a somewhat later and more favourable period. It is further stated that a prominent member of the association has intimated to the hon. secretary that he is willing to receive, on the recommendation of the judges, one or more vehicles to work in the heavy goods traffic of Liverpool and district on trial during a period of one month, and, further, that he is prepared, on it being demonstrated that such vehicles fulfil the conditions required for his satisfaction, to purchase 50 of them in all. He demands that the vehicle to satisfy him shall have carried five tons of goods during the official trial runs, and be capable of carrying up to 10 tons when required, and that during the month's trial the cost of working shall not exceed 3·5d. per net ton-mile; and he offers, during the continuance of these additional practical trials, to bear the expenses of working up to 3·5d. per net ton-mile. He has furnished a tentative estimate of the cost to which he is prepared to go, this including the prime cost of the vehicle, about £600, and the assumed expenditure per annum (embracing interest at 5 per cent. per annum and depreciation at 15 per cent. per annum, as well as the wages of driver and boy, stabling, repairs, etc.), amounting to about £300 per annum. As to the official competition, the points which will be taken into consideration by the judges in making their awards will be economy of working, including attendance; control in stopping, starting, changing speed, steering, and reversing, particularly under adverse conditions such as on inclines or in confined spaces; conditions of working, embracing noise, smell, visible vapour, number of mechanical operations requiring the driver's attention, efficiency of brakes, time occupied in

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preparing the vehicle for service on the road, ability to start from rest up an incline of 1 in 16, speed (within legal limits), distance run without taking fresh supplies of fuel or other agent employed for actuating the motor or assisting its working, ability to complete the course without stoppages, freedom from breakdown; strength and efficiency of construction and quality of workmanship, ratio of tare (1) to power of motor and (2) to weight of freight; and other conditions applied severally to steam-propelled and to oil-propelled vehicles. There will be two classes in the competition: one for vehicles capable of carrying a minimum load of two tons of goods, these vehicles to be either open or covered; and the other for vehicles capable of carrying a minimum load of five tons of goods, vehicles of this class to have level platforms only without any covers. The vehicles are to be capable of going anywhere where a horse-drawn vehicle carrying the same load can go, and of being placed in the same positions and withdrawn therefrom without external assistance. The particular manœuvre most called for is to work into and out of a loading berth when cramped for room, and it is required that vehicles shall be capable of working into and out of an embayment of one and a half times its own length. Trial runs will be made from Liverpool over minimum distances of 30 miles, but no longer than 40 miles, on four successive days, the trials beginning on the morning of Tuesday, May 24 next, and concluding on the afternoon or evening of the Friday following. Money prizes of £100, £75, and £50, and certificates of merit, will be given at the discretion of the judges.

The Working of the Light Railways Act.—An interesting and very important point has cropped up as to what extent tramway lines can be considered to come within the scope of the Light Railways Act of 1896. The Light Railway Commissioners have decided that the application in connection with the electric light railways at Taunton cannot be dealt with by them, and that it comes under the pre-existing Tramways Act. The matter has received the attention of the London Chamber of Commerce, and was discussed at a meeting of the Electrical Trade Section on Tuesday afternoon. The case was stated by Mr. Garcke, who said that the question of light railways was important, because it was a matter for consideration whether the Light Railways Act should receive the widest possible interpretation and be used for the purpose of promoting light railways in agricultural districts, and also tramways in urban districts and inside towns. If the Act was confined to the objects of promoting what were purely agricultural lines, one of the very great benefits which they expected to derive from the passing of the Act would be sacrificed. The issue had come before them in a more or less concrete form by the decision of the Commissioners in connection with the application for a light railway at Taunton. He was not particularly acquainted with the circumstances of this case, but he understood that the application was for the promotion of lines inside the town, extending 1½ or 2 miles, entirely confined to the urban district. The Commissioners held a local enquiry, at which all the local authorities concerned and other local interests were unanimously in favour of the order being granted. No objection was taken to the order on the ground of jurisdiction or otherwise, and the Commissioners reserved their decision. They subsequently sent a letter saying that they were unable to grant the application. In the opinion of the Commissioners, this was essentially and purely an urban tramway scheme, and being such was not within the scope of the Light Railways Acts, 1896. Mr. Garcke submitted that there was nothing in the Act which in any way defined a light railway. There was nothing in the Act to exclude from the operation of the Act a tramway or light railway within an urban district, and, as a matter of fact, they had been officially informed by the Board of Trade that an order for a light railway by which several towns were connected and existing tramways coupled up with these tramways had been passed. The effect of it was that the light railways passing through the urban district and through the town came outside the town and connected other towns. It seemed that the distinction that the Commissioners were drawing was simply this one distinction—whether the line comes outside the urban district or not, and he believed it was based on the probability of goods traffic being carried or not; and he submitted that the decision of the Commissioners in this case, if interpreted in other cases, would have very serious consequences in the way of restricting the kind of schemes that would otherwise be promoted. He had under his notice a scheme which would be an extension of the existing tramway system. Part of that extension would undoubtedly come within the category of a scheme which, according to the Commissioners, could be promoted under the Light Railways Act. It would come outside the urban district, but another part of the scheme was entirely within the urban district, and was entirely for goods traffic. Therefore the decision of the Commissioners would exclude light railways in urban districts which were planned essentially for the conveyance of goods and merchandise, which the aim of the Light Railways Act was supposed to assist. They were all aware that the Tramways Act had been a failure for many years past from the point of view of promoting tramway enterprises in this country. There were a large number of lines capable of being promoted with a fair chance of being remunerative, but under the Tramways Act they would be purely speculative. It had been hoped that the Light Railways Act would have come to the rescue of these schemes, and it was his opinion that it would be a very disastrous thing for the welfare and the encouragement of agricultural and other interests if the operation of the Light Railways Act were restricted. Therefore he moved, "That the Electrical Section recommend that a memorial be sent by the London Chamber of Commerce to the Board of Trade and to the Light Railway Commissioners asking that, in view of the desirability of encouraging the use of the facilities given by the Light Railways Act, 1896, for the construction of tramways and light railways in this country, it is hoped that the widest possible interpretation may be given to the objects of that Act." He had hope, if they could make out a strong case, and were able to show that there were really no valid reasons why that restricted interpretation should be given to the Act, either that the Board of Trade might be able to give an expression of opinion on the subject which would be favourable to the view he had expressed, or that the Light Railway Commissioners might be able to give the matter further consideration. The resolution was seconded by Mr. Percy Sellon and supported by Major Flood Page, who asked why, if the Act was intended to be confined to agricultural districts, it should be stated that "application shall be made to the Commissioners by the council of any county *or borough*." The Act was supposed to facilitate the bringing of agricultural produce into the markets, but what was the use of bringing it up to the end of a borough and then leaving it, to be carried perhaps two or three miles by some other means into the market. After some further discussion the resolution was unanimously adopted. It should be stated that the chair was taken by Mr. Sydney Morse.

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THE MECHANICAL CONSTRUCTION OF ELECTRICAL MACHINERY.

BY F. M. WEYMOUTH.

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THE DYNAMO.

(Concluded from page 588.)

Brush Gear.—Having touched on the circumstance that carbon brushes are used in a position directly radial to the commutator, an illustration in point is afforded herewith in Fig. 314. This represents a design of gear used with much success with the motors of tramcars, accumulator driven on the Jarman principle, which were running a few years ago at Croydon. A previous arrangement having given trouble, that now before us was made in the light of experience gained, and was suited to the existing rocker and spindle. To regard this device in some detail, the peculiarity of there being only one spindle, *c*, instead of two is thus to be noted. From this spindle are suspended two brackets, *a a* and *b b*, which for the sake of lightness and strength are cast in phosphor-bronze; the upper ends being hinged on the spindle in the manner shown, and well insulated therefrom, and from each other. Such close proximity of the

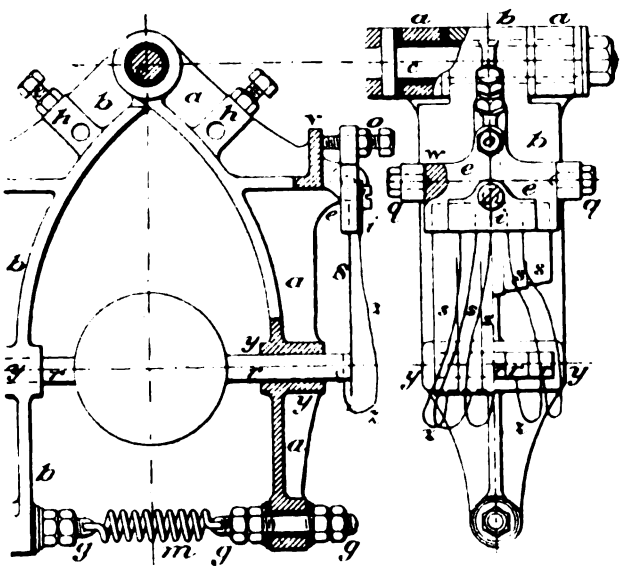

FIG. 314.

two holders of course constitutes an apparent drawback to the system, though not a matter that caused difficulty in practice.

The method of fitting the carbons, however, may be noticed. A difficulty to be met arose from the liability of the brushes to jump off the commutator under excessive vibration, thus giving rise to much sparking: for sometimes for short intervals a speed of 12 miles an hour would be attained on a road on which ordinary horse cars were also used. The method adopted, therefore, is to put not one solid carbon block each side, but five carbon sticks, *r r*, side by side in each holder. To keep these, therefore, at their work, vibration notwithstanding, a phosphor-bronze spring plate is fitted behind the carbons. This, lettered S where seen in end view, has its upper end soldered into a deep recess cored in the bottom of a gunmetal plate, *e e*, which latter is pivoted so as to swing free on the points of two screws, *q q*, as made clear in part section at *w*. The lower end of the plate, S, is cut into five fingers, lettered *s s* in the other view, so that thus one finger presses on each carbon. To maintain and regulate the pressure the upper end of the swinging plate, *e e*, is fitted with a pinching screw, *o*, whose point impinges on a projection, *v*, cast on the main bracket. It will thus be seen that, while by means of this screw, pressure would be applied to the carbons jointly, it yet, owing to the splitting of the plate, would act on them individually only. A still further spring, *m*, however, is required: for without this gravity would alone keep the brushes on the commutator, except for any dependence that might be put on a tight fit on the spindle, *c*. These latter, however, being insufficient with the vibration and jolting due to the circumstances, the spring, *m*, couples together the lower ends of the two holders, and so causes them jointly, so to speak, to close on the commutator between them. The spring is immediately attached at either end to bolts, *g g*, which are, of course, well insulated, as shown: and its tension is regulated by nuts on these bolts. It will be observed that both here and at the adjusting screw, *o*, above, locknuts are used, being proved a necessity by experience.

A point that may be noted in the application of these springs is the fact that the subduing of the vibrations is not devolved on one spring only, with one end, for instance, attached to the vibrating and jolting framework, and the other end fitted against the carbon. But there are here two, if it may not be said to be three, systems of springs, through which all vibration tending to make the carbons leave the commutator has to pass, and is reduced in its effect practically to nil.

The carbons, which are about $\frac{5}{16}$in. square in section, are also coated all over with a thin layer of deposited copper. They are an easy sliding fit in the rectangular box, *y y*, cast in the bracket to receive them; and thus the bracket may slightly oscillate or vibrate to and fro, but without in that respect carrying the carbons with it. The deposited copper coating would assist the passage of current between the bracket and the carbons. Flexible leads, as indicated at *z z*, are also carried from the end of each carbon to a terminal plate, *i i*, wherein their ends are all soldered, and which is attached by a screw to the plate, *e e*. These plates and the carbons are thus all easily removable without disturbing the main brackets, *a a* and

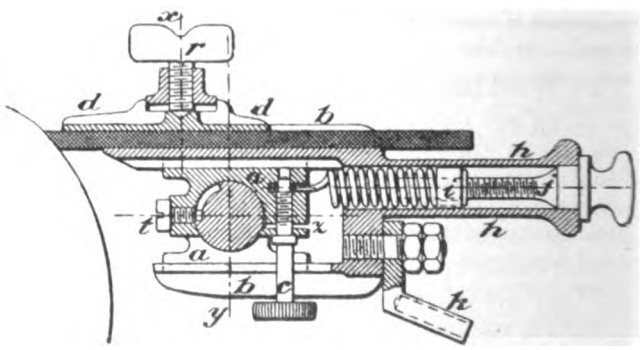

FIG. 315.

b b. But the current through the small cables, *z z*, will have to pass into the main bracket through the contact therewith afforded by its supports. These leads, however, have the effect of diminishing the flow of current through the flat springs, *s s*, which otherwise would have a tendency to heat them, and thus destroy their resilience. The main leads to and from the switches are attached to terminals, *h h*, cast on the brackets as shown.

The experience with these carbons thus mounted was that if of suitable quality they lasted about three months with constant daily wear. It was requisite, however, that they should be neither too hard nor too soft: for in the former case they would break, while in the latter they would, of course, not stand wear. The method of fixing them had the advantage of rendering their replacement a matter of a few minutes only. If a digression may be excused, the writer feels inclined to remark how regrettable it is that an enterprise such as this, with accumulator-driven cars, running so thoroughly successfully from at least a mechanical and passenger-carrying point of view, should have collapsed, owing, as the writer has been informed, to embezzlement by a responsible official. An advantage of the accumulator method in practice is, that in case of an obstacle on the line, the car made be run off the line and past the obstacle on to the line again, by its own power, which, of course, cannot be done on the trolley system, in which latter the cars are tied by the necessity of retaining connection with the conductor.

A further design of straight-feed brush gear is added here, in Figs. 315 to 317. This design, it may, perhaps,

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be mentioned, is a modification on an earlier design by the present writer. Such modification, however, consists in the removal of a spring catch holding-off gear, which experience has shown to be an unnecessary complication, and the substitution of a screw (*t*) with its point engaged in a slot (*m*) in the brush spindle. The writer has to thank very much Messrs. The Thames Ironworks and Shipbuilding Company, Limited, Blackwall, who have the earlier form in use, for the drawings from which these present diagrams are reproduced.

This gear, which we may now describe, is composed principally of two parts. Of these, the first is a block, *a a*, which is split on one side as shown at *z*, and is clamped on

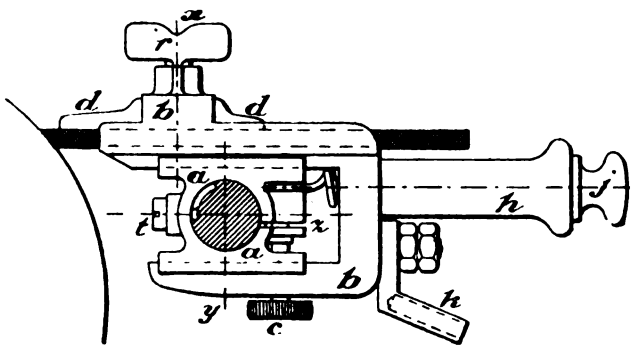
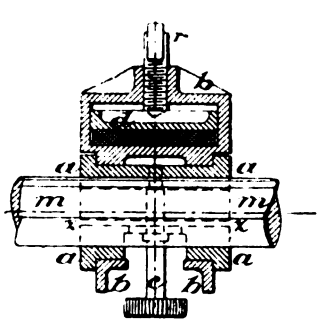


FIG. 316.

to the brush spindle by a screw, *c*, and thereby made a fixture. The second part is a jaw, *b b*, fitted with an easy sliding fit over the fixed block, *a a*, as shown; and this jaw, as may be perceived, carries with it the brush. A tubular projection, *h h*, cast on the back of the sliding jaw contains a tension spring, one end of which is engaged by the point of the clamping screw, *c*, and the other end is attached to a nut, *i*, which works on a screwed rod, *j*. It will thus be seen that tension in the spring will exert a pull on the jaw, and bring it with the brush toward the commutator, and so maintain the brush in contact with the latter. The pressure of the brush on the commutator is regulated by rotating the rod, *j*. The "straight feed" will thus be apparent, inasmuch as the brush can only move in a direction parallel with the upper and lower sides of the fixed block, *a a*.

In order to hold the brush off the commutator, when required, it is merely necessary to slacken the clamping screw, *c*, a little, when the whole structure may be rotated on the spindle, the tubular end, *h*, being depressed, and so the brush point will be elevated and put out of contact, and may be so retained by tightening the clamping screw in the new position. Too great a tilting of the brush is limited by the play of the point of the screw, *t*, within the



Section on x y.

FIG. 317.

groove, *m*, already alluded to. But by this latter arrangement also it is insured that when the brush is put back again into contact with the commutator, it will go exactly into its right position once more, if this is so chosen that the point of the screw, *t*, shall then be against the lower side of the slot, *m*, as depicted: and thus the precise fit of the chisel end of the brush on the commutator will be retained. It may be observed further, however, that the jaw and brush may be removed entirely by simply slacking the clamping screw, *c*, sufficiently to free its point from the spring.

With the use of gauze brushes especially, experience teaches the desirability of supporting these above very close up to the commutator: thus for this purpose the clamping plate, *d d*, is carried well forward toward the brush point as shown. When worn, it is only necessary to set the brush further forward in the holder by use of the clamping screw, *r*. It will be observed that the plate, *d*, is ribbed to avoid distortion under the concentrated pressure of the screw.

The current is taken off the jaw direct by means of a small flexible cable, if not two, having a socket, *k*, sweated on its end, which is then bolted to the jaw as shown. There is thus retained the advantage that the current has to pass no joints except such as are tight and properly made for the purpose. The weight of the attached cable has to be borne in mind when selecting the size of wire for the spring. It will be observed, more especially in Fig. 317, that the total width of the gear is very little more than the width of the brush, and thus the brushes may be near together, and economy in the length of the commutator is conserved.

NOTES ON ACCUMULATOR CONSTRUCTION.

BY DESMOND G. FITZ-GERALD.

[*Copyright.*]

XXX.

In considering, from our present standpoint, the original patent (No. 129, January 11, 1881) of Camille Faure, it should be borne in mind that the specification of this patent gave the first intimation that it is possible to avoid the long and tedious formation process of Planté by the simple device of applying on the lead plates a layer either of spongy metallic lead, or of an oxide, or of an insoluble salt of the same metal. According to M. René Tamine,* Planté was well aware that by applying red lead to the plates the period of formation would be reduced; but he never succeeded in obtaining a sufficient degree of adherence between this "active material" and the metal; nor did any account of his unsuccessful experiments in this direction reach the general electrical public. Having conceded to M. Faure the merit of originality, and the title of pioneer which is due to him, we need have no compunction in referring to the mistakes and shortcomings in his specification. The mistakes are, in an exaggerated form, those usually made by inventors and patentees: the specification and the claims are far too wide, the main points of novelty and utility are insufficiently referred to and defined; whilst, on the other hand, details of which the value is readily negatived by experiment are carefully insisted upon.

"The invention," says the inventor, "has reference to an economical and expeditious preparation of the elements of these (galvanic polarisation) batteries by covering them, by mechanically coating, electroplating, or chemical precipitation or deposit, with a layer of spongy or porous lead of suitable thickness." But this is not considered sufficient for one patent. "The invention also relates to various applications of the piles and batteries constructed according to the said invention, such as their employment as powerful regulators and magazines of electricity or electrical energy." Nor is the inventor yet satisfied. "The invention further relates more especially to the novel application of the system to vehicles of all descriptions propelled by electricity, as carriages on wheels, or boats or barges, by the combination upon such vehicle, or on another vehicle drawing it or pushing it, of an electro-dynamic machine with a polarisation battery constructed according to the said invention, and capable of being charged at convenient intervals by any suitable means." It is difficult to refrain from admiration of the tremendous scope of an invention which thus embraces accumulator traction in the distant future; but it would have been better if more attention had been given to particularly describing and ascertaining the mode in which the invention was to be performed.

* "Recherches sur les Accumulateurs Electriques," p. 99.

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"In carrying out this invention, leaden plates or blades are principally employed as a support for the porous or spongy materials with which they are covered by mechanical application, electroplating, or galvanoplastic process, chemical precipitation or deposit, or by simple adhesion. In order to render these supporting plates capable of storing up a sufficient quantity of electricity, the plate or pair of plates or elements are prepared by covering them with a coating composed of metallic salts or oxides, intimately mixed with inert substances, for example, by employing a coating of sulphate of lead mixed with pulverised coke, which mixture may be moistened with a small quantity of gelatine." It is now known that peroxide of lead, in presence of sulphuric acid, acts chemically upon, and is reduced by, carbon in any of its ordinary forms. But it took a very long time to find that out; and M. Faure may be excused for not being aware of it. But it is difficult to conceive that the gelatine idea could ever have been carried out in practice.

The specification goes on to state that when two elements, "prepared as hereinbefore described," are placed in dilute sulphuric acid and charged from a source of electricity, the salt of lead on one of the plates will be reduced, and will form an adhesive but very porous layer or coating, which is precisely the result it is desired to obtain. Nothing is said as yet of the other plate, but it is pointed out that when the current is reversed this in its turn will become reduced, whilst the lead reduced in the first instance will become peroxidised. Thus the peroxide element is formed from spongy metallic lead; this method of manufacture being, as is now understood, about the worst that can be adopted. It is next stated that the deposit of porous lead may be obtained "by means of galvanism" from a soluble salt of the metal. The employment of a powerful current of electricity is indicated, apparently with the object of obtaining the lead "in a pulverulent condition," instead of in large crystals. But none of the details and precautions necessary to obtain the deposition are mentioned; and it is now known that the lead in a pulverulent condition has no adherence to the lead cathode.

The specification then states that "The two primary elements may be of a metal other than lead, such as copper, for example, and may even consist of coke or carbon, and be surrounded with oxides or other salts (*sic*) of lead more or less mixed with carbon or other inert substance." From this it is evident that the inventor was not aware of the fact that, in the case of one of the two primary elements, or supports—viz., the anode copper, "for example," is quite inadmissible, since it would be oxidised and dissolved without any conversion of the active material into peroxide of lead. Moreover, as above observed, coke or carbon is not an inert material. The next statement, that "The deposit may be of any thickness," embodies a very serious error, and was soon disproved by actual experiment.

Drawings are then referred to illustrating various arrangements for carrying the invention into effect. In describing one of these arrangements the inventor states that "The spaces between the plates may, if preferred, be filled with felt, asbestos, or other sufficiently porous substance capable of maintaining the plates at the proper distance apart, and preventing the liquid from splashing in case of the battery being moved." This is the only reference, outside of the claims, to a device which was found to be absolutely essential in working the invention at all, and which was ultimately a failure by reason of the oxidisable character of the materials used for the diaphragms or "linings." Two of the drawings refer to arrangements for carrying into effect automotric traction by means of accumulators.

The claims under this patent are: (1) The improved secondary batteries enabling a large quantity of electro-chemical force or energy to be stored up in a small space and small weight substantially, as hereinbefore described. (2) The process of obtaining plates or supports capable of retaining and preserving electro-chemical force or energy by covering them with a layer of porous or spongy metallic (*sic*) matter deposited to any desired thickness by galvanising, chemically precipitating, or mechanical adhesion, substantially as described. (3) The employment of linings of indiarubber, felt, or other suitable materials for maintaining and holding up to or against the supporting plates the coating or layer of metallic substance mixed or not with inert matter. (4) The combination with a wheeled carriage, or other vehicle, or boat, or barge, of an electro-dynamic machine carried on the said carriage or vehicle, and a secondary or polarisation battery capable of being recharged at the end of a journey.

In the third claim the use of indiarubber is mentioned. The selection of this material was as unfortunate as that of "felt," as was demonstrated by experiments extending over a few months. It had been pointed out in the report of the Joint Committee of the Board of Trade and the Atlantic Telegraph Company (1861) that, even in air, "Caoutchouc is liable to deterioration by exposure to the action of oxygen in the presence of solar light"; and Mr. Latimer Clark has observed that in the course of a few years elastic vulcanised indiarubber becomes excessively rotten, unless protected from the action of oxygen.* Now, in forming and charging a lead accumulator, oxygen is evolved in very considerable quantity (XIII.); and so early as 1866 Planté, using small electrodes, had noticed that a portion of this oxygen is in the form of ozone.† The destructive action of this agent on the indiarubber tubes used to convey it is an observation as old as the researches of Schœnbein (1840); and the fact is referred to in many popular works on chemistry.‡

XXX. (*a*).

I should not have thought it necessary to insist at any length upon the destructibility of every form of soft indiarubber located in the electrolyte of a lead accumulator if it had not been for the following passage in the report of the meeting of the Institution of Electrical Engineers on the 11th inst., which appeared in the last issue of this journal (p. 662): "There was an American invention which had been explained to him, devised for the purpose of getting over the great difficulty which they had experienced even with fixed cells, and that was the difficulty of preventing the active material from crumbling away and becoming detached. That constituted the greatest difficulty of all that they had had, and with the vibration of the road and the vibration of the machinery they were sure to have that falling away increased very much. The American inventor had tackled the difficulty by encasing the whole of the plate with vulcanised rubber, not of the hard vulcanite form, but a quite soft and elastic form. Each of the positive plates was covered with a thick diaphragm of this rubber, which was pierced at regular intervals by properly formed apertures which gave the electrolyte free access to the surface of the plate, but at the same time allowed elastic support to the surface of the plate. That was to say, he applied a diaphragm to the surface of the plate which was sufficiently porous to allow free action of the electrolyte, and at the same time held the active material up to its backing. Some device of that kind seemed to be what they wanted before they submitted the ordinary accumulator to the vibration of tractive apparatus. If that could be done, they would have made a great step in advance."

For the purpose in view, something very different in chemical composition to caoutchouc (C_5H_8) is required—such as pyroxylin ($C_{18}H_{21}$, $9NO_2$, O_{15})—which forms the basis of the commercial products known as celluloid, or the inorganic substances specified in letters patent No. 1,054, 1896, owned by the British Electric Traction Company, Limited.

XXXI.

The second patent granted in this country to the representative of M. Faure is No. 1,676, April 16, 1881. The claims relate entirely to particular means for attaching or securing a porous or permeable covering over the layers of active substance, so as to maintain the latter against the plates or supports; and to imparting rigidity to the latter

* Minutes of evidence taken before the Submarine Telegraph Committee, p. 204.

† *Comptes Rendus*, t. lxiii., p. 181.

‡ Thus, in the "Cours Elémentaire de Chemie" of Debray: "L'ozone détruit les matières organiques; il peut même altérer rapidement le caoutchouc, il le perce et le rend cassant." And in Williamson's "Chemistry for Students": "By contact with indiarubber or cork or any other vegetable or animal substance, ozone is immediately destroyed by the oxidation of the hydrogen and carbon of the vegetable substance."

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by attaching them to a board or support or partition of wood, ebonite, or other similar impermeable material. The porous or permeable covering may consist of felt, cloth, asbestos paper, cardboard, gauze, or cloth made with lead or other wire, or any other similar porous or permeable material. This may be attached or secured to the plates by means of rivets, stitches, cement, trelliswork, etc. In the provisional specification it is stated that "the combinations of felt, a lead plate, and a sheet of indiarubber constitutes an important feature of this invention; these three substances producing the same effect as the same three substances individually and collectively as hereinbefore described, and this with or without the addition or intervention of red-lead or other active salts" (*sic*). But no mention of this "important feature" is made in the final specification—perhaps by reason of the difficulty of understanding what this description of it can really mean.

ALTERNATOR DESIGN.*

BY J. FISCHER-HINNEN.

(Concluded from page 654.)

It only remains now to determine the length, A B. It follows from the similarity of the triangles, D A B and D G H, that

$$\frac{A\,B}{D\,B} = \frac{G\,H}{D\,H}$$

or

$$\frac{A\,B}{2\,\pi\,c\,L_1\,J_1} = \frac{\Phi_2}{v_1\,\Phi_1} = \frac{\sin\,\phi_2}{v_1\,v_2}$$

or

$$A\,B = \frac{2\,\pi\,c\,L_1\,J_1}{v_1\,v_2}\sin\,\phi_2 \quad . \quad . \quad (18)$$

If we take the figure D C A B (Fig. 11), then we may

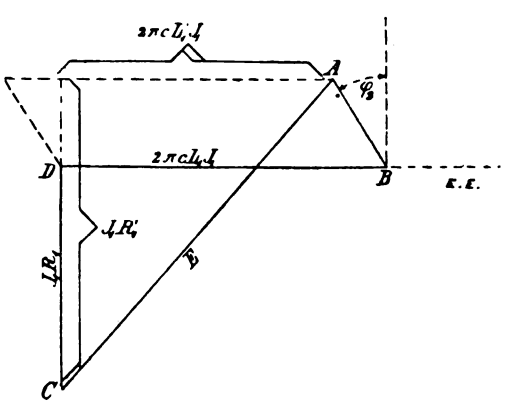

FIG. 11.

suppose that the original resistance, R_1, and the self-induction, L_1, are replaced by the resultant resistance, R_1', and the resultant self-induction, L_1', respectively, then

$$R_1' = R_1 + \frac{2\,\pi\,c\,L_1\,J_1}{v_1\,v_2}\sin\,\phi_2\cos\,\phi_2 \quad . \quad . \quad (19)$$

and

$$L'_1 = L_1 - \frac{L\,.\,\sin^2\,\phi_2}{v_1\,v_2} \quad . \quad . \quad . \quad . \quad . \quad . \quad (20)$$

Or since ϕ_2 is approximately equal to 90deg. the second part of equation (19) = 0, and in equation (20) $\sin^2\,\phi = 1$.

Consequently

$$R_1' = R_1 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (21)$$

$$L_1' = L_1\left(1 - \frac{1}{v_1\,v_2}\right) \quad . \quad . \quad (22)$$

Or, if L' stands for the resultant self-induction coefficient of both revolving fields,

$$L' = L_1 + L_1\left(1 - \frac{1}{v_1\,v_2}\right) = L\left(1 - \frac{1}{2\,v_1\,v_2}\right) \quad (23)$$

The last equation shows clearly the influence respectively of the leakage and of the air-gap between the armature and the magnets upon the action of the damping coil. If, for example, the air-gap is nothing, then v_1 and $v_2 = 1$. The resultant primary self-induction, therefore, would only be half as much as before.

There only remains one point to discuss, and that is, What must we make the diameter of the copper bars of the damping coil? When

J_1 and J_2 = the primary and secondary current respectively;
N_1 and N_2 = the number of turns in primary and secondary respectively;
λ_1 and λ_2 = the length of a winding in either circuit;
s_1 and s_2 = the sectional areas of the wires in the primary and secondary;

from Fig. 10 it follows that

$$J_2 = \frac{1}{v_2}\,\frac{N_1}{N_2}\,.\,J_1.$$

The respective losses of energy in watts are therefore in the primary

$$w_1 = J_1^2\,.\,\frac{N_1\,\lambda_1}{50\,.\,s_1} \quad . \quad . \quad . \quad . \quad . \quad (24)$$

and in the secondary

$$w_2 = J_2^2\,.\,\frac{N_2\,\lambda_2}{50\,.\,s_2} = \frac{1}{v_2^2}\,\frac{N_1^2\,J_1^2}{N_2^2}\,.\,\frac{N_2\,\lambda_2}{50\,.\,s_2} = \frac{J_1^2}{v_2^2}\,\frac{N_1^2}{N_2}\,\frac{\lambda}{50\,.\,s_2} \quad (25)$$

or, dividing (25) by (24), we get that

$$\frac{w_2}{w_1} = \frac{1}{v_2^2}\,.\,\frac{N_1\,s_1}{N_2\,s_2}\,\frac{\lambda_2}{\lambda_1} \quad . \quad . \quad . \quad . \quad (26)$$

$N_1\,s_1$ and $N_2\,s_2$ signify nothing more than half the sectional area of the total wires around the armature—that is, the damping coil.

Example 5.

What area have we to give the damping coil if $v_2 = 1{\cdot}3$, and $\lambda_2 = \lambda_1$, and the loss in the damping coil is to be half that of the armature wires? According to equation (26)—

$$(N_2\,s_2) = \frac{1}{1{\cdot}3^2}\,.\,\frac{1}{0{\cdot}5}\,.\,(N_1\,s_1) = 1{\cdot}18\,(N_1\,s_1).$$

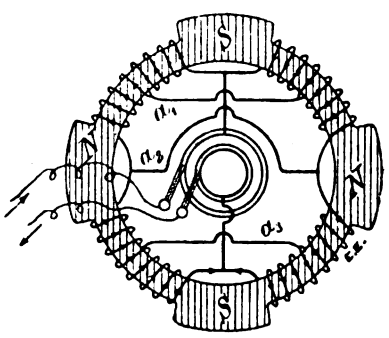

FIG. 12.

Fig. 12 illustrates another method of constructing a damping coil designed conjointly by Mr. G. Giles and the author. The magnets are similar in form to those used in Thury's continuous-current machine, with the difference that the turns are divided into two parallel circuits, the coils laying symmetrically round the points at which the current is introduced. These coils are connected with each other in the middle and at the ends by the wires, a_1, a_2, a_3. In this way currents are created in the magnet coils through the reaction of the armature. These currents run through the transverse connections, and cause, as in the preceding case, a reduction of the self-induction in the armature. As we all know, the magnet poles of the alternating-current machine are composed of laminated iron to avoid their becoming heated. That object is achieved by these means, while at the same time the equalising effect of the massive poles, which forms a damping coil, is lost, and at the same the loss of voltage is increased. The heating of the magnet poles is less noticeable in all two or three phase machines, and, in fact, all machines with revolving field, even when of most solid construction, because the field of the armature rotates synchronously with the magnet field, and, in consequence, only Foucault currents are created when it changes in strength. It is a well-known fact that by currents with a sine curve a field of constant strength is

* From the *Elektrotechnische Zeitschrift.*

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created. The normal alternating-current machines made by Farcot in Paris, for instance, which are of similar type to Mordey's alternators, but with Gramme armatures and fixed magnet coils, have unlaminated poles. The poles remain absolutely cold if the armature is wound for multiphase working, but if the three phases are switched on in series, one with the terminals reversed, then the poles get warm even after a short time of working. It is a curious fact that this heating is limited to a depth of about 10cm. from the pole surfaces.

Conclusion.

I did not like to close this article without touching briefly upon a question to which up to the present various answers have been vouchsafed. I am referring to the maximum loss of voltage which is admissible. As the value of a machine, independent of its efficiency, etc., is more or less estimated from its loss of voltage, the question remains: What loss of voltage may be considered admissible, and what shall be the standard for classification?

To find a solution to this which would be applicable in all cases is, of course, impossible, as the way in which the machine is intended to be used is an important factor. It is well known that a pretty large self-induction is an advantage as far as power transmission with synchronous motors is concerned. Also alternating-current generators with a great drop of voltage are useful in metallurgy, in the manufacture of carbide of calcium, etc., because through it the danger of burning out at short-circuit is avoided. The same advantage might be claimed for lighting installations, if there we had not to contend with the mitigating disadvantage that more supervision and regulation is necessary for these machines. I do not know how far the system of automatic regulation has been a success, but the tests which I have seen have not inspired me with too much confidence. Besides, an automatic regulation is made difficult, because, as a rule, alternating-current machines are used in installations in which great distances occur, so that the losses in the wires and in the transformers are important factors to be reckoned with.

In many instances, instead of the automatic regulator, the use of what is called a "homme à potentiel constant" is preferred. The latter accommodates the voltage of the machine to the currents at the time. Under these circumstances the drop of voltage also becomes a matter of importance, especially when arc lamps with choking coils or motors are switched on to the circuit. It is therefore interesting to examine the drop of voltage in machines which are known to be reliable. By 12 different machines of three makers universally acknowledged to be good, the drop of voltage was, with an average $\cos \phi = 0{\cdot}8$, between 20 to 27 per cent.—*i.e.*, an average of 23 per cent.—*i.e.*, $\eta = 0{\cdot}77$. Although these figures are larger than is generally supposed to be the fact, they are taken from "good" machines. If we now consider that the price of a machine increases with the size X (the relation of which to the drop of voltage we know from equation 10), then we will not go far wrong if we define the drop of voltage of 15 to 20 per cent. at $\cos \phi = 0{\cdot}8$ as the utmost limit in machines which are to stand the competition of the market. Under favourable circumstances one might arrive at a lesser drop, but as a rule such a machine would become too weighty.

It may not be out of place to say a word here in opposition to the inaccurate method of description of machines used by some makers in their catalogues. The output of alternating-current generators is set down in horse-power or kilowatt, without giving the corresponding $\cos \phi$. That is really a description which describes nothing, because the same generator which, when working upon ohmic resistance gives 100 h.p., may reach the limits of its output at inductive loads at half this amount. In order to avoid any misunderstanding, it is desirable to give the minimum $\cos \phi$ at which the quoted output can be obtained. A difference should also be made, when speaking of alternating-current generators, between watts and volt-amperes, describing the watt always as the product of $J \times E_1 \times \cos \phi$. Although this appears to be self-evident, yet in many instances contracts are made where frequently the manufacturer, as well as the customer, finds himself committed to the disadvantage in consequence of this omission.

Similar disagreements may occur when the voltage is given without respect to the way the machine is to be worked on the network. It is clear that a machine for 2,000 volts needs less insulation than one for 5,000 volts, providing it is used in the same manner. It is equally well known that a machine working upon a system of concentric cables of only three to four miles with 2,000 volts must be considerably better insulated than those working with 5,000 volts upon overhead conductors, and the cost is increased in the same ratio.

Errata.—Mr. Fischer-Hinnen informs us of two errors to be found in this article on p. 621 in our issue of Nov. 12. In the first column the formula $\Phi = \frac{D \pi \beta}{2p} . l . \beta$ should read:

$$\Phi = \frac{D \pi \beta l B}{2p}$$

and in the other column, in explaining that B is obtained from equation (11), the symbol B is by mistake left on the underside of the expression which follows.

TESTS OF THE ILLUMINATION OF THE ROTUNDA IN THE BUILDING FOR THE LIBRARY OF CONGRESS.*

BY DR. CARY T. HUTCHINSON.

The general appearance of the great rotunda or reading-room of the new library of Congress building is shown in the accompanying engraving (Fig. 1). The plan is an

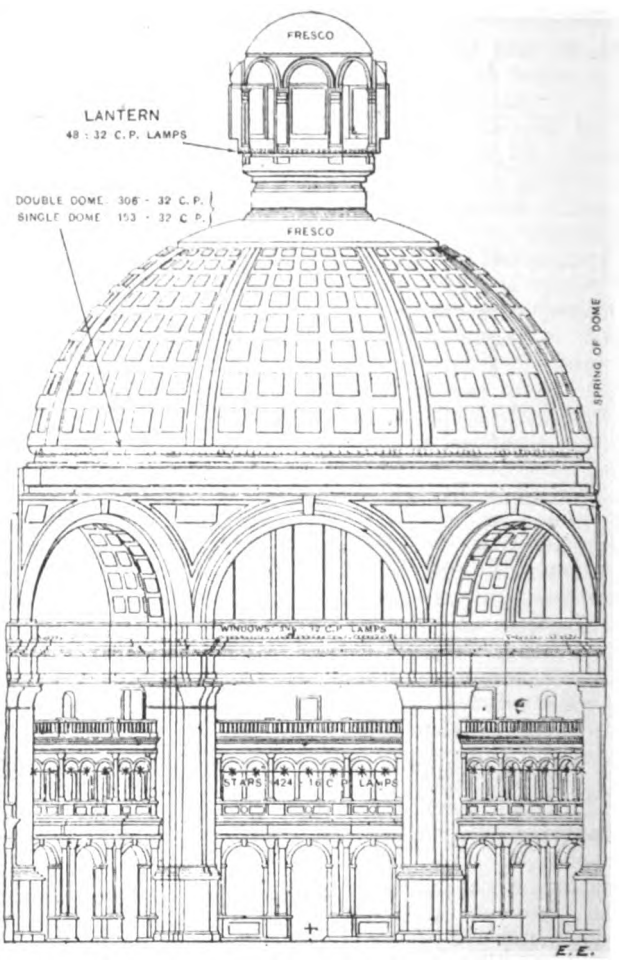

Fig 1.—Lighting Arrangement of the Reading-Room and Dome of the Library of Congress, Washington.

octagon, having a diameter of nearly 100ft. and a height of 82ft., surmounted by a dome, slightly flattened, having a height of 40ft. This dome is topped by a lantern, with a diameter of 20ft. and height of 25ft., which is finished by a small dome. The interior, up to the springing line

* From the *Electrical Engineer* (New York).

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of the window arches, is mainly polished marble, of medium to dark colours; from this point to the springing line of the dome it is stucco and fresco work, in medium tones; the main dome is finished in coffers; the interior of the dome of the lantern is an oil painting. There are a number of statues and paintings in various parts of the rotunda, all of which must be well lighted. The floor space is about 8,500 square feet, and the volume approximately 1,000,000 cubic feet.

The lights are on four levels, arranged symmetrically around the octagon. The first line is that of the "Stars," at a height of 29ft. from the floor, comprising 53 stars, each of eight 16-c.p. lamps, a total of 424 16-c.p. lamps. These are suspended by special fixtures across the springing line of the small arches of the first gallery. These lamps have no reflecting surfaces behind them, but serve to illuminate the book alcoves. The second line is at a height of 52ft. from the floor, and is composed of eight groups of 50 32-c.p. lamps. These lamps are arranged in one line at the bottom of each of the eight large windows; the window back of them serves, in part, as a reflector. The third line is at the base of the main dome, 84ft above the floor; the lamps are arranged uniformly around the circle and connected alternately in two circuits; each circuit has 153 32-c.p. lamps, making a total of 306 lamps. The lamps are set back slightly, and are partly visible from the floor; the dome serves as a reflector. The fourth line is at a height of 135ft.; the lamps are strung around the base of the lantern, and are not visible from the floor; there are 48 32-c.p. lamps. They are intended primarily to illuminate the painting on the small dome. The total number of lamps is then 424 16-c.p. and 750 32-c.p., making a total of 30,784 c.p., and demanding 95 kw.

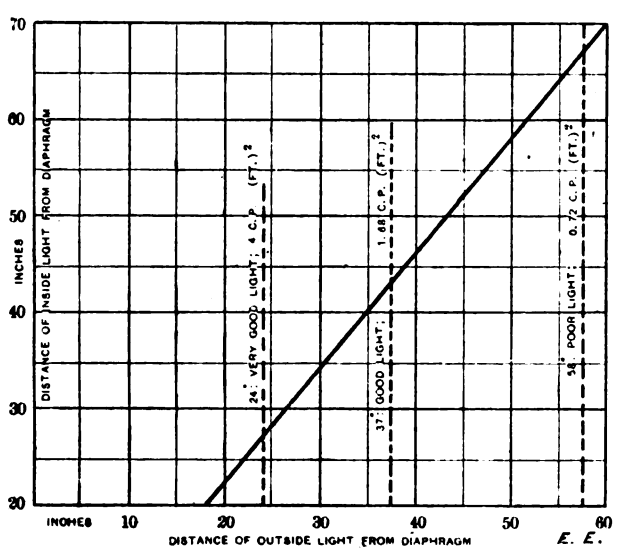

FIG. 2.—Test of Lighting of Congressional Library, Washington.

The tests were made by measuring with a photometer the illumination given by various combinations of circuits. The photometer was a rough affair, made for the purpose. It consisted of a box 8in. square and 6ft. long, with the inside surfaces thoroughly blackened; one end was closed by a sheet of paper with a grease spot at the centre; the other by a block through which passed a rod carrying at the inner end a 16-c.p. lamp; the rod was movable, and was properly graduated to give the distance of the lamp from the diaphragm. In all the illumination tests the plane of the diaphragm was horizontal, and about 2·5ft. from the floor; the photometer box projected through the floor. The photometer was compared with an outside light by placing it horizontally, with the outside light in the prolongation of the axis of the box; these tests were made at night with no other light in the room; the point of the outside lamp was directed towards the diaphragm. In this way the distance of the photometer lamp for various distances of outside lamp was obtained. The curve in Fig. 2 shows this comparison: ordinates are the distances of photometer lamp; abscissæ, of the outside lamp. The room is so large that reflection was not appreciable. At the same time a page of brevier type was placed on the diaphragm, and the distance of the lamps for "very good," "good," and "poor" illumination was estimated by the observers. This is, of course, a matter of individual judgment, and is very rough. It is added merely as a general guide.

TABLE I.

Location.	Number of lamps. 16 c.p.	Number of lamps. 32 c.p.	Total c.p.	Vertical height.	Distance.	Illumination. c.p. ÷ ft.²	Per cent.
				Ft.	Ft.		
Stars (S)	424	—	6,784	27	62	0 77	26
Windows (W).....	—	396	12,672	50	83	1·10	38
Dome (2D)	—	306	9,792	82	95	·94	33
Lantern (L).....	—	48	1,536	132	133	·09	3
Total	424	750	30,784			2 90	100
One circuit of dome (1D)	—	153	4 896	82	95	·47	16 5

The tables give the data and results of the test. Table I. shows the number of lamps in each set, the total candle-power, the vertical height, and the slant distance of a lamp from the diaphragm; it also gives the theoretical illumination of each set calculated by the formula, $c.p./ft.^2 = c.p. \times h/d^3$, making no allowances for reflection; and the proportion of the total illumination supplied by each set. The dome set is double, as stated, and the data is given for both circuits.

TABLE II.

No.	Lights burning.	Candle power.	Measured distance.	Corrected distance.	Illumination. c.p. ÷ ft.² Meas'd.	Illumination. c.p. ÷ ft.² Calc.	Ratio Meas'd ÷ Calc.	Per cent. for measured.
			In.	In.				
1	S+W+2D+L	30,784	25·00	22·50	4·54	2·90	1·57	100
2	S+W+1D+L	25,888	26·00	23·25	4·25	2·43	1·74	94
3	S+W +L	20,992	26·05	23·75	4·07	1·96	2·07	90
4	W+2D+L	24,000	28·00	25·00	3·68	2·13	1·73	81
5	W+1D+L	19,104	32·75	29·00	2·73	1·66	1·64	60
6	W +L	14,208	38·00	33·25	2·07	1 19	1·74	45
7	S +2D+L	18,112	32·50	28·75	2·78	1·80	1·54	61
8	S +1D+L	13,216	39·25	34·25	1·96	1·33	1·47	43
9	S +L	8,320	51·75	44·75	1·15	·86	1·34	25
10	2D+L	11,328	42·25	36·75	1·70	1 03	1 65	37
11	1D+L	6,432	57·50	49·50	·94	·56	1·68	21

Table II. records the result of the experiments. Column 1 is the number of the experiment; Column 2 the combination of circuits in use; Column 3 the aggregate candle-power of these circuits; Column 4 the observed distance of the photometer lamp; Column 5 this distance corrected by the curve of Fig. 2, so that the "corrected distance" is the distance of a single lamp in the open, with point to diaphragm, which gives equal illumination; Column 6 is the illumination in $c.p./ft.^2$ from this corrected distance; Column 7 the calculated illumination taken from the data of Table I.; Column 8 the ratio of the observed to the calculated illumination, which is a measure of the reflected diffusion; Column 9 the percentage that each combination of circuits is of the total measured illumination. The experiments of Table II. give 11 equations for the determination of the four quantities S, W, D, and L. These are reduced to four by using (4)+(5)+(6) as one; (7)+(8)+(9) as the second; (10)+(11) as the third; and (1) as the fourth. Solving these four as simultaneous equations, the values of Table III. are obtained for the separate sets of lights. Experiments (2) and (3) are omitted, as they do not agree at all with the others. Table III. gives the value of 2D as 32 per cent. of the total, yet a comparison of experiments (1) and (3) shows that cutting off the dome when all the other lights are on makes a difference of only 10 per cent.; (2) similarly gives a difference of only 6 per cent., instead of 16·5 per cent. The other nine experiments are consistent—that is, the observed values of the different combinations agree with the sum of the values of the parts composing them. I have no explanation of the discrepancy of (2) and (3). Table III. shows that the

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"Star" lights are less reflected, as would be expected from their situation; the "Windows" have a higher ratio than the "Dome" and the "Lantern," the highest of all. The lantern dome throws all the light straight down. The average of the entire room is 1·57, as shown. The differences in the coefficients are not great enough to change materially the relative effect of the different sets, as is shown by the last two columns of Table III. The total illumination, 4·54 c.p./ft.^{2}, is very brilliant: the windows alone give a fair reading light on the floor—viz., 1·87 c.p./ft.^{2}. There are, of course, no shadows anywhere.

TABLE III.

Location.	Illumination. M's'd. c.p. ÷ ft.^{2}	Illumination. Calc. c.p. ÷ ft.^{2}	Ratio. M's'd ÷ Calc.	Per cent. M's'd.	Per cent. Calc.
S	1·00	0·77	1·30	22	26
W	1·87	1·10	1·72	41	38
2D	1·42	·94	1·51	32	33
L	·25	·09	2·80	5	3
Total ...	4·54	2·90	1·57	100	100

TABLE IV.

	c.p./ft.^{2}.
Stars	$4·75 \times 10^2$ per kilowatt.
Windows	$4·70 \times 10^2$,, ,,
Dome	$4·67 \times 10^2$,, ,,
Lantern	$5·55 \times 10^2$,, ,,

Table IV. shows a rather unexpected result; it gives the illumination per kilowatt expended in the lamps, assuming 3·1 watts per candle-power. It will be seen that in spite of the widely varying arrangement and positions of the different lamps, the illumination per kilowatt is practically constant for the three main circuits, and is but slightly higher for the "Lantern." It would hardly be thought that more light per kilowatt could be obtained by placing the lamps at a height of 135ft. from the floor. The table suggests the conclusion that with fair diffusing surfaces the location of the lights has little influence on their effectiveness in illuminating the given surface.

It is generally assumed that the total light intensity required to illuminate an enclosed space with broken surfaces is proportional to the volume of the space (Palaz). The floor area of the rotunda is 8,500 square feet, the volume 1,000,000 cubic feet, approximately; assuming 5×10^{-2} as the average value of Table IV., it follows that the watts per cubic foot, per c.p./ft.^{2} = 2×10^{-2}; candle-power per cubic foot, per c.p./ft.^{2} = $6·5 \times 10^{-3}$; 4·5 c.p./ft.^{2} gives a brilliant illumination and requires per cubic foot, 9×10^{-2} watts; per cubic foot, $2·9 \times 10^{-2}$ c.p.

These tests were made under the direction of Mr. Bernard R. Green, the superintendent of the library.

ELECTRO-ZINCING.

BY SHERARD COWPER-COLES, A.M.I.C.E., M.I.MECH.E.

The following is an abstract of a paper read before the Liverpool Engineering Society on the 17th inst., which the council of the society has allowed us to reprint:

Amongst the most noteworthy changes of late years in the materials employed for constructional and engineering purposes is the very extensive substitution of steel for wrought iron. Ironmasters are dispensing with the puddler's services, and are using steel instead of puddled bars for rolling down into sheets, hoops, strips, and other products, while engineers are now employing steel in many situations where formerly only iron was to be found. The age of iron is giving place to an age of steel. With its many advantages over iron, steel unfortunately possesses one serious drawback—it corrodes more rapidly. The author then proceeds to detail the corrosion found to take place and the best means of preventing it. This he concludes to be a covering of zinc. He then reviews the development of the common hot galvanising processes, and the present practice of carrying out the same. The reduction of the tensile strength of wires by the hot galvanising process was also referred to. The author touches on the lead-covering process, and points out that the surfaces obtained by hot and by cold galvanising differ considerably in appearance. Hot-galvanised articles are often covered with large spangles or crystals, which are obtained by adding small quantities of tin to the galvanising bath; but this attractive appearance is gained at the cost of the durability of the protection afforded to the underlying metal, as the spangles render the coating unequal in thickness and inferior in quantity. For these reasons some of our leading engineers now specify that galvanised sheets shall be without spangle, and carry zinc to the weight of 1oz. per square foot. The zinc on electro-zinced articles has an unhealthy non-metallic look, which has created considerable prejudice against such articles when compared with the brilliancy and glitter of the spangles obtained by the hot process. The dull surface of electro-deposited zinc can, by the adjustment of the current, be developed into a mat surface, which has been found especially suitable for the coating of nails, as it increases the holding properties, whilst, on the other hand, hot galvanising decreases the holding power. To surface-harden galvanised sheets, aluminium has been added to the bath of molten zinc at the moment of dipping the iron sheets, whereby a compound surface of zinco-aluminium is formed on the articles under treatment. It has been claimed that the thin film of aluminium serves as a protective coating to the molten zinc, reducing the formation of ashes and hard zinc to about half the amount usual where protecting covers of sal ammonia, fat, or glycerine are used; the addition of the aluminium also enables a thinner coat of zinc to be applied. According to the patentee, metallic aluminium only enters into combination with zinc in the proportion corresponding with the atomic weights of the metals. The zinc applied by the hot process usually contains lead, tin, and iron, and it has been found that iron above 0·13 per cent. makes the zinc too brittle to be properly bent. Lead up to about 1 per cent. is harmless, but above 1½ per cent. will not dissolve, and the excess collects and forms weak spots. Arsenic, antimony, cadmium, and copper also occur, but practically never in quantities sufficient to be injurious. Some zinc removed from a Siemens-Martin hot-galvanised plate was found to be very brittle, breaking when attempts were made to bend it. Analysis gave the following results:

Zinc by difference	94·02
Tin	2·20
Iron	3·78
Arsenic	Trace

The average thickness of the coating was ·015in. On the other hand, zinc applied by the electro process is very pure, and it is found to resist the corroding action of a saturated solution of copper sulphate (Preece's test for Post Office telegraph wires) very much better than hot-galvanised iron. A specimen of hot-galvanised iron, having 1·48oz. per square foot, withstood three immersions, whilst a similar piece of iron, electro-galvanised, having 1·26oz. per square foot, withstood five immersions, as shown in Table No. 2.

TABLE 2—Giving Results of Sulphate of Copper Tests Made on Samples of Charcoal Iron, Coated with Zinc by Different Processes. Preece's Post Office Test.

Process used to coat the iron.	Grains per square foot.	Ounces per square foot.	No. of one-minute dips samples stood without showing metallic copper.
Hot galvanising	648·5	1·48	3
Acid bath ($ZnS0_4$)	446·4	1·02	4
Neutral bath (ZnS_{04})	552·64	1·26	5

From this it may be inferred that with coatings of zinc of equal thickness, the article coated by the electro process will withstand the ordinary corrosion due to atmospheric influences much better than steel coated by the hot galvanising process, or, expressed in other words, steel coated by the electro process will have as long a life as hot-galvanised steel, with less zinc than would be necessary in the case of the ordinary hot process.

The process of electro-zincing is, however, not without its difficulties. The deposits obtained from zinc sulphate solution are adhesive only when great care is exercised in the preparation of the receiving surface. After pickling, the iron should be well washed in alkali, otherwise the acid is retained in the pores of the metal and sows the seeds of decay. Other matters of moment are the slowness of electro-zincing when working with a low current density, and the difficulty experienced in coating articles of irregular shape. Difficulty is also experienced from the want of adhesion when the zinc has obtained a thickness beyond that corresponding to 1oz. of zinc per square foot. Attempts have been made to overcome this difficulty by the method employed to make silver adhere to a baser metal—namely, by quickening—that is, immersing the copper or copper alloy to be silvered in an aqueous solution of mercury. As mercury will not amalgamate with iron, an electric current has to be employed. Dr. Leeson, in 1842, patented the use of mercury for preparing metallic surfaces for electro-deposition both by simple immersion and by the electro-deposition of mercury. The application of this process to the coating of iron with zinc is found to be too costly: the mercury also has a tendency to render the zinc coating brittle. To reduce the labour that would otherwise be neces-

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sary in zincing small articles such as bolts and nuts, successful attempts were made in 1870 to coat small articles by placing them in a revolving perforated metallic cylinder. A similar arrangement has been employed for coating steel bullet jackets with cadmium and zinc. Even when ironwork is to be painted, a thin preparatory coating of zinc may be applied with great advantage. Engineers recognise the fact that the best results are obtained when the paint is applied direct to the iron surface before it has had time to rust, as the rust prevents the intimate contact of the paint and induces chemical action which causes the paint to peel from the iron. The durability of painted ironwork, therefore, largely depends upon the surface of the metal being properly cleansed and prepared. An excellent surface in this respect may be obtained at a very small cost by "zinc flashing"—that is, coating the iron or steel after pickling with a thin coat of zinc, which will resist the effects of the weather and retain a perfect surface for receiving a coat of paint until such time as it can be applied.

Having briefly pointed out the importance of galvanising and explained the nature of the results obtained, the author proceeds to give some idea of the actual process, more especially of electro-zincing, and a description of the plant employed. The first care in electro-zincing is to have a properly prepared surface; all traces of grease and rust must be removed. Machined work, which is usually very greasy, should be immersed for about half an hour before pickling in a hot solution of caustic soda, about ½lb. to the gallon of water. The work should then be placed in a hot pickle containing about 1 per cent. of commercial sulphuric acid. I have found that a considerable saving of acid can be effected by placing a false bottom in the pickling tank, so as to catch the heavier portion of scale as detached, the tray being removed after the day's work and the scale collected. The same object can be attained by placing an electromagnet behind a lead plate, the pickling solution being caused to circulate over the plate so that the scale may be attracted to the poles of the magnet and removed from time to time. After pickling, the work should be allowed to stand as long as possible in a bath of lime-water. Sand blasting is often used instead of pickling, and for many purposes

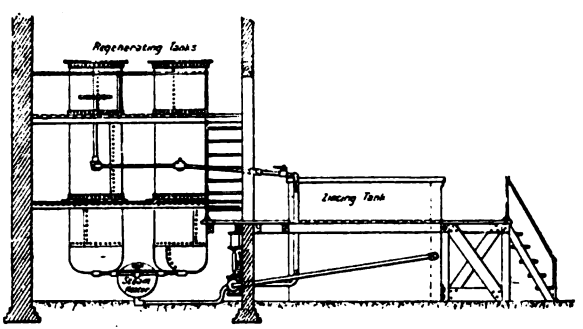

FIG. 1.

it is found to give better results, especially for cast-iron work, from which it is very difficult to remove the last traces of acid. The cost of sand blasting per square foot under the most favourable conditions, including cost of labour, sand, and power, is 1-10d., but the actual cost varies considerably with the nature of the work. When using quartz sand of the best quality the loss is about 10 per cent. each time it is passed through the machine; the loss when using chilled iron sand is very small, the waste of the material replacing more than nine-tenths of the apparent loss. In a complete sand-blast equipment the plate or casting is caused to travel slowly through the sand-blast room, whilst the two jets of sand propelled by air, at a pressure of 10lb. per square inch, are directed over its surface by workmen. The sand after it has done its work passes through an open floor grating and is caught in the hopper beneath, and at intervals allowed to return to the mixing chamber, the valves of which are regulated by levers in the sand-blast room.

Hitherto the great difficulty experienced in electro-depositing zinc has been to keep the electrolyte in working order, as zinc anodes, whether cast, rolled, amalgamated, or in the form of granulated zinc, fail to keep the solution up to its normal strength. I have found the adding of zinc dust to the electrolyte to be the only practical method of accomplishing this end. The zinc dust, which contains about 97·5 per cent. of metallic zinc, is cheaper in the first cost than virgin spelter; the use of it also considerably reduces the waste of zinc, as practically the whole of it is consumed. Zinc dust, or tultz, is a greyish amorphous substance, and must not be confused with zinc oxide; it is obtained as a sublimal product in the flues of the zinc-smelting furnaces. Small quantities of zinc dust are placed from time to time in the generating tanks, which are connected to the depositing vats by a system of piping as shown in the side elevation and plan in drawings (Figs. 1 and 2), the electrolyte flowing into the bottom of the depositing tanks by gravity, the lighter liquid being drawn off over a sill at the end or in the corner of the vat. The work to be zinced is secured to dogs fitted with cross-bars, which rest on copper strips attached to girders carrying the anodes. This arrangement effects a considerable economy in the first cost of the plant; it has also the advantage of allowing the electrodes to be brought much nearer together than would otherwise be the case. In the illustration shown the baths are capable of dealing with plates 6ft. by 5ft., the tanks having a capacity of 900 gallons. The heavier classes of work are transferred from the vats by an overhead carrier, the lighter by a trolley running on rails.

A special feature of the electrical process is that plates of very large dimensions can be speedily zinced on one or both sides, which is a matter of some importance now that plates of great length are being put in the straight run of steamers' hulls. The frames of such craft as torpedo-boat destroyers can also be galvanised after riveting up. The first cost of a galvanising plant having a capacity of 6,700 gallons (30ft. by 6ft. by 7ft.) is about £600, which is but little more than that of a hot-galvanising plant having a bath capacity of only 10ft. by 4ft. by 4ft. 6in. outside dimensions. Such a hot bath would hold 28 tons of zinc, which, at £15 a ton, amounts to £420. To keep this large quantity of zinc in a molten condition entails a heavy expenditure in fuel, the thickness of the iron bath averaging more than 1in. Moreover, the iron baths are a constant source of annoyance and expense, as the iron is dissolved by the zinc, resulting in the ultimate destruction of the tank. Table A gives the output of work of various sizes of zincing plants. The cost of electro-zincing varies with the nature of work to be zinced. The author's estimate of cost of zincing 20 tons of plate in a working week of 52 hours, the average thickness of plates being 5-16ths of an inch, and the thickness of zinc coating 1oz. per square foot, is £2. 11s., with electrical energy at 1d. per electrical horse-power.

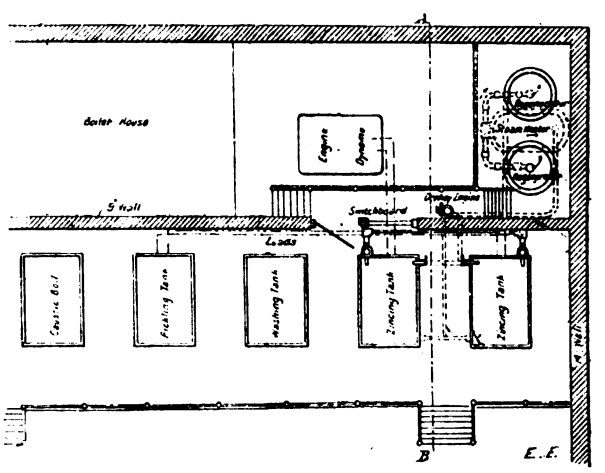

FIG. 2.

Both pickling and hot galvanising have the disadvantage of reducing the strength of wires and of distorting and rendering brittle iron and steel of small section. By exposure to the lowest working temperature of the hot galvanising bath (which averages some 1,000deg. F., the fusing point of zinc being 775deg. F.), steel wire of high breaking strain has its hardness, and consequently its ultimate tensile strength and elongational efficiency, reduced by as much as from 5 to 10 per cent. by the drawing of the temper and formation of an iron-zinc alloy on the surface of the steel. It is the practice when coating steel wire to keep the bath of molten zinc at as low a temperature as possible, and to run the wire through at a high rate of speed. But these combined causes lead to a considerable waste of zinc by reason of the rapid solidification of the metal on the comparatively cold wire, and they also conduce to the ready breaking or cracking off of the covering metal on bending or twisting, owing to the difficulty with which molten zinc of low temperature adheres to the steel except after prolonged contact. In some cases the wire on leaving the bath is wiped between asbestos rubbers, but steel thus treated is found to resist corrosion only for a short period. Many attempts have been made to electro-zinc wire, but until recently it has not been found practicable to produce a wire capable of withstanding more than one immersion in a copper sulphate solution. Most manufacturers have ceased to galvanise the best classes of steel wire (which cost some £35 per ton), on account of the great risk there is of rendering it worthless. This is unfortunate, for corrosion is found to be very marked on the inner strands of wire rope, and the advisability of protecting the steel is unquestionable.

Electro-zincing does not reduce the tensile strength or increase the elastic fatigue of steel wire, even in wires having a tensile strength of 170 tons or more per square inch, such as are used in the manufacture of pianos. The zinc coating put on by the hot process is also uneven, and the increased weight is often a

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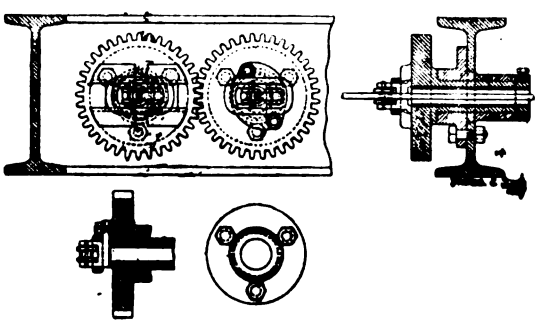
TABLE A.—Output of Work of Combined Zincing and Pickling Plants of Various Sizes. 100 Hours per Week, 5,200 Hours per Annum.

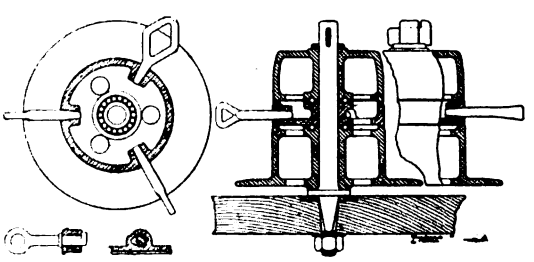
Size of plant.	Output of work per week in square feet at 1oz. of zinc per square foot.	Output of work per annum in square feet at 1oz. of zinc per square foot.	Output of work in tons per week $\frac{1}{16}$in. to $\frac{3}{8}$in. plate.											
			$\frac{1}{16}$in. plate.		$\frac{1}{8}$in. plate.		$\frac{3}{16}$in. plate.		$\frac{1}{4}$in. plate.		$\frac{5}{16}$in. plate.		$\frac{3}{8}$in. plate.	
Amperes.			tons	cwts.	tons	cwts.	tons	cwts.	tons	cwts.	tons	cwts.	tons	cwts.
2,900	10,284	534,768	5	15	11	10	17	4	22	19	28	14	34	9
4,500	15,508	806,416	8	13	17	6	25	19	34	12	43	5	51	18
5,600	20,011	1,040,572	10	8	20	19	33	9	44	13	55	1	66	19
7,000	25,180	1,302,360	14	1	28	5	42	7	56	4	70	5	84	6
8,800	31,017	1,612,884	17	5	34	11	51	19	69	5	86	10	103	15
10,100	36,186	1,881,672	20	4	40	8	60	11	80	15	100	19	121	5
11,600	41,356	2,150,812	23	1	46	2	69	4	92	6	115	7	138	8
14,000	46,525	2,419,300	25	19	51	18	77	17	103	17	129	16	155	15
14,500	51,695	2,688,140	28	16	57	12	86	10	115	8	144	4	173	0

matter for consideration. The thickness of the coating can only be varied within narrow limits, the minimum weight of zinc being about 1½oz. per square foot, the maximum 3oz., excepting when the molten zinc is raised many degrees above the most economical working temperature, and the articles are removed gradually from the bath so as to give the zinc time to drain off before getting chilled, or in the case of thin sheets and wires which are capable of having some of the zinc squeezed or wiped off by rollers or other suitable mechanical means. Excess of zinc has been removed from galvanised wire by passing it through asbestos rubbers, but wire thus treated soon rusts, as it is found in practice impossible to regulate the thickness of the zinc, the result being that an iron-zinc alloy is formed on the surface of the iron and no true coating of zinc. The weight of metal on galvanised sheets or terne plates is usually ¾oz. per square foot. Wires can be coated with zinc by electro-depositing to a thickness of 3-1,000in., or an increased diameter of 6-1,000in., capable of standing eight one-minute immersions in a saturated solution of copper sulphate. A wire 69-1,000in. in diameter, with a total thickness of 3-1,000in. of zinc applied by the electro process, will withstand repeated bending round a bar 1in. in diameter, without exhibiting any signs of peeling or cracking.



Figs. 3 and 4.

In a general arrangement of an electro-zincing plant for wires, the vat is constructed of wood and lined with sheet lead. The wood covers are also faced with lead, and are provided with counterweights so that they can be readily lifted for the purpose of cleaning the vat or inspecting the wires under treatment. The covers when in position form part of the anode making electrical contact with the ridges, and thus forming a circular lead anode around each wire. The solution is circulated rapidly through the plating vat and passed into tanks supplied with zinc dust, where it is revivified. Contact brushes, provided with weights or springs, press upon the wires in the spaces provided between the covers, collect the electric current, and at the same time burnish the zinc deposit. Figs. 3 and 4 show another form of burnisher suitable for brightening deposits. The coated wire is caused to pass through the agate rollers, which are mounted on carriers capable of turning on centres. The carriers are arranged to move on guides, so as to respond to any unevenness or alteration of position of the wires; the guides carrying the rollers are pressed together by rubber bands or springs to give the necessary pressure for burnishing. Figs. 5 and 6 illustrate a swift, arranged to carry two coils of wire, so as to economise space and reduce the first cost of the plant. Each swift is provided with two drums mounted so as to turn upon a spindle, the lower drum having a flange for supporting the lower coil of wire, there being between the drums and secured to the spindle a collar provided with pins or supports for carrying the upper coil of wire. The pins or supports are made so that they can be easily removed, or turned out of the way. When the coil on the lower drum becomes exhausted, a coil from the upper drum, if unexhausted, can be allowed to descend on to the lower drum by removing the pins or supports, which can then be again inserted in the collar, and a fresh coil or coils can be placed in the upper drum. An electrolyte from which good bright deposits can be obtained is composed of 40oz. of zinc sulphate of 1·1770 specific gravity (=19 per cent. of crytallised zinc sulphate), and 5oz. of ferrous sulphate to the gallon of water, the anodes being of lead. Dr. Kiliani, of Munich, who was the first to recognise the importance of E.M.F. in the separation of metals, found that during the electrolysis of a solution of zinc sulphate of 1·33 specific gravity (=76oz. $ZnSO_4+7H_2O$), the anodes and cathodes consisting of zinc plates, the evolution of gas was greatest with a weak current, and ceased when on 1 square centimetre of electrode surface 3 milligrammes of zinc were precipitated per minute—that is, 25·833 grains per square foot per hour. From a 10 per cent solution the deposit was best with a current yielding from 4 milligrammes to ·2 milligramme per square centimetre per minute, or 3·46 to 1·78 grains per square foot per hour. From very diluted solutions the zinc was always obtained in a spongy condition, accompanied by evolution of hydrogen; with a strong current, the deposit was very firm. With a weak current, and from a 1 per cent. solution, oxide of zinc was also precipitated even with an E.M.F. of 17 volts, when only 0·755 milligramme of zinc was deposited per minute on 1 square centimetre of cathode surface (= ·62 grain per square foot per hour. The same authority found that 2·35 volts are necessary to decompose zinc sulphate. Electrolytes made by adding caustic potash or soda to a suitable zinc salt have been



Figs 5 and 6.

found to be unworkable on a commercial scale, the zinc oxide formed on the surface of the anode being insoluble in caustic potash or soda. A solution of cyanide of potassium and zinc cyanide is also impracticable, both on account of cost and the insolubility of the anode. The same remarks apply to a potassio-tartrate solution, patented in 1855 by Watts, made by dissolving 200oz. of cyanide of potassium in 20 gallons of water, to which he added 80oz., by measure, of strong liquid ammonia. With this solution he filled large porous cells, and put them upright in a vessel containing the bulk of the solution. He placed strips of copper in the porous cells and large zinc anode in the outer vessel, and connected them up respectively with the negative and positive poles of a battery, and allowed the current to flow until zinc had been dissolved to the extent of 60oz. in all, or 3oz. to each gallon of solution. To this solution he added 80oz. of carbonate of potash by dissolving it in portions of the solution at a time and returning the dissolved salt to the bath. A fair coat of zinc is obtained with difficulty from solutions of zinc chloride and from the fused salt. One of the great impediments to the reduction of zinc on a commercial scale has been the tendency of the zinc, after depositing in a sound state for a short time, to come down in one of the varieties of the spongy deposits.

With regard to the best working conditions, most authorities recommend a current density of 18 to 20 amperes per square foot of cathode surface, and aqueous solutions of zinc sulphate, acetate, or chloride, ammonium chloride, or tartrate, as being the most suitable for its deposition. Herman's process has also been experimented with on a commercial scale, the chief feature being the addition of the sulphates of the alkalies or alkali earths to a weak solution of zinc sulphate. The zinc deposits obtained from hot electrolytes appear to be more porous than

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those obtained from cold electrolytes. Such a plant as shown in Figs. 1 and 2 would require a current of 3,500 amperes at an E.M.F. of seven volts. When the articles to be zinced are first placed in the bath it is found advantageous to use as high a current density as possible, and after a few minutes to reduce it to about 10 amperes per square foot.

TABLE OF WEIGHTS AND THICKNESSES OF ZINC COATINGS.

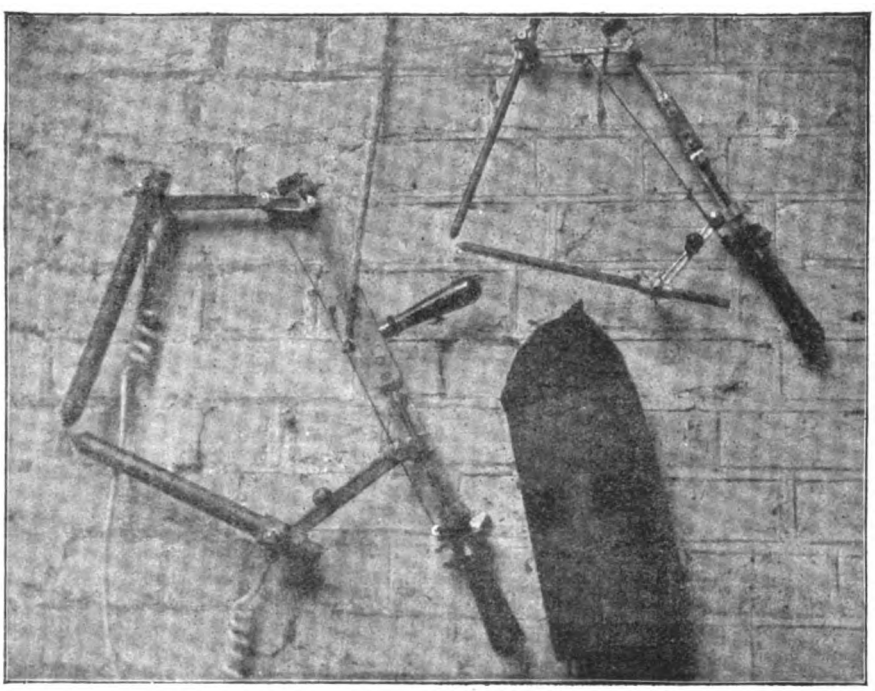
Weight of zinc, per superficial foot.	Weight of zinc, per superficial yard.	Thickness of coating.
1oz.	9oz.	·001698in. or $\frac{1}{589}$in.
¾oz.	6¾oz.	·001273in. or $\frac{1}{785}$in.
½oz.	4½oz.	·000849in. or $\frac{1}{1178}$in.
¼oz.	2¼oz.	·000424in. or $\frac{1}{2356}$in.

TABLE OF COST FOR VARIOUS THICKNESSES OF ZINC AND CADMIUM COATINGS.

Cost of zinc per square foot.	Cost of cadmium per square foot.	Weight of deposit per square foot.	Thickness of deposit	
			Zinc.	Cadmium.
d.	d.	oz.	in.	in.
·0107	2·625	·1	·00016	·0001
·0267	6 545	·25	·0004	·00025
·053	13·125	·50	·0008	·0005
·080	19·670	·75	·0012	·0075
·107	26·25	1	·0016	·001

THE VOLTEX PROCESS OF ELECTRIC WELDING.

The Voltex process of electric welding, brazing, soldering, and lead-burning now being introduced by the Electric Metal-Working Syndicate, of 61, Gracechurch-street, was on view at the Sunderland Exhibition on Saturday last. Unfortunately, current to work the apparatus was not obtainable that day, so that we could not see it actually at work. Welds which had been made by it and a number of brazed joints were on view, so that there was little doubt as to its actual capabilities.



The illustration shows two sizes of the apparatus, together with the mask with eyeholes covered with dark glass, employed to protect the workman's eyes from the light of the arc, and also in the case of heavy work requiring comparatively large currents, to protect his face from the heat radiated from the arc. The apparatus consists of a carbon-holder and a pair of carbon electrodes. In using the apparatus an arc is struck between the electrodes, and owing to the material of which these are made and their arrangement in the tool-holder, a powerful flame like that of a gas blow-pipe, but of much greater range of temperature, is projected from between the adjacent ends of the electrodes, and is directed upon the material to be heated. The portion of this "blow-pipe flame" nearest to the carbon points is of the highest temperature obtainable by artificial means, and its temperature gradually decreases as the distance from the electrodes is increased. The workman, therefore, by merely varying the distance of his work from the electrodes can apply to it a blow-pipe flame of a temperature ranging at will from that of the arc itself down to a temperature comparable to that of an ordinary gas blow-pipe. By varying the voltage or electric pressure by means of a regulating switch, the power of the blast can be still further increased or diminished at will.

Mr. G. W. de Tunzelmann is the consulting engineer to the company, and he assured us that with the carbons placed as shown there is no difficulty in getting a flame 8in. long. The composition of the carbons used is, however, the point on which he lays the greatest stress, and at the present this cannot be disclosed till certain foreign patents are complete. It will be noticed that this process is not unlike that devised by Dr. Zerener, in which, however, an electro-magnet is used to blow the arc out. Details of this will be found on pp. 148 and 235 of our seventeenth volume. The company is proposing to let out their apparatus at an annual rental, varying with the output of the sets, but they lay great stress on the point that little power is required. Thus a special plant for the purpose need not, as a rule, be installed, and also the working costs are kept down. In a circular issued about the process, the following comparative figures of the cost of brazing and filling up a cycle frame are given:

By Gas and Coke Process.—With gas at 2s. 10d. per 1,000 cubic feet.

	s.	d.
320 cubic feet of gas	1	1
Wages 1½ hours for brazing, at 9d. per hour	1	1½
Wages 4 hours and 20 minutes for filing off, at 8d. per hour	2	10½
Wear and tear of files, air blast, and coke	0	8
	5	9

By Voltex Process.—With electricity at 3d. per Board of Trade unit.

	s.	d.
1½ unit of electricity	0	4½
Wages 50 minutes for brazing, at 9d. per hour	0	7½
Wages one hour for filing off, at 8d. per hour	0	8
Consumption of patent carbon electrodes, and wear and tear of files	0	2½
	1	10½

The apparatus can also be seen at work on application at the Electrical and General Experimental Engineering Works, 2 and 4, Penywern-road, Earl's Court, London; the Goldsmiths' Institute, New Cross; the Northampton Institute, Clerkenwell; and at various technical colleges.

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BOUND VOLUMES.

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IN THE FUTURE.

Two circumstances have within the past few days impressed us that the views we have so long held in regard to the generation of electrical energy and its distribution from central stations are correct, and likely to be verified in the by no means distant future. The views we refer to are that central stations will require to be designed more with the purpose of providing power than for providing light. With perhaps the exception of Mr. Selby Bigge, no consulting engineer seems to have entered heartily into the question of power work. Factory after factory is being equipped with motors and a central generating plant for driving the various tools. Questions of detail are being worked out before the eyes of electrical engineers, but except in one or two instances they seem to ignore the whole subject. It seems but the other day that one point which agitated the minds of electrical engineers was, in high-pressure alternate-current distribution shall we have a transformer to every house, or transformer stations to groups of houses? We do not think it would be possible now to elicit two different opinions upon that point. Similarly, the question has now to be solved, whether to have a motor to drive each machine, or a motor to drive a group of machines. The latter involves the use of shafting, and one of the advantages that electrical engineers have been pressing as the result of using electrical energy is that it would do away with shafting, and the consequent constant loss of power resulting from having to continuously rotate the shafting and all its array of loose and fast pulleys. When, however, we find those who have paid most attention to the subject installing motors with shafting to groups of machines as cheaper and more advantageous than a motor to each machine, it shows that something more than abstract reasoning is required to solve the problem. We are inclined to the opinion that Kelvin's law of mains will apply, or slightly modified will apply to this question. Broadly speaking, the principal facts to be considered can soon be stated. First, a small motor for each machine will always be worked with a higher load, and, therefore, we may suppose a greater efficiency than a motor for a group of machines. Our reasoning in this matter is that the individual motor will be installed so that the maximum load of the particular machine to which it is attached is the load for which it is constructed. The common motor will seldom be called upon to drive all its machines at the same time; hence will more often be running light than will the individual motor, and consequently at a loss of efficiency. On the other hand, the larger motor will be, generally speaking, more efficient than the smaller; hence some or the whole of the losses referred to above may be balanced. Thus we shall get the two dominant factors of the case—constant losses, and interest upon increased cost. Of course, the question of one motor to each machine or a common motor to several machines hardly enters into a design where the individually-driven tools each absorb a number of horse-power, but only where the driven tools absorb little power. There

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is at this moment one of the most interesting experiments in power transmission ever attempted in an ordinary English central station about to be tried at Sunderland. Here the gas-driven pumping plant at some graving docks is to be exchanged for electrically-driven pumping plant. If this is successful—and there is no reason to think it will prove otherwise—and economical as compared with gas, it is fully certain that a very large development of electrical power transmission will take place in the district. Rumours are already rife to the effect that some sixteen thousand horse-power will have to be provided. Perhaps at the present moment Bradford stands first as to power connections, for we believe that between six and seven hundred horse-power, principally in small units, can be demanded of the central station. It will thus be seen that power distribution will most undoubtedly play a very important factor in central-station work in the near future.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TEMPERATURE VARIATIONS IN CLARK CELLS—A CORRECTION.

SIR,—I trust you will allow me to correct a mistake in your report of the last meeting of the Physical Society. In the discussion I wished to draw attention to the fact that when using a Board of Trade form of Clark cell under ordinary working conditions, rapid changes of temperature being avoided, it is unnecessary to trouble about "lag" if the absolute value of the E.M.F. is in question, because this is not known to a greater accuracy than $\frac{1}{10}$ per cent. (not *one* per cent. as reported); and, even if the accepted value of the volt be taken as correct, the E.M.F. in this form of cell is not reproducible to a greater accuracy than $\frac{1}{10}$ per cent. When, however, we are not concerned with the actual value of the E.M.F., but only with its constancy, the question of "lag" may be a serious one. The importance of "lag" depends simply on the experimental conditions—a fact which does not seem to be always appreciated.—Yours, etc.,

W. R. COOPER.

REVIEWS.

Magnetic Fields of Force. By H. EBERT. Translated by C. V. BURTON, D.Sc. Longman, Green, and Co. 10s. 6d.

This book is an exposition of the phenomena of magnetism, electromagnetism, and induction, based on the conception of lines of force, by Hermann Ebert, the professor of physics in the university of Kiel. The date of the original volume which Mr. Burton has translated is 1896, so that the matter is not old. The author has attempted to build up from first principles the laws of magnetism and electricity, using systematically the ideas of lines of force. Special stress is laid on three fundamental conceptions—*i.e*, the conception of lines of force, the conception of energy in a magnetic or electromagnetic field, and, finally, that of the symmetry of a medium, which is the seat of magnetic force. As the author rightly points out, the old fluid theory of magnetism is now worn out, and it is recognised that when an electric current is flowing the most important part of the whole phenomenon takes place in the field of magnetic force surrounding the conductors. The book is divided into two sections—the first dealing with the phenomena of magnetism, and the second the phenomena of the "galvanic" current and of electromagnetism. We think the translator should have used "electric" for "galvanic" in this connection. The book is not an elementary one, and the subject-matter is gone into most fully. The recently-published posthumous work by Prof. Heinrich Hertz is treated of at length. This deals with the question of the essential nature of electricity. In spite of these highly theoretical and to many readers abstruse portions of the volume, the other more elementary parts are not slurred over. In fact, the experiments described and illustrated make the elementary facts and phenomena most clear to the reader, and add immensely to the value of the work. The first two chapters, dealing with the magnet and the magnetic field, and the mutual action of two magnets, are particularly to be recommended in this respect. The following chapter, on magnetism as a terrestrial and astronomical phenomenon, would be more complete if the charts showing the declination and horizontal components of the earth's field at different parts of the globe were given. These charts are referred to, and hence should be given. The author's remarks on the northern lights are interesting. He claims that "numerous and careful observations have established the fact that the streamers or rays of the aurora are everywhere nearly coincident in direction with the magnetic lines of force." Again, "If the luminosity extends over only a few bundles of lines of force, we shall see a number of narrow parallel strips reaching downward from the sky. If a magnetic storm passes over the earth, the lines of force will wave to and fro like the stalks in a cornfield, the bands of light swelling and bellying out as if blown by the wind—an effect noticed by many observers." The author then describes the distribution of the areas round the poles, where the luminous effects are most frequent. The following deductions as to the magnetic influence of the sun on the earth open up a new subject to dynamo designers, and likewise afford relaxing reading. Coming back to the general subject, we get next a practical chapter on the measurement of fields of force; while Chapter V. deals with the representation of fields of force. Maxwell receives due credit in this chapter, and the work of other English physicists is also referred to largely. The chapters on the various theories are worthy of careful perusal. The author gives as concisely as possible what these theories really are, and in many cases mechanical models, as of the vortex action, are illustrated and described. The chapters on electromagnetism are all carefully prepared. We can highly recommend this book to the student who cares to know more than the mere working facts about magnetism.

The Dynamo: How Made and How Used. By S. R. BOTTONE. Tenth edition. Swan Sonnenschein and Co., Limited, and Whittaker and Co., White Hart-street, E.C.

The author's preface to this tenth edition is not wanting in self-appreciation. He says: "Originally intended as a guide to the amateur dynamo-builder, this little work quickly attained a high position in the literature of the dynamo. Each succeeding edition received large increments from its author—thanks to the kindly suggestions of its many readers—until now it stands almost alone as the only non-mathematical work in which the construction of almost every practical type of dynamo is carefully described and illustrated, along with such working directions for making patterns, winding, testing for and remedying faults as are not to be found in any other book. In this the tenth edition a chapter on the construction of a large dynamo of the best modern type, with modern drawings to scale, has been added." The book hardly bears out the author in his claims for it, although for amateur makers of small models it will be most useful. As soon, however, as the author leaves this part of his subject, we have to find fault with his construction details, and also sometimes with his technical terms. We believe it best for amateurs to get used to the terms employed in workshops, and the *tunnel* of a dynamo is not one of these. Again, in the construction of the six-unit dynamo, which is said to be of the best modern type, we notice the following peculiarities: The core plates are not keyed to the spindle, but are threaded on a vulcanite bush, which is slipped over the spindle. A 12-part commutator is used. The windings of the armature and field magnets for 50 or 100 volts are given, and given

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in pounds of wire to be used. This method of Mr. Bottone's of specifying the armature windings has always puzzled us, and as in this case the field magnets are either to be cast or wrought iron at the option of the builder, we fail altogether to understand his reasoning. We are told on p. 120 that the dynamo will be more efficient if wrought iron is used, but that the difference in a machine of this size will not be so great as to counterbalance the far greater ease with which the field magnets can be made and worked if cast. The illustrations of this machine do not inspire one with confidence, but are better than the very rough sketches appearing elsewhere in the book. Our conclusion, after reading the volume, is that, although mathematics are to be avoided when carried to excess, the entire neglect of even simple algebra and arithmetical proportion in dynamo-making opens up a darker chasm.

The "Mechanical World" Pocket Diary and Year-Book for 1898. 6d. Emmott and Co., *Mechanical World* Office, Manchester.

This is the eleventh year of publication of this most valuable little book, and the second decade of its life is commemorated by resetting it in new type, and by a better binding. The new type is somewhat smaller than the old, and more pages have been added, so that a great deal more information is included in this new year's issue. The matters treated of touch on nearly every subject of interest to mechanical engineers, and the treatment is such that the utmost condensation is effected. The most valuable part of the arrangement is the almost invariable practice of giving the authorities from whom the figures and conclusions are taken. In this way the reader knows the true value of the facts he has before him, and also, should he require extended information, where to look for it. One exceedingly useful table is found on p 183, which electrical engineers taking up factory power equipments will do well to consult. This table contains a list of a large number of machine tools and the horse-power required to drive them. The foreign equivalents to English weights and measures are also given just afterwards, and add to the completeness of the volume. A good index makes the information easily accessible; and we are sure that a sixpence could not be invested better than in purchasing this book.

INSTITUTION OF CIVIL ENGINEERS.

At the ordinary meeting on Tuesday, November 23, Sir John Wolfe Barry, K.C.B., F.R.S., the president, in the chair, the paper read was entitled "Central Station Electric Coal-Mining Plant in Pennsylvania, U.S.A.," by Mr. W. S. Gresley, A.M.I.C.E.

The author described and illustrated the application, to a somewhat scattered group of mines, of the electrical transmission of power for haulage, drainage, ventilation, coal-cutting, etc., from a central station conveniently placed on the property. The extent of the mining operations had become such that mule haulage on main roads, furnace ventilation, steam, mule, and hand pumping, syphoning and bailing of water, pick mining, etc., were too expensive and unsatisfactory; and electricity had been decided upon as the most reliable and practicable form of power for general use throughout the property, which was about 5,800 acres in extent. Direct current, at a pressure of 500 volts, was employed, with the generating station situated about the middle of the mines. There were four 100-kw. generators each belted to a 150-h.p. non-condensing high-speed engine, and six 125-h.p. tubular boilers. The generators were joined in parallel. Five collieries were equipped with electric motors; in three the coal was hauled about one mile by a 50-h.p. locomotive working on the overhead trolley system; each mine had a triplex 200-gallon pump, fitted with a motor developing 5 h.p. to 10 h.p.; three of the pits were equipped with Capell fans, driven from belted motors of 25 h.p. to 50 h.p.; and in two of the pits most of the coal was undermined by Jeffrey electric chain machines. Outside the mines the circuits were of bare copper wire carried on stout poles, but the river was crossed by five submarine heavily-armoured cables attached to pole-lines on each bank. In the mines most of the wires were bare, and were hung along the walls or fixed to blocks or pins on the roof. The locomotives hauled about 1,100 tons of coal each per 10-hour day. They displaced about 39 mules with their drivers. The three locomotives were similar, each weighing 10 tons, and all their electrical apparatus was interchangeable. Their speed was eight miles per hour. Particulars of the comparative advantages of haulage by electric motors and by mules were set forth in a table, and sections, plans, etc., of the roads were given. The coal seam, the "Pittsburg bed," was about 5½ft. thick and lay fairly level; each mining machine undercut about 120 tons per day. The "room and pillar" system of working was employed. Eleven coal-cutting machines were in use: each absorbed about 15 h.p., and cut about 2½ tons in 4½ minutes; but the actual cutting time was only six hours out of every 24, the rest being lost in moving the machines from place to place, changing the bits, and between shifts. Machine mining required about one-third fewer miners than pickwork. About 70 per cent. of the output was cut by machines. The electric pumping consisted almost entirely of keeping water out of numerous branches or dipping sections of each mine, so that the suctions consisted of long lengths of pipe fitted with valves, in charge of which men were employed to regulate and keep down the water as required. Particulars of the ventilating fans, etc., were shown in tabular form, for comparison with which, data, relative to the old furnaces, as well as to one of the fans when run by a steam-engine, were given. All the fans were belted direct to pulleys on the armature shaft, which ran at 625 revolutions per minute, the speed of the fans varying according to the requirements of the collieries. All were at present running light. The fans were of the Capell exhaust type, set up in brick races with iron covers and chimneys. The entire plant was in charge of an electrician with a staff of machinists. The machinery had been started in July, 1895. The daily coal consumption was about 17 tons—mostly slack and fine coal, produced in the undercutting. Load curves under different conditions of working were given, and indicated in a marked manner the extremely variable and sudden changes of load upon the dynamos, and showed what a large reserve of power must be provided for to successfully work such a plant. The average day load was about 42 per cent. of full load, the night load being only about half the day load. The total length of circuits already in use was about 40 miles, and the most distant motor from the power-house as yet in operation was a 30-h.p. fan motor, situated nearly 3½ miles from the central station. The success of the plant had been such that additional coal-cutters, etc., were now contemplated. One man had been killed from shock received through the trolley wire, but he was not concerned with working the locomotive or with the wiring. The installation had cost about £23. 10s. per horse-power developed by the engines; repairs and working cost about £5 per horse-power per year, or about 1½d. per ton of coal produced.

FORTHCOMING EVENTS.

The following are some of the announcements for the forthcoming week:

To-day (Friday).—Physical Society's meeting at the Rooms of the Chemical Society, Burlington House, at 5 p.m. ("Upon the Failure of German-Silver and Platinoid Wires," by Mr. Rollo Appleyard). Council meeting, 4.15 p.m.—Electro-Harmonic Society's Concert (ladies' night), St. James's Hall Restaurant (Banquet-Room), Regent-street, W., 8 p.m.

Monday, November 29.—Society of Arts, John-street, Adelphi, Cantor Lecture, 8 p.m. ("On Guttapercha," by Mr. Eugene F. A. Obach, Ph.D., F.C.S.); first of series of three.

Tuesday, November 30.—Institution of Civil Engineers, Great George street, Westminster, 8 p.m. ("On the Law of Condensation of Steam," by Messrs. Hugh L. Callender, M.A., F.R.S., and John T. Nicolson, B.Sc.).

Wednesday, December 1.—Society of Arts, third ordinary meeting, 8 p.m. ("The American Bicycle—the Theory and Practice of its Making," by Prof. Leonard Waldo, D.Sc.).

Thursday, December 2.—Chemical Society's meeting at Burlington House, at 8 p.m.—Finsbury City and Guilds Technical College, Leonard-street, City-road, E.C., 8 p.m. (Mr. Philip Dawson on "Electric Traction").

Friday, December 3.—Institution of Civil Engineers, students' meeting, 8 p.m. ("Permanent Way: its Construction and Relaying," by Mr. Grote Stirling, Stud.Inst.C.E.).

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THE INSTITUTION DINNER.

The Institution of Electrical Engineers held their annual dinner on Wednesday last, and this year the Hotel Cecil was selected as the meeting place. This was a much more more convenient spot than that selected last year, considering the foggy state of the atmosphere and the consequent disarrangement of the suburban railway traffic. Sir Henry Mance, C.I.E., presided, and was supported on his right by the Marquis of Tweeddale, and on his left by Lord Kelvin. The other guests included, amongst others, such well-known names as Sir John Wolfe Barry, K.C.B., F.R.S. (president of the Institution of Civil Engineers), Sir Courtenay Boyle, K.C.B. (permanent secretary of the Board of Trade), Dr. W. J. Collins (chairman of the London County Council), General Sir E. Markham, K.C.B, Sir Albert Kaye Rollit, M.P., Mr. J. C. Lamb, C.B., Colonel J. Pennycuick, Mr. W. H. M. Christie, F.R.S. (the Astronomer Royal), Mr. Shelford Bidwell, F.R.S., Sir J. Crichton-Browne, F.R.S., and Captain D. Brady, R.E., who is the adjutant of the new volunteer corps.

The dinner having been concluded, the PRESIDENT proposed the "Queen" and the other loyal toasts. In doing so he referred to the glories of her Majesty's long reign, which commenced in the same year that the telegraph was first practically demonstrated to be a success. He trusted that a period of prosperity and peace would follow on the rejoicings of this Jubilee year.

The remainder of the toast list was remarkable for the few toasts to be proposed, but the unusual number of responders made up for the short supply of proposers.

Prof. AYRTON opened the ball with "The Scientific Societies." The usual jokes were debarred by the altered form of the toast, as the learned or engineering societies were not differentiated from the scientific. Prof. Ayrton accordingly took the societies one by one, and passed an appropriate after-dinner remark on each. The suggestion that the Royal Institution was particularly strong because its forces acted in couples, was perhaps the best of them. It was difficult to associate Lord Kelvin with any particular society, but the electrical engineers owed practically their all to him. His vitality had permeated both the Institution and the whole profession. Prof. Ayrton then recalled some reminiscences of his first association as a pupil with Lord Kelvin in the Glasgow University, when the standard electrical apparatus was worked in a coal-cellar. Since then facilities for research had increased enormously. The speaker humorously referred to the whole American nation as a vast laboratory. Their unvarnished and rough-and-ready methods of carrying out work gave one the impression that they were awaiting improvements and putting up their installations with the idea of changing again soon.

Lord KELVIN, replying for the Royal Society, found fault with the programme, for, the Institution of Electrical Engineers being another toast, inferred that it was not a scientific society, whereas it was, in his opinion, the most scientific of them all. As regards the Royal Society, he was sure it was still doing its work well, as it had done for 200 years, and that the value of the association of scientific men for any specific purpose could not be over-estimated. The progress of the world was largely due to such institutions. He then reprimanded his old pupil for forgetting that it was a wine-cellar, not a coal-cellar, that held the original standard instruments at Glasgow.

Sir JOHN WOLFE BARRY, responding for the Civil Engineers, said that the scientific societies were most strongly bound together by the fact that they were all engaged in applying the great forces of nature for the use and convenience of man. One could not help seeing that the value of abstract science in its various applications was much more recognised now than it was 25 years ago. This country would be far behind if it relied entirely on practical knowledge or what was understood by the homely expression of the "rule o' thumb." Everybody now understood that they must go to science for new developments, and he trusted that the committee now appointed by Lord Salisbury to consider what steps could be taken to keep our manufacturers well informed in scientific developments would bear fruit. The establishment of an institution like the Reichsanstalt in Berlin would do good.

Sir JAMES CRICHTON-BROWNE then responded for the Royal Institution in a model after-dinner speech. He promised to harmonise with the occasion. Electricity was always brief, and sometimes abrupt. Picture Samuel Johnson, he suggested, reading a modern telegram with Boswell standing beside him. Electrical engineers added a boot, capable of holding an average portmanteau, to a cab, and it traversed the street with remarkable self-possession. He then referred to the great work carried out by Faraday in the Royal Institution.

Prof. SILVANUS P. THOMPSON then proposed the health of "The Guests," and referred to each guest personally. He warned Dr. Collins that the County Council would have to take up the subject of rapid transit, and that electric traction would do all that was wanting in this respect. He pointed out the benefit conferred on the working classes by allowing cheap and rapid access to the suburbs instead of compelling them to live in slums in the towns.

The Marquis of TWEEDDALE and Dr. COLLINS responded to the toast. The latter gentleman referred to the fact that the County Council had been called a moribund assembly, and that it had been stated that its members were suffering from severe overwork. He held, however, that the good work done should not be forgotten, and that, electrically, engineering as concerned with electric light had received every encouragement from the Council. He agreed with the proposer of the toast that improved facilities for travelling were wanted, and he hoped the electrical engineers would help to remove the difficulties of providing it. As regards the standardising department of the Council, he had ascertained that during the past eight months no less than 4,000 electric meters had been tested.

Sir COURTENAY BOYLE proposed the "Institution of Electrical Engineers," and said that there should be harmony between those who did the practical work and those responsible for the general procedure. The Board of Trade had already granted 256 provisional orders for electric lighting, and nearly 200 were in practical work. Municipalities had found out that the provision of electricity for lighting was not only beneficial but profitable. He wished he could say the same about electric traction, but in that this country was much behind. It behoved all to join in removing any obstruction in the way of the development of the industry, which would be most useful to the general public

Sir HENRY MANCE, in reply, remarked that Lord Kelvin was the only original member of the old Society of Telegraph Engineers present that night. He referred to the progress of the industry, and finally paid a high compliment to Mr. F. H. Webb, the retiring secretary.

Mr. WEBB responded, expressing his thanks for the way his name was received.

The following is a full list of gentlemen present:

Captain Abney, Mr. Alabaster, Mr. Albright, Mr. H. G. Allen, Mr. R. W. Allen, Mr. W. H. Allen, Mr. Anson, Mr. Appleby, Mr. Atherton, Prof. Ayrton, Mr. F. Bailey, Mr. Baldwin, Mr. Barclay, Mr. Barley, Sir J. W. Barry, Mr. Bastian, Mr. Bathurst, Mr. Baylor, Mr. Beaumont, Mr. Beckton, Mr. Beevor, Mr. Benedict, Colonel Beresford, Mr. A. Bergtheil, Mr. E. Bergtheil, Mr. Bersey, Mr. Bidwell, Mr. Biggs, Mr. G. Binswanger-Byng, Mr. M. Binswanger-Byng, Mr. Blenkarn, Mr. Blount, Mr. Bond, Dr. Bowman, Sir C. Boyle, Captain Brady, Mr. A. G. Bristow, Mr. G. L. Bristow, Hon. A. G. Brodrick, Mr. Brown, Sir J. C. Browne, Major Cardew, Alderman Carey, Mr. Casella, Mr. Chattock, Mr. Christie, Mr. Clirehugh, Mr. Cluer, Dr. Collins, Mr. Colvin, Mr. Cooke, Mr. Cooper, Mr. Cottam, Mr. Couzens, Mr. Cox-Walker, Sir C. Crauford, Mr. Crompton, Mr. Cunynghame, Mr. Cushing, Mr. D'Alton, Mr. Davis, Mr. Dawes, Mr. Dawson, Mr. Dearlove, Mr. Demarchi, Mr. Dennis, Mr. Dieselhorst, Mr. Dymond, Mr. Eden, Mr. Edwards, Alderman Ellis, Mr. Epstein, Mr. Erskine, Mr. Esson, Mr. Fairfax, Mr. Fawcus, Mr. Ferranti, Prof. Foster, Mr. Franckenburg, Mr. Fuller, Mr. Galindez, Mr. Gaster, Mr. Gavey, Mr. Geipel, Mr. Gibbings, Mr. Gorham, Prof. Greenhill, Mr. Griffiths, Mr. Grindle, Mr. Grove, Mr. H. E. Harrison, Mr. H. T. Harrison, Mr. Hawkins, Mr. A. W. Heaviside, Mr. B. Heaviside, Mr. Herring, Mr. Hill, Mr. Hirst, Mr. Hollington, Mr. Howard, Mr. Hughes, Prof. Hughes, Mr. Jackson, Mr. Jacob, Mr. Jenkin, Lord Kelvin, Mr. Kempe, Mr. Kilgour, Mr. J. E. Kingsbury, Mr. H. H. Kingsbury, Mr. Knight, Mr. Kolle, Mr. Lamb, Mr. Langdon, Mr. Lange, Mr. de Lattre, Colonel Leese, Mr. Lightfoot, Mr.

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A. E. J. Lister, Mr. J. L. Lister, Mr. Lord, Mr. Loveridge, Mr. H. J. McDougall, Mr. P. W. McDougall, Mr. McMillan, Mr. Madgen, Mr. J. C. Mance, Sir H. Mance, Mr. R. H. Mance, Mr. Manville, General Markham, Mr. H. Marsh, Mr. H. H. S. Marsh, Mr. C. P. Martin, Mr. E. M. Martin, Mr. Mavor, Mr. Miller, Mr. Minty, Mr. Mordey, Mr. Morse, Mr. Morton, Mr. Munro, Alderman Norman, Mr. Norton, Mr. O'Brien, Mr. Offor, Mr. O'Gorman, Mr. Parshall, Mr. Paynter, Mr. Pearce, Mr. Pender, Colonel Pennycuick, Mr. Penton, Mr. Penton, jun., Prof. Perry, Mr. Phillips, Mr. Porter, Mr. Possman, Mr. Powell, Mr. Poynton, Mr. A. H. Preece, Mr. Radford, Mr. Ram, Mr. T. T. Rawlings, Mr. W. R. Rawlings, Mr. T. Rawlins, Mr. W. Rawlins, Mr. Raworth, Mr. Rawson, Mr. Reynolds, Mr. Rippon, Rev. Dr. Robertson, Mr. Robson, Sir A. Rollit, Mr. Schultz, Mr. Sellon, Mr. Seymour, Mr. Shoolbred, Mr. Siemens, Mr. Sinclair, Mr. Slatter, Mr. F. Smith, Prof. R. H. Smith, Mr. Spagnoletti, Mr. C. P. Sparks, Mr. H. C. Sparks, Mr. Sparks (friend), Mr. Stearn, Mr. Still, Mr. Stockwell, Mr. Stothert, Mr. Stöttner, Mr. Swan, Mr. Swinburne, Mr. Swinton, Mr. Taylor, Prof. Thompson, Mr. Thornbery, Prof. Tilden, Mr. Tree, Mr. Trower, Mr. de Tunzelmann, Marquis of Tweeddale, Mr. Wallis-Jones, Mr. Walton, Mr. Warburg, Mr. F. Ward, Mr. Webb, Mr. Widnell, Mr. Winkfield, Mr. C. E. Winter, Mr. W. H. Winter, Major Woodley, Major Woods, Mr. Woods, Rev. F. Wooley, Mr. A. Wright, Mr. E. Wright.

At last night's meeting of the Institution the following were the candidates balloted for:

Member.—J. L. Owen, Thorneycroft, Beeches-road, West Bromwich.

Associates.—F. Beanland, Bega. Harrogate; H. M. Brigg, B.A., North-Western Hotel, P.O. Box 1,792, Johannesburg; W. P. Digby, 2, Bath-terrace, Seaham Harbour, co. Durham; J. Enright, B.Sc., 202, Holland-road, Kensington, W.; J. W. Flower, Northampton Institute, Clerkenwell, E.C.; A. Goodsir, Broome, Roebuck Bay, Western Australia; H. C. Gunton, care of Peter Brotherhood, Esq., engineer, Belvedere-road, Lambeth, S.E.; C. F. Parkinson, 129, Euston road, Morecambe; W. G. McMillan, F.I.C., 8, Leigham Court-road West, Streatham; A. Philip, B.Sc., F.I.C., Assoc.R.Sch.Mines, The Merchant Venturers' Technical College, Bristol; R. W. L. Phillips, Electric Lighting Station, Bristol; R. Cecil Pierce, Clifton-court, Clifton, Bristol; Captain W. Wood, Woodite Works, Mitcham, Surrey.

Students.—K. A. C. Creswell, 12, Regent's Park-road, N.W.; A. S Esslemont, 15, Forest-road South, Aberdeen; M. Finkelstein, 41, Hanover-street, Fitzroy, Melbourne, Australia; H. A. F. King, Brightlands, Gipsy-lane, Barnes; G. Layton 48, Lancaster-park, Richmond; A. W. Norris, 195, Clapham-road, S.W.; H. A. Pearson, 1, Victoria-terrace, Bridlington Quay; C. T. Stephenson, 101, Elphin-road, Launceston, Tasmania; A. C. Weber, 15, Maryon-road, Charlton, Kent.

ELECTRIC WAVES.

BY ALBERT CAMPBELL, B.A.

The following is a brief *résumé* of an interesting lecture delivered by Mr. Campbell before the Camera Club on Monday last; Mr. Wm. Clarke, M.I.C.E., in the chair. The lecture was fully illustrated by experiments, diagrams, and lantern slides, most of the apparatus used being of the lecturer's own make.

Mr. Campbell, who was introduced by the hon. secretary (Mr. J. Wallis Godfrey, M.A.), commenced by referring to Clerk Maxwell's electromagnetic theory of light and his wonderful predictions of how electric waves would behave in free space if they could be produced These predictions had all been amply verified by practical demonstrations by Hertz, and after him, or at the same time, by many other observers, amongst whom Dr. Oliver Lodge stood pre-eminent. The lecturer then described and demonstrated the general properties of vibration, such as wave-length, velocity of propagation, and frequence. The use of the foreign term "periodicity," instead of "frequency," was condemned on account of the fact that the latter term was more orthodox amongst standard writers. As a comparison of different wave-lengths, the author gave the following number of waves in an inch length:

Shortest Hertzian wave.....	4·3
Longest heat wave	1,000
Red light	33,000
Yellow light	44,000
Violet light	64,000
X-rays (?)	1,800,000

Resonance was next illustrated by two magnets suspended by equal strings so as to be in "syntony." When one was set oscillating it very soon gave up all its energy to the other, which in its turn gave it back again.

The waves of current in conductors were then discussed, and the lecturer's frequency teller was exhibited indicating the frequency of an interrupted current, the action being by means of a resonating reed. The condition of the space around a conductor carrying an ordinary alternating current was explained. The 100-volt direct-current supply was made alternating by means of a motor with ring collectors on opposite segments of the commutator. This current was sent through a coil of wire, and induced sufficient current in another coil about 50cm. above it to light a small incandescent lamp. The wave-length here was about 6,000 miles. Shorter electric waves could be generated by means of curents of much higher frequency. They were easily produced by electric discharges across a gap in a conductor.

A condenser was then described, and a Leyden jar was charged by an induction coil and discharged by tongs and also by a wet string, the contrast being pointed out. Lord Kelvin's beautiful solution of the problem of condenser discharges was explained. In his equation,

$$L\ddot{q} + R\dot{q} + \frac{q}{C} = 0,$$

each term represents an E.M.F.—the first that due to the electric inertia, the second due to the resistance (electric friction), and the third due to the charge in the condenser (electric strain). The sum of the three naturally must = 0.

The solution $q = Ae^{m_1 t} + Be^{m_2 t}$ becomes $q = P \sin Qt$ when m_1 and m_2 are imaginary, and in this case we have an oscillatory discharge. A very simple hydraulic model (suggested by Dr. Lodge's more complicated one) was shown, illustrating the two kinds of condenser discharges.

Lodge's experiment on the alternative path was next shown, illustrating how conducting circuits behave to high-frequency differences of potential. Next came Hertz's experiments and one of his types of oscillator—an air condenser with outspread plates and his ring resonator were shown. The work of Branly and Lodge on "coherers" followed. Righi oscillators (one with oil dielectric) were next shown, and with the help of two parabolic mirrors, a coherer, and a relay connected with an electric lamp, several properties of the short electromagnetic waves were shown, including the opacity of copper, the transparency of wood, and polarisation effects. That is to say, one parabolic reflector was made to direct the electric waves on to another, what we may call a receiver, which was set up at the other end of the room. Connected with this was a coherer and a small relay, from which a wire was run to a small incandescent lamp on top of the arrangement. As soon as the current was turned on the oscillator, the coherer acted on the relay and turned on the light. The lecturer explained that the shaking of the elements contained in the coherer tube beforehand was done automatically in the apparatus constructed by Dr. Lodge and Marconi. When a sheet of boxwood was placed before the sending mirror, the waves penetrated it and the light continued, but a copper plate similarly placed cut them off, and if placed in the vicinity deflected them. A polarised screen was then interposed, and it was shown that the waves passed through the screen when the latter was placed in such a position that the stripes run vertically, but when placed horizontally no waves passed and no light was shown by the relay lamp. Finally, an electric bell outside the room, which was also supplied with a coherer and a relay, was rung simply by means of the electric waves, thus showing clearly that the waves passed through the air and through the walls, and indicated their presence at the point made susceptible to them.

An interesting discussion took place, in which Messrs. J. Bergheim, A. A. Campbell Swinton, M.I.E.E., H. E. Harrison, B.Sc., M.I.C.E., A. P. Kapteyn, M.I.C.E., Augustus Stroh, and Mr. Luke, C.I.E. (late chief of the Indian Government Telegraphs), expressed their appreciation of the lucid manner in which the interesting subject had been treated by Mr. Campbell. Two points came in for a large share of this discussion: first, whether a person placed in a dark room could or could not see a light emanating from a magnet. Examples were quoted where

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such had been seen and where it had not. It was contended on the one hand by Mr. Campbell Swinton that the latter proved that no light was emitted; while Mr. Bergheim and others argued that light waves affected various people in different ways, and that because some people could not see what others saw, the latter were establishing a fact and not the former. Mr. Campbell Swinton inclined to the view that Hughes had a preferential claim over Hertz's invention. Mr. A. Stroh thought that, as Hughes did not understand what he saw, he was not entitled to such, illustrating his meaning by saying that the fact of many people having seen lightning before Benjamin Franklin did not detract from the latter's claim to his invention.

The usual vote of thanks to lecturer and chairman terminated the official part of the meeting, and Mr. Campbell then explained various points to those eager for further information. An agreeable feature of the evening was that the weed was not debarred, and liquid refreshment could be partaken of simultaneously with the more substantial fare supplied by the lecturer.

THE DISTRIBUTION OF ELECTRICAL ENERGY.*

BY C. H. WORDINGHAM, A.M.I.C.E., M.I.M.E., M.I.E.E, CITY ELECTRICAL ENGINEER, MANCHESTER.

(Continued from page 661.)

Turning to the second class, the conductor is usually in the form of strip, since this can be readily rolled up to bring it on the ground, and it may either be supported at frequent intervals on insulators slotted to receive it, or it may be tightly stretched at long intervals, intermediate supports being provided at a fair distance apart. Unquestionably the latter method is the best, since the number of insulators can be greatly reduced, while their shape can be made so as to give each insulator a much higher resistance. Conductors insulated as in the first class may, of course, be used in drawing-in systems; when laid on the built-in system they are either protected with steel armouring and laid directly in the ground, or they are placed in a trough of iron or wood, and are surrounded with bitumen, pitch, or some similar material, the additional protection of armour being used in some cases.

In the author's opinion the best system of distributing mains is that in which bare copper is tightly stretched between porcelain insulators carried by cast-iron bearers. This system, which was introduced a good many years ago by Mr. Crompton, will be found fully described in its latest form in the appendix. A very fairly high insulation resistance is attained, higher even than is absolutely necessary. The actual result will depend largely upon the atmosphere in the culvert when the test is made. Table A gives figures under various conditions. It must be borne in mind that in most of the instances given, the insulators were reeking with moisture, the culvert being quite new, and having been closed in the instant the concrete was strong enough to bear the weight of the flags.

The question will naturally be asked, What does this insulation become under working conditions? Unfortunately, it is seldom possible to make tests after a line has once gone into use, but in one instance circumstances admitted of a test, particulars of which are given below: culvert closed, June 16, 1896; copper strip run, September 1, 1896; current turned on a few days after September 1, 1896 (exact date cannot be given); length of culvert, 78 yards; current taken off and main tested, February 2, 1897.

INSULATION RESISTANCE OF LENGTH.

	Positive pole of battery in line.	Megohms.	Negative pole of battery in line.	Megohms.
Positive conductor ...		161·3	...	122
,, intermediate		73·9	...	57·7
Middle conductor ...		42·3	...	34·1
Negative intermediate		36·5	...	36·5
,, conductors...		24·5	...	23·4

The above tests show what is almost universally found, that the insulation resistance of the negative pole, whatever the system of mains employed, is substantially lower than that of the positive pole. That of the negative, however, in this case is very satisfactorily high.

A great advantage of these mains is their security. The conductors being rigidly fixed at a good distance from one another, and the insulation being absolutely incombustible, there is far less danger of a short-circuit than with any continuously-insulated system. The durability of these mains promises to very greatly exceed that of every other kind. After 2¼ years' experience of this, and over four years' experience of another system

* Paper read before the Northern Society of Electrical Engineers.

TABLE A.—Insulation Resistance of Stretched Bare Copper Mains.

Length of culvert.	Size of conductor.	Insulation resistance. Of length	Insulation resistance. Per mile.	Date culvert closed in.	Date strip fixed.	Date of test.	*
Yds.	Sq. in.	Megohms.	Megohms.				
56	¼	1316	42	Feb., 1897.	Mar. 25, 1897.	May 3, 1897.	A
	¼	390	12				
	¼	351	11				
	¼	164	5				
	¼	211	7				
107	¼	2308	140	Jan. 23, 1897, to Feb. 2, 1897.	Mar. 23, 1897.	Mar. 26 1897.	B
	¼	860	52				
	¼	2799	170				
	¼	939	57				
	¼	1069	65				
89	¼	67	3·39	May 13, 1897.	Aug. 31, 1896.	Feb. 1, 1897.	C
	¼	56	2·83				
	¼	165	8 32				
	¼	9	0·43				
	¼	98	4·93				
51	¼	2071	60	Oct. 27, 1896.	Dec. 4, 1896.	Dec. 8, 1896.	D
	¼	810	23·4				
	¼	3589	104				
	¼	953	27·6				
	¼	1737	50				
85	¼	3735	180	Sept. 22, 1896.	Nov. 23, 1896.	Dec. 2, 1896.	E
	¼	12865	621				
	¼	898	43				
	¼	2573	124				
	¼	957	46				
84	¼	6·3	0 3	July 29, 1896.	Sept. 3, 1896.	Nov. 27, 1896.	B
	¼	8·1	0·386				
	¼	6·9	0 328				
	¼	36·8	1·75				
	¼	29·8	1·42				
82	¼	103	4·7	Sept. 25, 1896.	Nov. 20, 1897.	Nov. 26, 1896.	B
	¼	42	1·95				
	¼	5·3	0 246				
	¼	23	1·06				
	¼	723	33·68				
77	¼	104	4·55	Aug. 10, 1896.	Sept. 4, 1896.	Nov. 25, 1896.	F
	¼	275	12 02				
	¼	136	5 9				
	¼	141	6·18				
	¼	50	2·2				
85	¼	3·3	0·159	Oct. 23, 1896.	Nov. 16, 1896.	Jan. 18, 1897.	G
	¼	39·1	1 88				
	¼	6·8	0·328				
76	¼	13·8	0·595	Oct. 22, 1896.	Nov. 16, 1896.	Jan. 18, 1897	G
	¼	10·9	0·47				
	¼	5·6	0·241				
58	½	349	11·4	Oct. 2, 1896.	Nov. 13, 1896.	Dec. 4, 1896.	H
	½	1944	64				
	½	53	1·74				
55	¼	88	2·7	Oct. 26, 1896.	Nov. 16, 1896.	Dec. 3, 1896.	C
	¼	537	16·7				
	¼	618	19				

* Weather at time of test: A. Fine—dry. B. Damp. C. Very damp. D. Fine. E. Raining heavily. F. Damp—frosty. G. Dry—very frosty. H. Raining.

NOTE.—The above tests were made after one minute's electrification with the negative pole of a battery giving about 400 volts, the direct deflection method being employed. One division of galvanometer scale corresponded to about 12,000 megohms.

of bare copper distributors, also described in the appendix, which although very good is inferior to the stretched system in several respects, the author is able to state that not a yard of either kind has had to be renewed, nor is there any sign of deterioration. The ease and cheapness with which service connections can be made is a great recommendation. In the original Crompton system all such connections were made at an insulator, to which access was obtained by means of a box lid. In the author's practice these insulators are flagged over, and connection made at any point, even midway between two insulators. This is done quite safely by fixing the service conductors in the wall of the culvert. They then actually assist in keeping the main conductors rigid. A porcelain insulator is placed beneath a service cable where it crosses the bare strip to prevent accidental contact. It will be noticed that, contrary to all continuously insulated systems, the T-joint does not lower the insulation resistance of the mains to any appreciable extent. The cost of the system does not differ greatly from any other good class of mains, but even if its first cost were much higher, the author would prefer it on account of its durability and safety. The relative cost diminishes rapidly as the size of the conductors increase. Without insisting greatly on the point, it may be mentioned that it is quite easy to draw in additional copper at any time, but to do this all the T-joints must be unclamped and the supply cut off from the main.

The supposed drawbacks to the system are danger of flooding and liability to explosion of gas. As regards the former, it is

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difficult to see how the water could get in, but, even if it did, it is unlikely it would reach the copper, as the culverts have all a fall of at least 1 in 100, and are connected to boxes at each end, all of which are drained to the sewers. Further than this, even if the copper were immersed, supposing the water to be pure, it is quite likely that it would be found feasible to continue running on the main until the culvert could be emptied. With respect to explosion, it is of course possible that gas might find its way into the culvert, but with good ventilation, such as is recommended in another part of this paper, the danger is small, and the author has never had an instance, though he has had several explosions where insulated cables have been run in pipes, and that without the presence of coal-gas.

The author begs the indulgence of the members of the society if he be somewhat of an enthusiast in respect to bare copper; he would plead in extenuation that his enthusiasm is based upon experience, while he has observed that the strongest opponents of the system are those who have never laid or used a yard of this class of main. In Manchester there is 1 mile 308 yards of distributor laid on the slotted insulator system which have been at work for over four years, and there are 4 miles 1,690 yards, or just five miles, of distributor on the stretched system which have been at work for varying periods up to 2¼ years. Both classes are in perfect order, and show no signs of deterioration. In one instance there was a short-circuit with the slotted insulator system owing to the wedges becoming loose, and allowing the copper to buckle, and there was one short-circuit on the Crompton system on the first length laid due to the carelessness and inexperience of a workman causing two strips to be forced together. With these two exceptions, there has been no trouble of any kind with either system of distributors. The one disadvantage of bare copper is its want of flexibility; there must be a clear way of considerable cross-section for it, and in certain positions it is therefore impossible to employ it; it is not advisable either to lay bare copper in wide roadways subject to heavy traffic. When bare copper cannot be used, the author considers the next best system is a number of continuously-insulated cables laid side by side, supported and separated by wooden bridges, and completely surrounded by Trinidad bitumen held in cast-iron or wooden troughs. This system was introduced some 10 or 12 years ago by Mr. Callender, and has given excellent results; the system as used in Manchester is fully described in the appendix. The insulation the author prefers is vulcanised bitumen, as it is much cheaper than rubber, is probably more durable, is very light for laying, and is easily jointed. Its insulation resistance, while considerably lower than rubber, is amply high enough. The tests which the cables used have to pass are given in the appendix.

Here it may be well to correct a very widespread illusion. It is commonly supposed that the core of vulcanised bitumen cables readily decentralises. This is not the case. The material is tough, and the melting point very high; on three occasions the author has had short-circuits on these cables, once from a pick being driven through them, and twice from bad joints, and on each occasion he was much struck with the small distance to which the damage had extended, the covering being intact and not melted, quite close to the molten copper. Joints on these cables are made very expeditiously, and it will be observed that the system admits of the mains being tapped at any point (for method of jointing see appendix). The figures given in Table B will serve as a guide to the results attained as regards insulation resistance.

The author has only used these cables for slightly over a year, but they appear highly promising, and with the exception of the short-circuits above mentioned, none of which can be ascribed to the cables themselves, they have given no trouble whatever. The quantity now laid as distributing mains in Manchester is as follows:

	1/8 sq. in.	⅛ sq. in.	¼ sq. in.	½ sq. in.
Length of single conductor laid	2 miles.	8 miles.	14 miles.	3 miles.

The author has laid a fair amount of vulcanised indiarubber-covered cables on this system, chiefly cable which had been withdrawn from pipes, and which had had old T connections cut off, and the places made good; he would not have dared to use these cables over again, except in this way. The results so far have been very satisfactory. The main point of the so-called "solid system" is the exclusion from the cables of moisture, and of everything that can harm them. The Trinidad bitumen used for this purpose is waterproof, and it is known that it remains unchanged for centuries. In laying rubber cables in this manner, it is important to remember that the bitumen must not be used hotter than is absolutely necessary to enable it to flow, otherwise the rubber will be over-vulcanised.

(To be continued.)

TABLE B.—Vulcanised Bitumen Cables laid on Callender's Solid System.

Length of conductors.	Size of conductor.	Insulation resistance. Of length.	Insulation resistance. Per mile.	Date of test.	Weather at time of test.
Yards.	Sq in.	Megohms.	Megohms.		
58	⅛	18568	612	May 26, 1897.	Very damp.
	⅛	14442	476		
	⅛	16247	535		
	⅛	12998	428		
	⅛	14442	476		
187	¼	12480	1326	Nov. 4, 1896.	Very foggy.
	¼	20800	2210		
	¼	20800	2210		
	¼	20800	2210		
	¼	15600	1657		
254	⅛	12669	1828 3	Jan. 19, 1897.	Very frosty.
	⅛	10365 5	1495·9		
	⅛	5701	822·7		
	⅛	10365·5	1495·9		
	⅛	12669	1828 3		
252	⅛	6003	859	Feb. 15, 1897.	Damp.
	⅛	6003	859		
	⅛	85	12·1		
	⅛	2641	378·1		
	⅛	4002	573		
85	⅛	14642	707·1	March 30, 1897.	Fine.
	⅛	14642	707·1		
	⅛	12812	618·7		
	⅛	17083	825		
	⅛	17083	825		
237	⅛	10100	1360	Feb. 5, 1897.	Drizzling rain.
	⅛	10100	1360		
	⅛	8912	1200		
	⅛	15150	2040		
	⅛	8912	1200		
18	¼	19505	199	Feb 1, 1897.	Very damp.
	¼	19505	199		
	¼	27307	279		
	¼	22756	232		
	¼	22756	232		
75	⅛	33726	1437	April 12, 1897.	Very damp.
	⅛	25294·5	1077·8		
	⅛	33726	1437		

NOTE.—The insulation resistance was tested with the same apparatus as was the copper strip.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. The answers to any question should be sent within 10 days after the question has appeared, and should be written on one side of the paper only. Questions may be sent at any time. The first question this week is a leading one, and a full explanation of the phenomenon to be expected if the fuse goes should be given.

QUESTIONS.

14. Is it necessary and advisable to put fuses in the field circuit of large direct-current and alternate-current generators?—T. A. LOCKE.

15. Draw up a form such as you would advise being filled in each day, and present to the chief engineer, to show the results of the day's working.—P. T.

ANSWERS.

Question 7.—Seeing that local authorities repay the capital by periodic instalments over a number of years, yet have to keep their plant in a state of efficiency, is it necessary or desirable to depreciate the value of the plant as appearing on the books annually? Give reasons.

Best Answer to No. 7 (*awarded* 10s.).—In answer to your Question No. 7, in the issue of October 29, I should like to express my opinion with reference to depreciation. I do not think it is either necessary or desirable to depreciate annually the plant under the circumstances named. If the plant is kept in an efficient state, and the repair and maintenance of the same is charged against the *revenue account*, there is no reason why the capital should be depreciated. Further, if the value of the plant, together with the amount placed, say, in a sinking fund annually, is sufficient to repay the money borrowed, plus the interest which may have accrued, then it is not at all necessary to resort to depreciation, because all that a department could be called upon to do would be to provide a sum of money equal to the amount which has been loaned to it with

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interest added. It would, however, be wise to open a reserve fund and place to this account a contribution annually in case some serious damage occurred to the plant. For instance, a fire might take place, and if the plant was not insured then probably a rate in aid would be required if a reserve fund had not been opened. The latter method of providing a reserve fund is certainly the best way of dealing with any damage done to the machinery by some serious accident; but when the plant is kept in repair and maintained out of the revenue of the department there is no necessity, nor is it desirable, to depreciate the capital.—JOE A. SWIFT.

Answer No. 7.—This is a very debatable subject, and one upon which opinions are very much divided. My own opinion is that, seeing the plant is kept in a state of efficiency out of the revenue, there is no need to burden the undertaking with an annual depreciation charge in addition to the obligatory sinking fund or repayment of capital. Particularly should this be so during the early years of the works. Later on, when profits are made and a large sum could easily be spared each year, it may be desirable to start a reserve fund, but not if by so doing the charges for current have to be kept so high as to prevent the rapid accession of new customers. I think, as the present-day ratepayers have to bear the burden of the sinking fund and other capital charges, they should not be called upon to do more than this, and that when the whole of the original capital has been extinguished, the then ratepayers should bear their share of new capital outlay if such be required.—T. A. LOCKE.

Answer No. 7.—Although the practice of laying aside a sum for depreciation every year somewhat unduly depresses the profits of the electrical supply department in the eyes of the electricians concerned, yet the practice is both necessary and desirable. Even granting that there was no "antiquation" factor in the case, the value of the machinery would hardly be the same after several years' wear and tear, however well it were kept up. If it appeared in the corporation's books as equal to its original value, then it is obvious that some of the so-called profits in the meantime must have come out of the capital borrowed. The next generation would hardly think us wise, even if we had made huge profits and repaid the original loan, if they found that the object of our book-keeping was to make it appear that our profits had been larger than they really were. If, on the other hand, we had only paid our way or made a loss, then our book-keeping would convict us either of stupidity or dishonesty.—J. C. R. (Kingston-on-Thames).

Question No. 10.—What are the relative advantages and disadvantages of exciters driven in the following ways: (1) direct on alternator shaft; (2) by belt from alternator shaft; (3) by independent engine?

Best Answer to No. 10 (*awarded* 10s.).—The first two ways are practically identical, with the exception that No. 2 is not so good mechanically as No. 1, there being a possibility of the belt breaking or coming off. However, as a rule alternators do not go at a very high speed, so with the second method a much smaller and consequently cheaper exciter will do the same work, as it can run at a much higher speed. On the whole, I should say that, if expense is no object, direct driving on the alternator shaft is preferable to driving by belt, as it is safer, takes up less room, requires less attention, and is more efficient. Ropes are usually used, as they give less trouble than and are not so liable to come off as belts. The real difficulties crop up when we come to compare Nos. 1 and 2 with No. 3. A question is here raised which has never been properly decided. In favour of Nos. 1 and 2 we have the facts that each unit is complete in itself, there is no auxiliary exciting plant to attend to, and no doubt there is less danger of failure of the whole lighting plant. As the power for excitation is taken from a large and presumably economical engine, and as the exciter is usually running at its full load, the efficiency is no doubt higher. The first cost will be less, probably, as a large engine costs less per horse-power than a small one. There is no doubt that it is very convenient to be able to run up a unit and find the full voltage on it when it is up to speed without having to switch on exciter circuits, and there is no danger of switching off the exciter before the alternator is separated from the rest, as no switching need be done at all. Again, the cost of the switching gear is saved. Another advantage is that if by any chance the high-tension circuit should become connected to the exciter circuit, only one small exciter will be burnt out, whereas with system No. 3 all the exciters may be ruined which are running, with disastrous results to the running of the plant for a day or two. All the above advantages are perfectly general. When we come to the disadvantages of the separate excitation (Nos. 1 and 2) compared with the common separate excitation (No. 3), other factors appear on the scene. Are the alternators paralleled, and are they air-core machines, or, in other words, have they a small self-induction? If so, then the separate excitation has a very great disadvantage—viz., that if by any chance an exciter brush should become lifted, or should the shunt circuit of the exciter become broken—we have a dynamo with a low self-induction and with no voltage put across a, say, 2,000-volt main. If there is only one alternator paralleled with it, both may be burnt out, but in any case one will probably be damaged. There will certainly be a failure of the light. With an iron-core machine there is less danger of disaster, as the self-induction will moderate the effect of the short-circuit. It has often occurred to me in this connection that it is a very dangerous thing to use shunt-wound exciters for alternators run in parallel where they are driven from the alternators. The exciters are small, and it is appalling to think that the safety of the plant and the continuity of the supply hangs upon a piece of No. 20 or 22 German-silver wire, which is used for the regulating resistance. I have even seen exciters sent out for 150-kw. alternators with only one brush on each pole of the exciter. Surely, these risks are too great. With an independent exciting circuit the resistance wires are much thicker and more mechanical, and the regulating is done by means of a resistance in series with each alternator field-magnet circuit. Any bad contact will cause an arc, but there is hardly any chance of breaking the circuit. The latter also applies to series-wound exciters. Some of these risks are done away with if the small exciters are all paralleled when the alternators are paralleled. The lifting of a brush will then not cause a short-circuit, but the other exciters will carry the load; at all events, what happens to one alternator will happen to all, so no permanent damage will be done. There is a great temptation to go further into the question, but a whole number of the paper could easily be taken up. It will suffice to say that when a battery of accumulators is paralleled with the exciting circuit, nearly all the disadvantages of No. 3 are done away with. The score of extra capital outlay is still left against it, and also that of extra attention, but there is very little to say against its efficiency. My own opinion is that No. 3 is the best if used with accumulators; that when iron-core machines are used, No. 1 system is good if series exciters are used; that if shunt exciters are used the regulation should not be carried out by the shunt circuit, but by resistance in the alternator field circuit; and that No. 2 system is not, as a rule, as good as No. 1 system. The only real advantages of Nos. 1 and 2 over No. 3 are that if the high-tension circuit gets connected with the exciter circuit, there will be only a failure of one exciter, and not the whole exciting circuit. By placing a reliable earthing device on the exciter circuit, even this disadvantage is minimised.—W. FENNELL.

Answer No. 10.—In stating the *pros* and *cons.* for the different methods of driving exciters for alternators, one can only state them generally; and it must be remembered that in this, as in everything else, circumstances prevail to a great extent. Taking the first-named method—viz, *direct coupled on alternator shaft*—we have the following advantages: (1) it saves a certain amount of ground space, and this in many stations is a great consideration; (2) the various losses through the inefficiency of belts or ropes are eliminated; (3) there is an economy in the use of oil and also in attendance in connection with the oiling, as it is done by the same pump as the alternator oiling, and the same oil is used throughout the machine; (4) being connected direct on to the alternator shaft, it is necessarily a slower-speed

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machine, and has consequently less wear and tear, and owing to being slower speed must be larger, and consequently gives a better electrical efficiency and lasts longer. The disadvantages, however, of this method are: (1) that being a slower-speed it must be a larger machine, and consequently the capital cost is much greater; (2) it cannot be used in case of emergency for another alternator or any other purpose without running the alternator itself.

Now taking the second-mentioned method—viz., *belt or rope driven*—we have the following advantages: by this method the speed can be geared up, and therefore a smaller machine used, and hence less capital cost. It, however, has the following disadvantages—viz.: (1) it takes up more ground space than direct driven; (2) has certain losses due to belt or ropes; (3) it is not so economical with oil, and requires more attendance in the oiling owing to the higher speed; (4) owing to the higher speed, there is more wear in the bearings and on the commutator; (5) being a smaller machine, has not so good an efficiency.

Now taking the last-mentioned method—viz., separate engine—we have the following advantages: (1) it can be used separately for different alternators, and thus it is easier to keep a stand-by ready for emergency; (2) it can be used for different purposes when the alternator is not running, as, for instance, could be used to charge a few secondary cells for switchboard lighting to be used in case of emergency, etc. The disadvantages of this method are: (1) the capital cost is about double; (2) it is very inefficient to have a small engine specially for it, as the efficiency of the alternator engine is much greater than that of a small one, besides the losses through condensation, etc., in the extra steam-piping; (3) repairs to the engine in addition to the exciter makes the up-keep comparatively high; (4) it is not economical in oil, and requires much more attendance than either of the other methods; (5) the ground space taken up is much more also than in either of the other methods. In weighing up these advantages and disadvantages it seems as though the second-class rope or belt-driven exciter is the best method, and *experientia docet*, so from the fact that it is more generally adopted than either of the other methods, it looks as though manufacturers evidently think so too.—W. WYLD, A.I.E.E.

Answer No. 10.—Taking the different methods of driving exciters in the order given in the question, we have:

1. *Those Direct on Alternator Shaft.*—The advantages of this method are: positive driving as compared with (2); independence of outside motive power as compared with (3); no necessity to run large exciting plant when only one alternator is working; no necessity to use field switches, as the current in the fields dies down when the machine is stopped. This is of great importance with large alternators. The disadvantages are: larger and more costly exciter than in (2), owing to the slower speed of running; more frequent regulation necessary, owing to the variations in the speed of the prime mover affecting both alternator and exciter; a failure of the exciter puts the large plant out of action.

2. *By Belt (or Ropes) from the Alternator Shaft.*—This has practically the same advantages and disadvantages as the previous method. Of course the driving is not positive. The speed of the exciters in this case can be greater than that of the prime mover, and so smaller machines used. These two methods are about equally balanced with one another.

3. *By Independent Engines.*—The advantages are: the number of small machines in the station is reduced; no time is lost in waiting for the exciter to "build up" when starting another alternator, as the field has simply to be switched on; the voltage of a number of machines can be simultaneously varied by altering the field of the exciter. The following are the disadvantages: a large exciter has to be kept running if only one alternator be used; to reduce the risk of breakdown, a spare steam exciter must be kept ready; whenever an alternator is stopped, its field must be shut off without lowering the pressure of the exciter. This means special switches, and with large machines a great risk of damaging the field insulation. In order to overcome the first two disadvantages accumulators are sometimes used in connection with the separate exciters.—T. A. LOCKE.

ELECTRIC LIGHTING IN HORNSEY.

At the meeting of the Hornsey District Council last week the Electric Lighting Committee reported that Mr. C. F. Cory-Wright had been appointed chairman of the committee. The committee, having considered the reference, recommended that the Council's solicitor be instructed to take the necessary steps for obtaining the provisional order, and issue an advertisement in the form accompanying the report. They propose that the roads to be scheduled as streets in which cables are to be laid down within a specified time be High-street, Hornsey, Tottenham-lane, The Broadway, Crouch End, Middle-lane (The Broadway to Elder-avenue), Park-road (The Broadway to Wolseley-road), Crouch End-hill (The Broadway to Christ Church), Crouch-hill (The Broadway to Haringey-park), and Turnpike-lane. The committee also settled the form of memorial to the Board of Trade, including the lists to accompany it, copies of which, with a print of the proposed provisional order, also accompanied the report, the sum proposed to be expended being fixed at £35,000.

Copies of reports on the question generally, made by the Council's engineer and Mr. Robert Hammond, M.I.C.E., consulting electrical engineer, were considered by the committee.

Mr. Lovegrove's report, after giving particulars to be considered in regard to the notice by advertisement of the intended application, went on to say that, owing to the scattered nature of the Hornsey district, the system most suitable for adoption was the high-pressure alternating current, the electricity being distributed from a central station by high-pressure feeders to various parts of the district, and reduced by transformers to low pressure. This system involves a high-pressure station, the best position for which is the geographical centre of the district. This would be about the centre of the Playing Fields, Crouch End. The amenities of the district will not allow of this position being seriously considered. The most suitable locality for the works is in the neighbourhood of the sanitary depôt, Hornsey, but there are alternative sites: the sanitary depôt's destructor works and the Council's freehold (of three acres) at Cross-lane. With regard to the dust destructor being worked in conjunction with the electric lighting station, I would point out that in many recent installations of electricity, the steam from the destructor boilers has been used wholly or partly for the electric station. A thorough insight is necessary in all these cases to ascertain the amount of steam raised from the refuse, and the electrical energy produced. The experience of one town or works must not be taken as a basis for another, the thermal value of the house refuse differing considerably. Hornsey house refuse is of the poorest possible character, so much so that during the summer months it is with difficulty that the furnaces are kept alight. The heat produced is about 800deg. F. at outlet of main flue to boilers, and the steam raised is at times not sufficient for the present machinery, which includes mortar mill, sawing, drilling, and turning machinery, and slab-making machinery now being fixed. The present position of the boilers is not conducive to full advantage being obtained from the heat produced, but in the event of reconstruction of the furnaces becoming necessary, this could be improved and more efficient results obtained. The land available is cramped, and does not lend itself to what will be the ultimate requirement of the electric lighting station, nor is it an advantage to place valuable machinery too close to the dust-disposal works. Additional land could, however, possibly be obtained adjoining the depôt for the erection of suitable buildings.

From the above remarks it will be seen that this question requires careful consideration in detail before a decision is arrived at.

The free library is designed to be electrically lighted with temporary plant, and ultimately to be supplied from the proposed plant at the swimming-baths. The bath scheme must, in any event, include boilers for heating the tanks and slipper baths, and there will then be an ample steam supply for the laundry, pumping, and electric machinery proposed. The swimming-baths will not be erected and ready for the fixing of the electric machinery for at least 18 months, and should there be the probability of a general electricity supply, arrangements could then be made for temporary hired plant with a view to subsequent connection to the mains.

Compulsory Area.—Having regard to the probable site of the electricity works being at Hornsey, it is suggested that the list of streets referred to in Requirement No. 2 should be as follows: High-street, Hornsey, Tottenham-lane, The Broadway, Crouch End, Middle-lane (The Broadway to Elder-avenue), Park-road (The Broadway to Wolseley-road), Crouch End-hill (The Broadway to Edison-road), Crouch-hill (The Broadway to Haringey-park). These streets comprise 129 houses, 374 shops, four churches and chapels, and eight public buildings. It would be desirable to provide in this section of lighting for at least 6,000 8-c.p. lamps for private consumers and public buildings.

Public Lighting.—The number of arc lamps, 2,000 c.p., placed from 60 to 80 yards apart, required for lighting the

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whole length of the scheduled streets, would be 45, displacing 75 existing gas lamps. The lamps displaced (after allowing for 10 midnight burners paid for by private lampowners) represent a present annual expenditure for gas, lighting, and maintenance of £260. I would mention, in passing, that while it may be desirable to light the main streets with arc lights, this system, on account of the cost, cannot be generally adopted in the side thoroughfares, even if the mains are extended for private lighting. It would be practicable to fit the public lamps with a 16-c.p. incandescent electric light. This, however, would involve increased cost, with very small increase of light on the existing 15-c.p. gas-burner. In the event of the recent experiments in incandescent gas lighting being confirmed by an extended trial, an increase of light varying from 25 to 35 candles could be obtained at practically the same cost as at present.

Amount to be Expended.—The estimate for this amount should provide for the erection of buildings that will meet the requirements of the district for several years, and planned so as to be easily extended. The machinery should be equal to the probable requirements of the compulsory area, with an allowance for the extension which invariably immediately follows the installation of an electric scheme. This should not be less than 300 kw. or 10,000 8-c.p. lights, which would be equal to 15,000 8-c.p. lights installed on consumers' premises. The cost of an installation to meet these requirements, including buildings, generating machinery, and reserve plant, with 2½ miles of mains, would, I estimate, amount to £30,000.

Financial Considerations.—No installation of electric lighting has, up to the present, shown a profit on the first year's working, the results being entirely dependent upon the demand for light. The best guide in this respect is the experience of similar districts. Mr. Lovegrove then goes on to quote the case of Hampstead, from the revenue account of which parish it appears that for the first 15 months ending December 31, 1895, there was a loss of £2,916, after paying off interest and principal of loans, and for the 15 months ending March, 1897, there was a net profit, after paying off interest and principal of loans, amounting to £1,900. In the case of Ealing it is only in the third year that the debtor and creditor account balance, the loss on the first two years being about £3,000.

Appended to Mr. Lovegrove's report was the opinion of Mr. R. Hammond, whom Mr. Lovegrove was authorised to consult, as follows: I have pleasure in expressing my complete conformity with the same both as regards the procedure to be followed in the obtaining of a provisional order and in the general principles connected with the laying down of the works and the distribution of electrical energy therefrom. With regard to the dust destructor, I agree with you that the question of the utilisation of the excess steam is one which requires very careful consideration in detail, as though manifestly it is wise to use every available means at hand of assisting the generation of electricity, my experience leads me to believe that too much reliance cannot be placed upon the source of power derived from a dust destructor.

Area of Supply and Initial Capital Expenditure.—You are right in recommending that the whole of the parish of Hornsey should be included in your application, and also in your statement that whatever area may be inserted in the provisional order as the compulsory area, the Council will be empowered to extend their mains whenever business presents itself. Indeed, they will be bound to snpply on requisition, provided that the consumer guarantees a revenue sufficient to amply cover the interest and redemption on the capital expenditure on the necessary mains extension. It will be noticed, however, that under this clause the Council is not bound to extend the mains unless the business offered is of an extremely profitable nature. I draw attention to this clause because it is one you must bear in mind in fixing upon your capital outlay. It would, for instance, be most unsound to limit your capital outlay to that sufficient simply to supply mains in the compulsory area, and I consider it is essential that your Council should not put the provisional order into operation unless they were prepared to face an expenditure which would provide sufficient margin for complying with the demands from ratepayers outside the compulsory area. With regard to the nature of the generating works, your Council, in deciding the size of the first plant, will have to choose between two policies: (1) the laying down of sufficiently small plant to give, as it were, a sample of electric lighting in the district, which small plant would have to be disposed of when extension became necessary; and (2) the laying down from the very beginning of plant of a sufficiently large size to fit into the permanent requirements later on. Hornsey will, I think, do wisely to lay down plant from the very beginning of a sufficiently large size to deal with permanent work later on. I am glad to notice that in this respect you have anticipated my views, and have provided for a 300-kw. set. I should only add that, having decided that this should be the unit, it will be necessary to put it down in duplicate for the purpose of reserve. I should also recommend the addition of a small self-contained set for running during the hours of daylight, as under the provisional order a continuous service would be necessary. The same reserve principle should be applied to the boilers. With regard to system of distribution, your recommendation of the alternating high-tension system is sound. The one objection that can be urged against electric lighting in Hornsey is its scattered nature, and this objection would have had very great weight in the early days of the industry, when the distribution was limited to low tension. Now, however, that the alternating high-tension system has been applied with such great success throughout the country there need be no hesitation to apply electric lighting to Hornsey on this score, and the high-tension alternating system is the one I think that should be adopted. With regard to mains, the compulsory area scales about one mile and a quarter, but, as I have already said, the pioneer capital should be fixed at such a figure as would include mains extensions, and instead of limiting the figure to that sufficient to cover the 1½ miles of pioneer area, I should recommend that provision should be made for five miles, in order that extensions to this extent could be made wherever they were demanded. I agree with your idea of providing arc lighting in the compulsory area. It has been found in other places that arc lighting has proved an excellent advertisement of the electric lighting, and has largely stimulated the demand for electric lighting in the houses *en route*. With regard to your estimate of £30,000, I am able to state that for this sum a first-class start could be made, but I think the Council should be prepared for the increasing of this figure to £35,000, in order to provide amply for the mains extensions which I have indicated above, and also for the purpose of laying down the pioneer plant at the central station in duplicate. For this figure an installation could be obtained with sufficient generating plant and mains distribution to deal with the number of lights which would yield a revenue of, say, 6d. per unit sufficient to cover the costs of working and the interest and sinking fund. My estimate also covers the provision of buildings of a substantial nature of a size adapted for the permanent installation by easy extensions.

Mr. BURT, in seconding, said he and Mr. Crump were now quite agreed upon the scheme and other points with regard thereto.

The report was agreed to.

LEGAL INTELLIGENCE.

ACTION BY AN ELECTRICAL ENGINEER.

In the Westminster County Court on the 23rd inst., his Honour Judge Lumley Smith, Q.C., heard a case of Rose *v.* Jacobs, in which the plaintiff, an electrical engineer carrying on business in Regent-street, sought to recover a sum of £34 in respect of electrical work done, and fittings supplied to the order of the defendant.

The **Plaintiff** was called and proved the order and completion of the work, and said that many applications had been made for payment, but all to no purpose.

The defence was that the work was badly carried out, and that a great portion of it had to be done over again by another firm.

His **Honour** said that, if the defence was a good one, it ought to have been put forward before. It was too late now, and there would be judgment for the plaintiff for the amount claimed, with costs.

COMPANIES' MEETINGS AND REPORTS.

WIRELESS TELEGRAPH AND SIGNAL COMPANY, LIMITED.

The statutory general meeting was held on Tuesday last at Cannon-street Hotel.

Mr. Edgar Appleby, who presided, said the whole of the share capital had been applied for and allotted, and they were now engaged in the development of a useful and valuable patent. So far they had made satisfactory progress, although, as was only natural in a matter of this description, the business had been a little involved and intricate. Mr. Marconi had been making experiments on Salisbury Plain, which had added greatly to the useful purpose served by the experiment he made across the Bristol Channel. Certain new points had been developed, and to cover these the requisite steps had been taken by their patent agents. The Board were assured by Messrs. Carpmael that in all respects their patent was valid. In conclusion, he said care had been taken to conserve the financial resources of the Company, and he believed when the time came for the Board to place the usual statement before the shareholders it would be acknowledged that the directors had conducted their affairs honestly.

Mr. Goodbody asked if the directors were satisfied with the experiments which had been made.

The **Chairman** replied that the experiments made by Mr. Marconi, and in the presence of various experts, had perfectly satisfied the Board. The invention would be found most useful for such purposes as communication with lighthouses from the land, and from lighthouses to passing ships or vessels in distress. Mr. Marconi had successfully sent messages 12 miles, and he was

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sanguine that in another fortnight he would be able to send one 20 miles.

Mr. W. Smith, in answer to further questions, stated that everything attempted had been satisfactorily carried out. Greater results might have been obtained, but they had been more anxious to perfect their invention than to produce anything of a sensational character. The directors were most sanguine of the ultimate value of the Company's patent.

No resolution was submitted to the meeting.

VENEZUELA TELEPHONE AND ELECTRICAL APPLIANCES COMPANY, LIMITED.

Sir Douglas Fox presided over the ordinary general meeting of this Company, which was held at 28, Victoria-street, Westminster, on Tuesday last.

The **Chairman**, in moving the adoption of the report, stated that they had made very fair progress during the past year. They not only showed an improvement in their general business, but also that the result of the extensions which had been acquired by the Company between Caracas and Valencia and in the Cua and Sucre districts had been attended by a very fair profit. Their property had been thoroughly well maintained, and they had an excellent manager in Venezuela, who kept them thoroughly acquainted regularly with what was going on there. The number of their subscribers had increased from 2,524 on June 30, 1896, to 2,737 on June 30 last. There was a constant growth in the number of telephones required, and they had also had to purchase the additional lines he had mentioned. To provide the additional capital required for these purposes they had issued 550 of the preference shares of £10 each, authorised by the resolution passed at the extraordinary general meeting held on November 24, 1896.

Mr. J. W. Philipps seconded the motion, which was carried unanimously.

ELECTRO-CHEMICAL COMPANY, LIMITED.

The annual general meeting of this Company was held at St. Helens, Colonel Holland, C.B., in the chair.

Mr. Martin Pirie (Alexander Pirie and Sons, papermakers, Aberdeen) and Mr. John Henry Walter (one of the proprietors of the *Times*) were re-elected directors.

The **Chairman** said that arrangements had been made for 1,600 additional electrical horse-power, making in all 5,100 e.h.p., or over 6,000 indicated horse-power. Samples of the electrolytic products made by the Company were produced, and carefully examined by those present. The Chairman added that the business generally was being carried on profitably, the present weekly out-turn being about 70 tons of 70 per cent. caustic soda, 130 tons of 37 to 38 per cent. bleach, and five or six tons of exceptionally pure chlorate of potash. It was hoped, however, that these amounts would shortly be very considerably increased, and there was a ready sale for all their products at good prices. The Company had sold its Japan patent for £6,000, half of which amount had already been received in cash; the balance was payable next January. They had also sold their French, Belgian, and Russian patents for £37,000, and arrangements were being made for the sale of other foreign patents. Several shareholders were present, all of whom had previous to the meeting inspected the buildings, plant, and machinery, and expressed themselves very pleased with everything they had seen.

The proceedings terminated with a cordial vote of thanks to the chairman and directors for their services during the past year.

CONTRACTS FOR ELECTRICAL SUPPLIES

CONTRACTS OPEN.

Barrow-in-Furness.—The Corporation invite tenders for the supply and erection of engines, etc., particulars of which will be found in our advertising columns. Tenders by December 15.

Catanzaro (Italy).—Tenders are invited for electric tramway or other light railway between the town and the railway station. The deposit required is £400. Specifications are to be obtained from, and tenders addressed to, the Municipal Authorities by December 30.

Paris.—Tenders are invited for the supply in four lots of telegraph apparatus (system, Baudot). Specifications are to be obtained from, and tenders addressed to, Postal Department, rue de Grenelle 103, Paris, and tenders are to be sent in by November 30.

Hackney.—The Joint Public Health and Electric Lighting Committee of the Vestry are considering the question of lighting Hackney by electricity, either combined with a dust destructor or without, and are prepared to consider any scheme for this purpose from parties in a position to carry it out, particulars of which appear in our advertising columns.

Londonderry.—The Corporation invite tenders for the supply of carbons for one year from January 1, 1898. Schedules of quantities and further particulars may be obtained on application to Mr. John Christie, city electrical engineer, Guildhall, Londonderry. Tenders, accompanied by samples, marked "Tender for Carbons," to be lodged with him by December 9.

Ashton-under-Lyne.—Tenders are invited for the wiring, supply, and fixing of electroliers and all other fittings or things necessary in order to light the baths assembly-room and entrances with electricity from the town's mains, by the Baths Committee. Information may be had from Mr. John Neal, borough comptroller Town Hall, and tenders must be sent in by noon on November 30.

Dundee.—Tenders are invited for supply of an economiser to be delivered and erected at the electric lighting station, Dudhope-crescent, Dundee, by the Dundee Gas Commissioners. Specifications and plans may be had on application to Mr. Walter H. Tittensor, city electrical engineer. Tenders to be lodged with Sir Thomas Thornton, clerk to the Commissioners, City Chambers Dundee, by 12 noon on December 3. Particulars appear in our advertising columns.

Blackburn.—The Blackburn Corporation Tramways Company are prepared to receive tenders for eight tramcar bodies, with trucks, motors, controllers, trolley poles, etc. Specification, general conditions, and form of tender may be had on payment of £2. 2s., returnable on receipt of a bona fide tender upon the prescribed form and within the stated time. Drawings and plans of route may be inspected at the office of Mr. E. M. Lacey, engineer, 10, Delahay-street, Westminster. Sealed tenders, addressed to Mr. J. W. Baker, secretary, Blackburn Corporation Tramway Company, Railway-road, Blackburn, and endorsed "Electric Tramcars," to be delivered to him by 12 noon on 27th inst.

Leicester.—The Sanitary Committee invite designs and tenders for motor vehicles for the collection of house refuse. The motive power, capacity, and all other particulars are to be described in a full specification, accompanied by drawings and delivered at the office of Mr. E. George Mawbey, C.E., borough engineer and surveyor, Town Hall, Leicester, addressed to the Chairman of the Sanitary Committee, by January 31. The loaded wagons would have to ascend an incline of 1 in 20, turn in a limited space, back and tip over a beam about 14in. high by 12in. in width, and when empty descend a road having a gradient of 1 in 15. The Committee do not bind themselves to accept any proposal, and firms tendering must do so at their own cost, no fees being allowed for the preparation of drawings, etc.

London, W.C.—The Metropolitan Asylums Board invite tenders for the execution of certain additions and alterations to the electric fire alarm system at the South-Eastern Fever Hospital Hatfield-street, New Cross-road, S.E. Copies of the specification form of tender, and conditions of contract, which have been prepared by Messrs. Burstall and Monkhouse, electrical engineers 14, Old Queen-street, Westminster, S.W., can be obtained at the Chief Office of the Board, Norfolk House, Norfolk-street, W.C., upon depositing the sum of £2. 2s., which will be returned only to those who send in a bona fide tender in accordance with the terms of the advertisement, and who return the specification and conditions of contract. Tenders, which will only be received on the lithographed form supplied by the Board, must be sealed, and endorsed "Tender for Additions, &c., to Fire-Alarm System, South-Eastern Hospital," and must be delivered at the offices by 10 a.m. on December 2. Unless the tender be accompanied by the specification and conditions of contract it will not be considered.

Canterbury.—The Electric Lighting Committee of the Corporation are prepared to receive tenders for the supply and erection of plant as follows: (Section A) boiler-house plant—Lancashire boilers and accessories, mechanical stokers, feed-pump, injector, economiser, electric motor: (B) engine-house plant—steam dynamos and accessories, condensers, oil-filter, steam, exhaust, feed, blow-off, and sundry pipes, valves, feed-water and storage tanks, &c.; (C) overhead travelling crane; (D) switchboard and instruments; (E) accumulators; (F) mains—insulated cables and trenching; (G) public lamps—arc and incandescent street lamps, lamp-posts, and brackets; (H) meters. The whole bound up in one specification, price £2. 2s., returnable on receipt of bona fide tender. Further copies £1. 1s., not returnable. Tenderers are at liberty to tender for any section, but not for part of a section. Specifications, with terms and conditions of tender and contract, may be obtained at the offices of Mr. Robert Hammond, consulting engineer to the Corporation, Ormonde House, Great Trinity-lane, London, E.C., on payment of £2. 2s., which sum will be refunded on the return of the specification, filled up, with a bona fide tender. Tenders, sealed, and marked "Tender for Electricity Works," must be addressed to Mr. Henry Fielding, town clerk, 15, Burgate-street, Canterbury, and delivered by December 20.

Madras.—Tenders are invited for the utilisation of water flowing from the Periyár Lake for purposes other than irrigation and not incompatible with the use of the water for drinking. The irrigating season extends over nine to ten months, during which time the discharge is likely to be from 1,100 to about 500 cubic feet a second, according to the demands for irrigation and the available quantity in the lake. Subject to the risk of interruption by accident or drought, supply can be given throughout the irrigation season. No supply can be guaranteed at other times, but, so long as water is available, the Government will be prepared to issue it in such daily quantities as may seem to it advisable with reference to the time which is likely to elapse before the supply is replenished by the setting in of the rains. The fall from the tunnel to the foot of the hills is approximately 900ft., and the distance measured along the course of the stream about 6,800ft. One cubic foot per second falling 900ft. is estimated to produce over 60 effective horse-power. Intending lessees should state the quantity of water required in cubic feet per second and the annual rent offered for each cubic foot per second. No rent will be charged for the first year from the date of the concession; for the second year the charge will be one-fifth, and an additional charge of one-fifth will be

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made every year until the full rent is reached. The whole or part of the concession may be surrendered on a year's notice being given. Lessees will construct at their own expense, on plans to be approved by Government, all the weirs and other works required to divert the water from the river below the tunnel. For further information, application may be made to the Chief Engineer for Irrigation, Madras, by whom tenders will be received up to July 1, 1898.

RESULTS OF TENDERS.

Eccles.—The tender of Mr. G. Macfarlane, at £1,970, for erecting an electric lighting station, has been accepted by the Corporation.

Bradford.—The Guardians have accepted the tender of H. Scholes and Co., of Manchester, at £186. 5s., for the installation of electric light in the nurses' home.

London, S.W.—The following tenders have been received by the Chelsea Electricity Supply Company, Limited, Chelsea, for office alterations and additions:

W. Stimpson	£297
C. F. Kearley (accepted)	289

London, W.—The London School Board have received the following tenders for providing and fixing telephone from superintendent's room to lodge at Gordon House, Isleworth:

Edmundsons' Electricity Corporation, Limited	£15 10 0
Gent and Co.	13 0 0
Private Wire and Telephone Installation Company*	12 19 6
J. W. Gray and Son	7 10 0

* Recommended for acceptance.

BUSINESS NOTES.

Perth.—Mr. Bailie Wright has been appointed convener of the Electric Lighting Committee of the Council.

Rawmarsh.—A deputation has been appointed to glean information as to the probable cost of the proposed lighting scheme.

Darlington.—The Town Council will apply to the Board of Trade for extension of the powers contained in their provisional order of 1890.

Camberwell.—The Vestry have disapproved of the proposal of the London Electric Supply Corporation to lay distributing mains in Camberwell-road.

Bristol.—At the last meeting of the Council, the Mayor said he hoped that before the next meeting the electric light would be introduced into the chamber.

Derby.—A largely-attended dinner took place last week at the Liberal Club to commemorate the successful installation of the electric light at the clubhouse.

Darlington.—The Council have adopted the Gas Committee's report recommending that notice be given to extend the area for the electric light supply of the borough.

Llangollen.—The Urban District Council have given notice of their intention to apply to the Board of Trade for a provisional order to instal electric light in the town.

Ossett.—Notice has just been given of the intention of the Corporation to apply for a provisional order so enable them to supply electricity for public and private purposes.

Ilfracombe.—At a special meeting of the Ilfracombe District Council on the 18th inst., it was decided to apply for a provisional order for the lighting of the district by electricity.

Bournemouth.—The Town Council on the 24th inst. decided to oppose the introduction of tramways by public companies, believing that any scheme should be carrred out by the Council.

Long Eaton.—The Electric Light Committee have considered the best method of obtaining information, and decided to get particulars from several places now using the electric light.

Appointments Vacant.—Increased activity in the business evidently tends to increased opportunity for employment. In another column appear various advertisements for electricians, etc.

Catalogue.—We beg to acknowledge receipt of the illustrated and mathematical catalogue (W, 1897) of Messrs. Elliott Bros., manufacturers of electrical, optical, engineering, and mathematical apparatus, London.

Aberdeen.—The new Gas and Lighting Committee stands as follows: Councillor Johnston (convener), Lord Provost Mearns, Councillors Bain, Boddie, Croll, Cooper, Fleming, Kemp, Gray, Maitland, and Bailie Sangster.

Bowness.—At the last meeting of the Harbour Commissioners the electric lighting of the dock was further considered, when it was agreed to continue the matter with the engineer and Mr. Carlow, to report thereon to the next meeting.

Stanley.—The Stanley Mills which were used formerly for the manufacture of twine, but which have for several years been unoccupied, are now to be opened for the manufacture of soap and chemicals. The mill is lighted up by electricity.

Rochdale.—Notice has been given of the intention of the Corporation to apply to the Board of Trade, under the Electric Lighting Acts of 1882 and 1888, for a provisional order to enable them to supply electricity for public and private purposes.

Swansea.—A special meeting of the Electric Lighting and Tramways Committee of the Swansea Corporation was hurriedly summoned last Monday, and the notices were marked "important." Some new development of the triple scheme may be expected.

Aldershot.—Mr. Reginald P. Wilson, consulting electrical engineer, Westminster, has been appointed to assist the Aldershot District Council in the matter of obtaining a provisional order, and to advise them generally with regard to the question of electric lighting.

Grimsby.—At a recent meeting of the Town Council, Alderman Dobson was unanimously reappointed chairman of the Lighting Committee. Councillor Curry was re-elected vice-chairman. Mr. Chatburn was added to the sub-committee appointed to deal with the question of electric lighting.

Metropolitan District Railway.—Apparently the trials which were made some time ago with an electric locomotive on the Inner Circle have proved successful, for it is now stated that the system is to be worked by electricity, and that the transformation is to take place in a very short time.

Dewsbury.—Besides lighting the newly-reconstructed thoroughfare known as New Bridge-street, and which is to be supplied with special lamps, the Corporation committee having charge of this department of municipal work have resolved to extend the lighting to various other principal roads.

Brazilian Submarine Telegraph Company.—The directors of the Brazilian Submarine Telegraph Company, Limited, have declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, free of income tax, for the quarter ended September 30 last, and payable on 21st prox.

Brighton.—The application of the British Electric Traction Company to the Light Railways Commission for authority to construct light railways, otherwise tramways, along three routes in Brighton was discussed by the Town Council last week, with the result that the project will be opposed at all its stages.

Leeds.—A motion referring to the purchase of the Yorkshire House-to-House Electricity Company's undertaking by the Corporation was brought under the notice of the Parliamentary Committee of the City Council last week. It was resolved to convene a special meeting of the committee to consider the matter.

Nottingham.—The Tramways Committee of the Nottingham Corporation have received an offer with regard to the tramway undertaking, which the Council had itself only recently acquired at a cost of £80,000. The offer, which was made on behalf of a syndicate of local gentlemen of the highest standing, has been declined.

Cefn.—A special meeting of the Parish Council was held on the 19th inst., when the resolution to take into consideration the advisability of devising some mode of lighting other than gas for the next season, which had been passed at the parish meeting on the subject of the lighting of the streets, was unanimously confirmed.

Electrical Trades Union.—A meeting of the electrical workers of Leeds was held on Saturday last to consider the desirability of forming a branch of the Electrical Trades Union for the city. Addresses were given by Mr F. Sims, the organising secretary of the union, and several workmen, after which it was decided to start a Leeds branch.

Edinburgh.—At the last meeting of the Electric Lighting Committee of the Town Council it was resolved to recommend the Town Council to rent an area of ground from George Heriot's Trust in Macdonald-road as a site for the new electric lighting station, and to accept offers for a supply of additional plant, amounting to nearly £20,000.

Cardiff.—Shortly before six o'clock on Sunday last the electric light suddenly went out in some parts of the town. The cause of the failure was the breakdown of one of the main cables between the electric lighting station and the centre of the town. The stoppage was only of very short duration, as the fault was soon discovered, and promptly repaired.

Hastings.—The Hastings and St. Leonards-on-Sea Electric Light Company, Limited, have received permission to extend a low-tension main enclosed in iron pipes laid under the footways at a depth of 2ft., and a distance of 2ft. from the kerb, from an existing transformer to a brick box, thence to carry a service main in accordance with a plan submitted.

Folkestone.—At a special meeting of the Folkestone Town Council it was agreed, after much discussion, to affix the Corporation's seal to the formal deed of transfer of the powers of the Corporation under the Folkestone Electric Lighting Provisional Order, 1896, to the Folkestone Electricity Supply Company, Limited, approved by the Board of Trade.

Hampstead.—A motion asking that the Lighting Committee be instructed to prepare a plan for the electric lighting of Heath-street north of its junction with High-street has been referred to the Lighting Committee of the Vestry. A petition has been received from the tradesmen of Heath-street in favour of the lighting of that portion of the thoroughfare by electricity.

Manchester.—The Earl of Jersey and Colonel Boughey, acting as commissioners under the Light Railways Act, held an enquiry on the 22nd inst. relative to a proposed light railway. The line is part of a scheme for developing Trafford Park, and is intended to form a means of inter-communication between several populous suburban districts. There is considerable opposition to the project.

Gateshead.—An extraordinary meeting of the shareholders of the Gateshead and District Tramways Company will be held next month to consider and, if approved, confirm an agreement made between the directors of that company and those of the British Electric Traction Company. The agreement provides for the purchase of the existing shares of the former company by the latter.

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Breakdown.—In consequence of some mishap to the machinery, the electric light supplied to a part of the Law Courts from an outside source broke down for a time last Wednesday. As the gas had been disconnected, the primitive candle had to be resorted to for lighting purposes during the day in the Queen's Bench, judges' corridor, and some of the offices. The light, however, was soon restored.

Motorcar Trials.—The Liverpool centre of the Self-Propelled Traffic Association announce trials of motor vehicles for heavy traffic to take place in May next. The chief object of the trials is to arrive at a type of heavy motor-wagon suitable for trade requirements in Liverpool and neighbourhood. Money prizes of £100, £75, and £50, also certificates of merit, will be given at the discretion of the judges.

Worcester.—The Council have decided, on the recommendation of the Electricity Committee, to spend a sum of £500 in the erection of a fish pass at the Powick Weir, to comply with the demands of the Severn Fishing Board and the Board of Trade, in consequence of the Council having raised the crest of the weir some 9in., with a view to obtaining a greater amount of water at the electricity generating station to work the turbines.

Skipton.—The Electric Lighting Committee reported at the last meeting of the Council that Dr. Hopkinson had replied stating his terms for visiting the town and advising generally upon the system of electric lighting to be adopted. The committee decided to take no further steps in the proposal to establish electric lighting for the town until the question of the proposed purchase of the gasworks had been discussed by the Council.

Walsall.—At the last meeting of the Guardians a letter was received from the Corporation electric engineer, stating that an extension of the electric mains was contemplated, and asking if the Guardians contemplated lighting their buildings with electricity. The Chairman moved that the clerk be instructed to write and enquire as to the advantages to be derived from the use of electricity over gas, and also whether it would be more economical.

Brierley Hill.—A special meeting of the Urban Council was held last week in reference to the electric tramway scheme. A resolution on the minutes was rescinded, and the meeting then passed a resolution under which a clause is to be inserted in the agreement with the British Electric Traction Company to the effect that the company shall erect and maintain an electrical generating station within the urban authority's district for generating electricity for working the tramways in the district.

Barrow-in-Furness.—Mr. Robert H. Bicknell, Local Government Board inspector, held an enquiry at the town hall on the 24th inst. respecting an application made by the Corporation for sanction to a loan of £30,000 for electric lighting purposes. The details of the scheme were explained by Mr. Manville (of Messrs. Kincaid, Waller, and Manville, Westminster, who are acting as electrical engineers for the Corporation) and Mr. Fox, the borough engineer, who has prepared the plans for the buildings. There was no opposition.

National Electric Free Wiring Company, Limited.—We are informed that this Company has obtained the contract for the electric wiring and fittings for the new Liverpool head post office (1,125 incandescent and 58 arc lamps) and also that for the electric wiring for the new technical institute at West Ham with about 1,400 lights. The Company state that during the past two months they have carried out 60 installations, with an aggregate of over 1,000 lights. In all of the foregoing installations their patent system of wiring has been used throughout.

Redditch.—A special meeting of the District Council was held last week to consider the report of Mr. McMullen, who was instructed to prepare a scheme for lighting the central portions of the town with electricity. It had been stated that if 1,800 lights were promised to be taken, the scheme, which was estimated to cost £8,000, should be carried out. Promises to take over 2,500 lights have been received, in addition to those required for lighting the streets. It was resolved to request Mr. McMullen to prepare a scheme sufficient to meet the increased demand, and to supply estimates of the cost.

Buxton.—At the last meeting of the Urban District Council the report and recommendation of the deputation *re* electric lighting appointed to confer with the parliamentary agents were submitted. It was decided that action be at once taken by the Council to establish an installation for the supply of electric light in Buxton, under the Council's existing provisional order; that Prof. Kennedy, of London, be requested to inspect and report on the subject, and to meet the Council, as per his letter of the 11th inst.; and that the whole of the members of the Council form the Electric Lighting Committee *pro tem.*, with power to form sub-committees.

City of London Electric Lighting Company, Limited.—We are informed that the directors of this Company have decided to make a further issue of 10,000 ordinary shares at the price of £18 per £10 share, and to give to all holders of the existing 50,000 fully-paid ordinary shares who were registered on the Company's books on the 10th inst. the right to apply for and have allotted to them the present issue of 10,000 shares in the proportion of one new share for every five old shares. Application forms and fractional certificates for such shares were posted on the 19th inst. to the holders of the existing ordinary shares as mentioned above.

Electric Cable-Making in Scotland.—The *Scotsman* says up to the present the making of electric cables has been an unknown industry in Scotland. That this should be so, considering the rapid advances that have been made in the use of electricity for power and lighting, is rather remarkable. In a few weeks, however, Scottish enterprise will be vindicated by the starting of the Craigpark Works, at Alexandra-parade, Glasgow, where cables of all descriptions for electrical installations will be made. The Craigpark Works have been acquired by the company, fully equipped with machinery for cable construction, so that operations will be begun almost immediately.

Holborn.—Notices are advertised of an application to the Board of Trade under the Electric Lighting Acts, 1882 and 1888, for a provisional order to authorise the Charing Cross and Strand Electricity Supply Corporation, Limited, to supply electricity for public and private purposes, and to supply electrical power and energy within parts of the parishes of St. Andrew-above-Bars and St. George-the-Martyr, in the district of the Board of Works for the Holborn District, in the county of London; power to make charges, to acquire lands, to break up streets, to construct works, to lay mains, wires, and other apparatus; to make arrangements with local authorities, and other purposes.

Glasgow.—At the meeting of the Corporation on the 18th inst. notice of motion was tabled for the next meeting that it be an instruction to the Tramways and Parliamentary Bills Committees to apply to Parliament at the earliest opportunity for power to lay a line of tramways from Springburn along Keppochhill-road to Possil-road. The Corporation are still debating the question of single-deck *v.* double-deck cars for the tramways. In the minutes of the Tramway Committee a reference was made to the inspection of a single-deck car which had been constructed and recommended for adoption on the experimental electrical tramway route to Springburn. This minute was approved of.

Newington.—A special meeting of St. Mary's Vestry was held on the 24th inst. in order to receive a joint report from the Roads and Depôt Committee and the Electric Lighting Committee, recommending that the offer of the Brandon trustees to grant the Vestry a lease for a term of 999 years of the houses 22, 24, 30, 32, and 34, Penrose-street, at a ground rent of £150 per annum be accepted, and that the agreement stand referred to the Electric Lighting Committee with instructions to demolish the property and clear the site for the electric lighting station, and that in future all recommendations in connection with the property be submitted to the Vestry by the Electric Lighting Committee.

Leith.—At a meeting of the special committee of the Town Council on the 23rd inst, the Clerk intimated that he had received a letter from the Edinburgh Street Tramway Company requesting to be allowed to comply with their request in their letter of July 13 last—namely, to cable the Leith-walk section in terms of agreement of 1892, asking power to construct the tramway extending from Bernard street across the Water of Leith to join the Commercial street line, and also asking the Council to withdraw their objection to this line as lodged with the Board of Trade. The Town Clerk intimated that he had received a letter from the Board of Trade stating that they no longer withhold their sanction to the construction of this second line. The committee are awaiting the sub-committee's report on the matter before taking further action.

Applications for Orders.—Up to the end of last week statutory notice had been given by 17 local authorities and others of their intention to apply to the Board of Trade for provisional orders, under the Electric Lighting Acts, 1882 and 1888, for power to produce and supply electricity for lighting purposes. Since then similar notice has been given by 12 other authorities to a similar effect—namely, the Rural District Council of Chelmsford, the Vestry of the parish of Marylebone, the Midland Electric Light and Power Company, Limited (for the borough of Royal Leamington Spa), the Hastings Corporation, the Haworth Urban District Council, the Weston-super-Mare Electric Light and Power Syndicate, the Crewe Corporation, the Lewes Corporation, the Gravesend Corporation, the Dartford Urban District Council, the Aston Manor Urban District Council, and the Batley Corporation.

Bermondsey.—At the last meeting of the Vestry the Electric Lighting Committee reported that they had had under consideration the sums proposed to be expended in connection with the provisional order, when obtained. The rules made by the Board of Trade provided that the Vestry must deposit with the memorial a statement of the sums proposed to be expended. Mr. Manville, in his report, estimated that the sum of £15,635 would be required for works in the compulsory streets suggested in his report, and for the lighting of the public arc and incandescent lamps. The committee, being of opinion that the portion of Grange-road between Bermondsey New-road and Spa-road should be added to the compulsory streets specified by Mr. Manville, recommended that the sum of £16,000 be the amount named in the statement to be deposited with the Board of Trade. The report was carried.

Whitechapel.—At the last meeting of the members of the Board of Works held on the 22nd inst., applications from Mr. Lawson, the engineer and manager to the County of London and Brush Provincial Electric Lighting Company, with reference to the application proposed to be made by that company to light this district, and suggesting certain terms, and from Mr. Sydney Morse, on behalf of the County of London and Brush Provincial Electric Lighting Company, upon the same subject, were considered. Also a notice of motion by the Chairman, "That it be referred to the special committee appointed by the Board on May 10, 1897, for electric lighting purposes, to consider and to report to the Board upon the advisability of enlarging the destructor premises of the Board, and the mode of carrying out such enlargement, if considered desirable, for electric lighting purposes."

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Dresden.—An important and interesting ceremony took place in the large hall of the Crystal Palace, Leipzig, on Friday last, the 19th inst., in the form of a dinner given by Messrs. Koerting and Mathiesen, of that city, the well-known arc-lamp manufacturers, to their employés, numbering several hundreds, to celebrate the fact of the firm having on that day brought the total of lamps manufactured and sold by them to the large figure of 50,000. The dinner and subsequent entertainment were very much appreciated by those present, and after the usual loyal toasts that of "Prosperity and Success to the Firm" was proposed and enthusiastically received, thus ending a gathering the purpose of which is probably unique in the arc-lamp world. *Inter alia*, it may be mentioned that some very large orders are being booked, both for ordinary and long-duration lamps, by this firm's agent in Great Britain—Mr. G. Braulik, of London.

Wimbledon.—The Electric Lighting Committee reported at the last meeting of the Urban District Council that Mr. A. H. Preece had attended a meeting held on November 9, and submitted his preliminary plans of the proposed buildings and works for the electric lighting station. The plans were approved, and the committee recommended the Council to adopt them. The clerk was instructed to enquire of the Local Government Board when the sanction for the loan might be expected. With regard to the private streets about to be made up, the committee recommended that the surveyor obtain the necessary pipes for the proposed electric mains. It was stated that the committee went into the question of the dust destructor, and arranged that this should be added when required without any extra cost. The Chairman observed that the plans were very well prepared. The Clerk, in answer to questions, stated that no further enquiry would be held on the subject. He was expecting the Local Government Board's sanction to the scheme every day.

Llandudno.—The Council are taking steps to apply for a provisional order under the Tramways Act of 1870. At the last meeting of the committee the surveyor said he doubted whether the plans could be got ready in time to enable them to be deposited as required by the Act, and he was authorised to advertise immediately, and to obtain what assistance he may consider necessary to attain the object. On further consideration of the route which it is proposed that the tramway should take, it was decided to recommend that it be as follows—viz., commencing at the junction of Bodafon-road and Brynybia-road near Adwyrydd, down a road called Ffynon Sadwrn to its junction with the proposed extension of Mostyn-avenue, across the fields on line of Mostyn-avenue, along Mostyn-avenue, Mostyn-street extension to North-Western Hotel, through Mostyn-street, Gloddaeth-street, and along Conway-crescent and West-parade to its junction with Abbey-road. The above was formally passed without discussion by the Urban District Council at their last meeting.

Dundee.—The Dundee Suburban Railway Company has notified its intention to apply to Parliament in the ensuing session for an extension of the time limited by the Dundee Suburban Railway Acts of 1884, 1889, 1894, and 1896 for the construction of the railway authorised by these Acts.—It is understood that the Caledonian Railway Company are to promote a Bill for the construction of a railway branching off the Forfar direct line at Barnhill, following the valley of the Dichty, and then dividing into two sections, one connecting with their line at Maryfield, and the other joining the Newtyle Railway at Downfield, the N.B. Company having running powers over the line.—The Corporation have approved of a scheme for extending the area of public lighting by electricity. Since the introduction of electric lighting in Dundee some years ago all that has been done in the way of public lighting has been limited to four lamps on the High-street. Now, however, it is proposed to provide 30 additional lamps, each of 2,000 c p It is expected that the new arrangements will be completed before the end of January.

Swindon.—A joint meeting of the Old Swindon and New Swindon Urban District Councils was held last week to consider the question of electric lighting and the application for electric light railways. The Chairman, in opening the meeting, said that both Councils had agreed to the report of the Incorporation Committee, which was as follows: "That it be recommended to the two Councils that the clerks apply to the Board of Trade, setting out the proposed incorporation, and asking, on behalf of the two Councils (1) to extend the area of the present provisional order so as to include the area of the district of Old Swindon; (2) to postpone the revocation of the present order for a further period, and that the two clerks be authorised to have an interview with the Board of Trade to explain the whole position, and to obtain all possible information on the above points, and also as to the proposed application for a light railway with electric motive power. That the two Councils be recommended to oppose the proposed application of the Hon. A. H. Willoughby for a light railway with electric motive power."

St. Just.—At the invitation of the Council, Mr. Solomon James, Pendeen, presented his report on the possibility of generating by water an electric light supply. The report stated that at this period of the year the stream is very small. On October 29 and November 3 it was running at a certain point 5,000 gallons per minute. A good many of the water rights of the stream are apparently free. In one part there is a fall of 103ft. 9in. He estimated that £91. 15s. would be required for the construction of a dam, and 1,000ft. of 5in. pipe would also be needed. Two dynamos complete would cost £590. Twenty-five lamps would light the town. It would cost about £150 a mile to lay the cable. One thousand pounds would do the whole work. He further stated that he should be in London on the 24th, and if the Council wished he would call on Messrs. Johnson and Phillips, electrical engineers, and explain the whole scheme. It was agreed that the clerk write to Messrs. Boyns and Chenhalls asking them what amount they will let the water rights for, and that Mr. Solomon James be empowered to make further enquiries as to the cost.

Eccleshill.—The District Council, having determined to push forward their scheme for a tramline from the terminus of the Bolton road line to Eccleshill, are taking prompt action. They have already given notice that they will apply to the Board of Trade, on or before December 23, for a provisional order empowering them to construct such a tramway. The principal line will be three furlongs and seven chains in length, and will commence at the Bradford city boundary in Bolton-road, and pass in a north-easterly direction along Bolton-road, Stonehall-road, and Stoney-lane, terminating in the last-mentioned road at a point 66 yards north-east of the centre of the entrance to the Mechanics' Institute. Passing places are to be provided in Bolton-road and in Stonehall-road, and there will also be a short line from Stonehall-road across the recreation ground, terminating in Mooreside-road, with a branch returning to the main line. In all, the lines will be four furlongs and three chains long, and one furlong of this will be double. The Council are asking for powers enabling them to work the tramways themselves, or to lease them, as they may deem desirable, and to use any kind of traction.

Douglas.—At a special meeting of the Town Council on the 22nd inst. the question of electric lighting and electric traction was again discussed. As previously reported, the tramways company had offered, in consideration of being allowed to substitute the trolley system of electric traction for horse traction on Douglas Bay Tramways, to light by electricity free Douglas promenades and the principal thoroughfares, and to supply electric light to consumers at a fixed price, but in consequence of feelings on the subject expressed by certain councillors, the offer was withdrawn. A notice of motion was tabled for the next meeting to the effect that the expenses incurred by the company in sending a deputation of the Council to the Continent on the matter be refunded.—An electric lighting company is being formed for supplying a portion of the town with electric light. The scheme for the present will include a portion of the Loch Promenade from the Jubilee Clock, including the Villiers Hotel, round by Regent-street and Duke-street, which comprises huge blocks of valuable hotel, boarding, and shop property. The scheme is to be considered and developed at a meeting which has been convened.

Oswestry.—A well-attended meeting of promoters and supporters of the proposed light railway from Oswestry to Llangynog, by way of the Tanat Valley, was held on the 15th inst. Mr. J. Parry-Jones (town clerk) said the Light Railway Commissioners had issued an order sanctioning the construction of the line, and the next step to be taken was to obtain the approval of the Board of Trade and the Light Railway Commissioners to the amounts which were being advanced by the local authorities. These sums make a total of £16 500 The Light Railway Commissioners were at present considering the way in which the order would be drawn up, and it would probably be received about Christmas. Application had also been made to the Treasury for a free grant towards the construction of the line, and he anticipated that they would have a favourable answer. The amount of private subscriptions at present was £8,900, and this sum would have to be raised to £11,500 before the Treasury would make their grant, but in order that the matter should go through he had personally guaranteed that the deficiency of over £2 000 should be forthcoming. It was decided to take steps to obtain further support to the line.

St. Pancras.—A meeting of the Vestry was held on the 24th inst., when reports were adopted from the Electricity and Public Lighting Committee, with reference to the extension of the electric light in various districts (from Chalk Farm to Mother Shipton), and to provide private lighting mains in these localities, at a total estimated cost of £5,422; and from the Special (Dusting and Refuse Destructor) Committee, with reference to the purchase of six additional dust-vans. Also notices of motion as follows: "That the resolution of the Vestry of October 27, 1897, adjourning the consideration of the application of the National Telephone Company, Limited, to extend their system by means of underground pipes from Euston-road to Gower-street, until the London County Council has considered the subject of the metropolitan telephone service, be and is hereby rescinded; that, in accordance with the recommendation contained in paragraph 7 of the report of the Highways, Sewers, and Public Works Committee of November 15, 1897, the application of the National Telephone Company to lay mains underground from Euston-road to Gower street be granted, subject to any terms and conditions that the Vestry may deem it desirable to impose for the privilege conceded."

Fulham.—At a meeting of the Vestry on the 24th inst., the report of the Lighting, Electric Lighting, and Dust Destructor Committee stated that the committee had received a letter from Mr. F. F. Bennett, of Manchester, stating that he would be pleased to act in the capacity of consulting engineer for the Vestry, he having had 15 years' experience; also a letter from Mr. Sydney Morse stating, on behalf of his clients, the County of London and Brush Provincial Electric Lighting Company, that it is their intention to apply next session for a provisional order under the Electric Lighting Acts in respect of a portion of the parish of Fulham. The committee have referred the matter to the Law and Parliamentary Committee, and also have appointed a sub-committee, with the surveyor and medical officer of health, to consider the whole of the proposals and offers received in respect of electric lighting and dust destructors, together with the reports of the deputation, and to report. Since the previous meeting of the Vestry 14 new lamps have been erected in various streets, and the

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surveyor has also been instructed to report as to the cost of keeping the incandescent burners on the lamp at the corner of Munster and Dawes roads for the past 12 months; also as to the better means of lighting this corner.

Metropolitan Electric Supply Company, Limited.—This Company notify their intention of applying for a Bill to authorise them to hold and use as a station for generating electric current or electrical energy certain lands recently acquired by them at Willesden and Acton, and to establish and work on these lands plant for generating electrical energy, and for other purposes incidental to or connected with their undertaking or business. Power will be asked to enable the Company to lay down an electric cable or wire or lines of cable or wire, together with any necessary conduits, pipes, tubes, or coverings, inspection boxes, and other conveniences and appliances from the lands mentioned to the Company's station at Amberley-road, Paddington. It is intended to seek power to lay such cable or wire or lines of cable or wire along Acton-lane, Minet-avenue, Harley road, Bramshill-road, Station-road, Tubbs-road, High-street, Harlesden, Harrow-road, and Amberley-road. Similar powers will be asked for enabling the Company to lay a cable, with the necessary conveniences, along the Grand Junction Canal, or its towing path, commencing at the Company's works on the lands referred to in Willesden and Acton, passing thence through Willesden, Acton, Hammersmith, St. Mary Abbott, Kensington, and Chelsea, to and terminating in Paddington at the Company's works at Amberley-road.

Acton.—At the last meeting of the Council a letter was read from Sir R. Nicholson, who wrote, on behalf of the Middlesex County Council, to ask what the views of the Acton Council were with reference to the proposed construction of an electric tramway from Acton-hill through Ealing to Hanwell. Mr. Godfrey also wrote on the subject of tramways, stating that the London United Tramways Company proposes to apply to Parliament during the ensuing session for power to construct additional tramways, some of which would be in the Acton district. Unless he received directions to the contrary, he proposed to follow the usual plan of affixing the street notices to the lamp-posts in those streets which will be affected. It was said that although overhead wires might possibly be objectionable, the Council ought not to oppose the scheme on that account. The company might be a good customer to the Council. Electric lighting might soon be provided for Acton, and they might sell the day load to the company. Others thought the extension of the tramway would be a good thing rather than otherwise, but there was a general consensus of opinion against overhead wires. The Surveyor said Ealing meant to fight the scheme tooth and nail. It was agreed to reply to the effect that at present the Council had no definite opinion with regard to the scheme, except that it was strongly opposed to the use of overhead wires.

Salford.—The annual meeting of the Electric Lighting Committee was held on the 19th inst., when Councillor Haworth was re-elected as chairman. In returning thanks, the Chairman said they were in charge of a most important undertaking, and during the next 12 months they would have to be responsible for a large expenditure of money. A letter was read from the Local Government Board stating that with reference to the application of the Corporation for sanction to borrow £13,000 for the purposes of electric lighting, the Board would direct that an enquiry should be held as soon as the engagements of the inspectors would permit. The Board repeated the warning already given to the Council, not to commence operations before the necessary sanction had been received. The Chairman said the delay would be a serious matter. They knew not at what date an inspector would be able to visit Salford The letter was in reply to one written by the town clerk. That gentleman had previously written asking for an enquiry at once, and received no reply. Directly he threatened to proceed with the work independent of the sanction to borrow he speedily got a reply. The difficulties under which the committee at present laboured to meet the demands of their customers, new and old, formed the subject of a long discussion, which under the circumstances was deferred until the next meeting of the committee.

Rowley Regis.—At the last meeting of the Council, the Chairman said the local enquiry respecting the light railways was held at Dudley on Saturday, and it appeared that the Dudley authorities were prepared to oppose the scheme, but the Commissioners had decided to make the order except for the Dudley district, and recommended the promoters to come to terms with the Dudley authorities. The latter said they had got the light railways in their own hands, and they thought Rowley Regis should make its own railways. That was, however, impracticable, and Rowley would not get the railways for at least seven years. He thought that if light railways should be provided, the scheme should be carried out by the promoters. The chairman was requested to convene a public meeting for the purpose of supporting the promoters of the scheme.—A largely-attended meeting of the ratepayers and inhabitants, convened by the District Council, was held on the 22nd inst. A resolution was passed expressing regret that the Dudley Corporation were opposing the scheme for tramways as proposed by the British Electric Traction Company, and requesting the chairman to forward a copy of the resolution to the Light Railway Commissioners, begging them to give their sanction to the proposed order, and urging them to prevent the division of the proposed railways into sections, or anything which would delay the construction of them

Blackpool.—As anticipated in our last issue, a deputation from the Blackpool Tradesmen's Association attended the meeting of the Electric Lighting Committee of the Corporation, and various complaints respecting the increased charges, the greater heat from the bulbs, the unreliability of the light, etc., were all gone into. Specific cases were given, and while in some cases the electrical engineer had satisfactory explanations at hand, the committee gave instructions that all should be gone into, and a further report made upon them. Mr. Quin gave a decisive denial to the idea that the doubling of the voltage had the least effect either in increasing the charges for the light, or in leading to greater heat, as some of the deputation seemed to think. He pointed out that a tradesman who used electric light for not more than 1½ hours per night on an average throughout the year, meant an absolute loss to the electricity works. An average of two hours per night all the year round was about the dividing line between loss and profit to the electricity works. The committee agreed to go thoroughly into the conditions, and see what could be done. At the meeting of the executive of the Tradesmen's Association on Tuesday evening, the deputation gave their report, and the secretary was instructed to write to other towns where tradesmen use the electric light, and to ascertain the charges and the cost of the current.

Blairgowrie.—Mr. Yorke, electrical engineer, Glasgow, has, says the *Blairgowrie Advertiser*, in reply to a communication from Mr. J. L Ford, Blairgowrie, written a letter in which he says that if water power is not obtained at a nominal rate it would be impossible to supply the electric light at a price that would encourage its being taken up. The introduction of the electric light at Fort-William had proved of immense value to the town through the large increase of summer visitors. The two proprietors there were recouped for the practically free use of the water by the increase in rents. He suggested that a deputation should approach the superior with regard to the use of the water, and that an electric lighting committee should be convened, and should visit Fort-William to inspect the arrangements there. If a small town like Fort-William could be successfully lit by electricity with water power over three miles away, surely Blairgowrie, with nearly double the number of inhabitants, and with water power close at hand, should be able to show even more favourable results. In Fort-William the lighting was carried out by a local company, which had made arrangements with the town for 21 years for the public lighting, supplying six arc lamps of 1,000 c.p. each. The town only paid the company the sum they previously paid for gas, though the lighting is immensely superior, and the hours had also been prolonged. Mr. Yorke offered to visit Blairgowrie and give a preliminary inspection and report.

Shoreditch.—At the meeting of the Vestry Mr. Winkler drew attention to the fact that 33 tons of coal had been ordered in three weeks for the dust destructor. He asked the Vestry to compare this fact with the estimate of the engineer and some other people in their report that the 20,000 tons of refuse would give as much heat as Shoreditch ever would require. Things were getting serious. Mr. Kershaw gave the official figures as follows: in June, the opening month, before they had got into working order they burned 39¼ tons of coal; in July, 20 tons; August, 22; September, 30; October, 30; and in this month of November they had received 30 tons and burned 24. The cause was that while the slopping was about the parish received very little dust, and as a result they had to burn coal. They were only burning coal between Saturday night and Sunday morning, when the refuse was exhausted. At the meeting of the same Vestry the Lighting Committee reported that they had made enquiries of other vestries as to what facilities are given by them to the National Telephone Company, and being informed by the Islington Vestry that "notwithstanding numerous applications on behalf of the company the Vestry has hitherto refused to allow such cables to be laid," the committee recommended that in future the same policy be adopted by this Vestry, so far as may be consistent with the existing agreement. The report was carried after some discussion.

Eastern Telegraph Company, Limited.—Amongst the Bills to be brought before the ensuing session of Parliament is one by this Company for the conversion and consolidation of their preference shares into preference stock, "and, if necessary or desirable, to provide that the holders of such preference stock shall be entitled to receive a cumulative preferential dividend of £3. 10s. per cent. per annum, or some other rate per cent. per annum to be prescribed by the Bill out of the net receipts or profits of the Company from time to time." Provision will be made in the Bill for the creation and issue by the Company—and the vesting in and acceptance by the holders of the existing preference shares to be converted and consolidated—of preference stock in substitution therefor, "upon such terms and conditions as may be considered necessary or desirable." For these purposes the Company will ask for authority to increase the nominal amount of their existing preference share capital, and for the general purposes of the Company or of the Bill to apply their funds and revenues, and to raise further moneys by the creation and issue of new shares or stock, with or without a preferential or guaranteed dividend, or other rights or privileges, and by borrowing, and by the creation and issue of debenture stock; "and to define and prescribe the ranking of any such shares, stock, or debenture stock." Powers will be sought for to enable or require trustees and other persons under disability to accept the converted or consolidated preference stock in substitution for the existing preference shares held by them, and also to enable them and other persons to consent to the Bill.

Shrewsbury.—A special meeting of the Shrewsbury Town Council was held recently, when the following resolution was carried *re* the proposed electric light works: "That application be made to

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the Board of Trade on or before December 21, 1897, for a provisional order, under the Electric Lighting Acts, 1882 and 1888, to authorise the mayor, aldermen, and burgesses of the borough of Shrewsbury to supply electricity for public and private purposes within the said borough." The Chairman of the Lighting Committee said that he regretted to have to state that the Shrewsbury Electric Lighting Company were desirous of altering the terms on which the Council were to take over the undertaking of the company. The Council had agreed to purchase the undertaking for £21,500, and were prepared to stand by that arrangement, but the company were now endeavouring to attach further terms which had already been submitted to the Finance Committee and rejected by it. In addition to the purchase price which had been agreed upon, the company wanted the Corporation to pay a commission of 10 per cent. on all liabilities incurred from January 1 last until the completion of the purchase, or a sum not exceeding £500 as a fund to meet current expenses, such as official salaries, engineers' fees, and legal and other expenses. Further, that in the event of the Corporation not becoming purchasers of the undertaking, and the outlay having been incurred by the company to provide for street-lighting or the lighting of public buildings (of which expenditure due notice would be given to the Corporation), the Corporation should take current from the company in full value equal to the payment of 10 per cent. on such outlay.

The Tees-side Tramways.—Rapid progress is being made with the building of this line. The *North Eastern Daily Gazette* of November 23 says: "A further step was taken this morning in connection with the laying down of the new electric tramway system. Promptly at 7.30 a gang of 75 excavators commenced to tear up Corporation-road, working from the town hall towards Marton-road, and in a few seconds the scene was transformed from the quietness of early morning into one of bustle and noise as the lusty arms of the men swung great sledge-hammers driving iron wedges into the ground or wielded their picks. The road had already been marked out, and proper duties had been taken under the personal superintendence of Mr. Clifton Robinson, and the men, working with that quickness which has all along been the admiration of those who have watched them, quickly had a section of roadway 100 yards long and 16ft. wide excavated. In a few hours sufficient progress had been made to enable the excavators to move forward on to the next section, which in the meantime had been measured and marked out, while on to the ground vacated by them came a second gang of men laying concrete. By the time work ceases to-night some 50 yards of concrete will have been laid, while nearly 200 yards of excavation will have been completed. This evening the platelayers will have completed their work at Stockton, and early to-morrow morning they, too, will be drafted down to Middlesbrough, and before many of the townspeople have well realised that work has commenced, a long stretch of double rails will have been laid down Corporation-road. In quick succession these will be followed by a gang of men properly connecting all the rails with copper bonds, and then the paviours will come on the scene, to be followed by a gang putting on the final dressing to properly set the paving, so that in all there will be seven gangs of men all properly organised, and each following close on the other's heels, along the whole length of Corporation-road and North Ormesby-road to the first railway crossing, where the line at that end terminates. So well and so quickly do the men work that it is expected the excavations will have reached the North Ormesby end of the road by Tuesday next, and they will be quickly followed by the other workmen. From there the gangs will proceed to Linthorpe end of the line, and with the advent of December work will commence in the Crescent, Linthorpe. In the meantime rapid progress is being made with the work along Parliament-road and on the Newport section. At a special meeting of the Streets Committee yesterday an arrangement was come to by which Mr. Robinson should continue his double track from the depôt at the bottom of Newport Bank to Glebe-road beside St. Paul's Church, so that there may be no delaying of traffic by keeping cars waiting at crossing points. It was also arranged that the crossing point in Newport-road opposite Spencer and Farrar streets should be extended as far as the infirmary, thus giving a greater length of crossing. This will mean that for all practical purposes the track is a double one throughout the entire system, the only single-track sections being two short lengths in Newport-road, the short length in Grange-road from Albert-road to Linthorpe-road, and a somewhat longer section in the narrow part of North Ormesby-road, opposite St. John's Church. This will enormously facilitate traffic, and if it were necessary would enable cars to be run continuously with only an interval of one minute between each. In about a week the car service, at all events, so far as the Newport section is concerned, will be suspended, and the lines will be taken up, a commencement being made at the Albert-road end, and it is expected that by the end of a fortnight from that time the entire road will have been finished."

TRAFFIC RECEIPTS.

Bristol Tramways.—The traffic returns for the week ending November 19 wore £2,553. 11s. 9d., compared with £1,872. 2s. 5d. for the corresponding period of last year, being an increase of £681. 9s. 4d.

Dover Tramways.—The traffic receipts for the week ending November 20 were £99. 17s. 0d. The total receipts up to the same date were £1,338. 15s. 3d. The mileage open at present is only two miles.

Birmingham Tramways.—The traffic receipts for the week ending November 20 were £3,609. 6s. 5d., as compared with £3,102. 9s. 5d. in the corresponding week in 1896, being an increase of £506. 17s. 0d.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended November 21 amounted to £1,326, as compared with £1,183 in the corresponding week of the previous year, being an increase of £143.

City and South London Railway.—The returns for the week ended November 21 were £1,063, compared with £1,017 for the corresponding period of last year, being an increase of £46. The total receipts for the half-year 1897 amounted to £19,724, compared with £19,842 for the corresponding period last year, being a decrease of £118.

South Staffordshire Tramways.—The traffic returns for the week ending November 19 were £588. 15s. 0d., as compared with £570. 18s. 9d. in the corresponding week of the previous year. The aggregate receipts so far this year were £29,318 5s. 11d., as compared with £28,384. 14s. 4d. in the corresponding period in 1896.

S.D. Tramways, Dublin.—The traffic receipts for the week ending November 19 were £380. 12s. 8d., as compared with £411. 16s. 10d. in the corresponding week in the previous year, being a decrease of £31. 4s. 2d. The number of passengers carried was 65,213 in 1897 and 62,750 in 1896. The aggregate returns up to date are £13,549. 12s. 1d., as compared with £14,135. 18s. 11d. last year, being a decrease of £586. 6s. 10d. The mileage open is the same as last year—viz., eight miles.

PROVISIONAL PATENTS, 1897.

NOVEMBER 15

26640. Improvements in electrical resistance apparatus. Frederic Hughes, 23, Coleman-street, London. (Complete specification.)

26646. Improvements in wattmeters and in the means for damping in same and in other apparatus. The British Thomson-Houston Company, Limited, and Frank Holden, 70, Chancery-lane, London.

26647. Improvements in or relating to alternating electric current meters. Charles Orme Bastion and Francis Malger Staunton, 31, Southampton-buildings, Chancery-lane, London.

26656. Improvements in and relating to electric accumulator plates. Paul Ferdinand Ribbe, 322, High Holborn, London. (Complete specification.)

26657. An improved device for guiding the carbons in electric arc lamps. Richard Wilhelm Ludwig Holsten and the Elektrische Bogenlampenfabrik Naeck und Holsten Gesellschaft mit beschränkter Haftung, 6, Lord-street, Liverpool. (Complete specification.)

26659. An improved automatic cut-out or short-circuiting device for electric arc lamps. Richard Wilhelm Ludwig Holsten and the Elektrische Bogenlampenfabrik Naeck und Holsten Gesellschaft mit beschränkter Haftung, 6, Lord-street, Liverpool. (Complete specification.)

26660. An improved electric arc lamp. Richard Wilhelm Ludwig Holsten and the Elektrische Bogenlampenfabrik Naeck und Holsten Gesellschaft mit beschränkter Haftung, 6, Lord-street, Liverpool. (Complete specification.)

26671. Improvements in or relating to electrical indicating apparatus for use in hotels, restaurants, workshops, and for analogous purposes. Alfred Julius Boult, 111, Hatton-garden, London. (Henri Moutardier and Louis Boudet, France.)

26672. Improvements in or relating to electrically-controlled operating devices for railways. Paul Leschinsky, 111, Hatton-garden, London.

26680. Improvements in electric accumulators or storage batteries. Alberto Tribelhorn, 11, Southampton-buildings, Chancery-lane, London.

26682. Improvements in electro-medical and exercising apparatus. William Alfred Webb, 46, Lincoln's-inn-fields, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, June 2, 1897, being date of application in United States.) (Complete specification.)

NOVEMBER 16.

26709. Improvements in portable electric guns. Arnold Dickinson Manlove, Belmont, near Chesterfield.

26727. Improvements in electric brakes for cars. Oliver J. Menzies and John Angus Bell, 77, Colmore-row, Birmingham. (Complete specification.)

26729. Improvements in alternating-current electric motors. William Lloyd Wise, 46, Lincoln's-inn-fields, London. (Alexander James Churchward, United States.) (Complete specification.)

26732. Improvements in or relating to systems of electrical distribution. Leonard Andrews, 46, Lincoln's-inn-fields, London.

26733. Improvements in magnetic cut-out apparatus. Leonard Andrews, 46, Lincoln's-inn-fields, London.

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26734. The application of one handle in relation to electrical switches. William Hughes, 21, Ullswater-road, West Norwood, London.

26750. Improvements in phonographs. William Henry Dunkley, 61, Jamaica-row, Birmingham.

26752. Improvements in flexible conduits for electrical conductors. Edwin Truman Greenfield, 45, Southampton-buildings, Chancery-lane, London. (Complete specification).

26762. An improvement in the bulbs of electric incandescent lamps. Frederick Whippy Few, 11, Southampton-buildings, Chancery-lane, London.

26781. Certain improvements in electric light switches. Gerald Albert Phillips, 128, Colmore-row, Birmingham.

26799. New or improved means and apparatus for utilising part of the heat of gas and other heating stoves for the purpose of generating electric currents. Herbert John Dowsing, 115, Cannon-street, London.

26803. Improvements in the bulbs or envelopes of electric glow lamps. George Washington Smiley, 53, Chancery-lane, London. (Forest William Dunlap, Germany.)

NOVEMBER 17.

26827. Improvements in electric arc lamps of the enclosed type. Albert Lewis Davis, 23, Alexandra-road, Gipsy-hill, Upper Norwood, London.

26880. Improvements in and relating to electrical furnaces specially applicable for the production of calcium carbide. George William Benjamin Crees, William Lang Durban, and John Gore, 7, Southampton buildings, Chancery-lane, London.

26881. Improvements in and relating to electrical furnaces specially applicable for the production of calcium carbide. George William Benjamin Crees, William Lang Durban, and John Gore, 7, Southampton-buildings, Chancery-lane, London.

26918. Improvements in or connected with electrically-driven vehicles. John Hopkinson, 47, Lincoln's-inn-fields, London.

26919. Improvements in or relating to the application of electrodes in electrolytic processes. Otto Carl Strecker and Hans Hermann Strecker, 322, High Holborn, London. (Complete specification.)

26921. Improved process for preparing insoluble or hardly soluble salts from metallic anodes by electrolysis of aqueous solutions containing two salts. Otto Carl Strecker and Hans Hermann Strecker, 322, High Holborn, London. (Complete specification.)

26923. Improvements in or relating to the production of protoxides and oxides or of hydro-protoxides and hydroxides from metallic anodes by electrolysis of alkaline salts solutions. Otto Carl Strecker and Hans Hermann Strecker, 322, High Holborn, London. (Complete specification.)

26935. Improvements in or relating to apparatus for indicating and registering variations of insulation resistance in electric networks and circuits generally. Alfred Julius Boult, 111, Hatton-garden, London. (Maurice Travailleur, Belgium.) (Complete specification.)

NOVEMBER 18.

26986. Electric trembling interruptor. Eugène Ducretet, 8, Rue des Princes, Brussels.

26994. Improvement in motors by magnetic power. Sidney Johnson, 28, St. John's-square, Clerkenwell, London.

27021. Improvements in brushes for dynamos and electromotors. Chaimsonovitz Prosper Elieson and William Slater Naylor, 4, South-street, Finsbury, London.

27022. Improvements in accumulator boxes. Chaimsonovitz Prosper Elieson and William Slater Naylor, 4, South-street, Finsbury, London.

NOVEMBER 19.

27120. Improvements in or connected with apparatus for electrically illuminating and displaying letters, numerals, devices, and the like for advertising and decorative purposes. Timpron P. Martin, 15, Water-street, Liverpool. (Complete specification.)

27122. The spiral incandescent electric lamp. Alfred Collier, 137, Earlsfield-road, Wandsworth, London.

27130. Improvements in electrically-illuminated signs. Charles Bean King, jun., 28, Church-row, Hampstead, London.

27153. Improvements in boxes and fittings for electrical conduits. William Righter Comings, Wandlemere, Riverside-road, Summers Town, London.

27156. A method of renewing incandescent electric lamps. Sebastian Ziani de Ferranti and Jacob Atherton, 70, Palace-chambers, Westminster, London.

27165. Improvements in electrical storage batteries or accumulators. John Walter Townsend, 65, Chancery-lane, London.

27178. Improvements in dynamo brushes. William Morris Mordey, 46, Lincoln's-inn-fields, London.

NOVEMBER 20.

27206. Improvements in ceiling roses and similar fittings for electric light service. Albert Edgar Tanner, 70, Market-street, Manchester.

27183. Improvements in lightning arresters and cut-outs applicable to telegraph apparatus. Charley Branzell, Chas. Ellison, S. Gust Peterson, Axel Fridstrom, John Sundell, Monsos and Larson, Andrew C. Anderson, and Walfrid Nystrom, Fairfield, Kingston-on-Thames.

27271. Improvements in holders for electric glow lamps. Henry Charles Gover and Charles Faraday Proctor, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1896.

26267. Enamelling processes for electric heating apparatus. Crompton and Fox.

26677. Electric switches for use in connection with electrically-propelled vehicles and locomotives and for other purposes. Snell, Grove, and Hills.

27207. Electric ignition of charges in explosion engines. Pennington.

27482. Incandescent electric lampholders. Watson.

27903. Electrical glow lamps. Scharf.

28101. Means for lighting by electricity and incandescence. Sinclair.

26764. Apparatus for use in electrolysis, more especially intended for use in the electrolysis of zinc chloride. Hurter and United Alkali Company, Limited.

29831. Current collectors for electric railway or tramway cars with overhead conductors. Siemens Bros. and Co., Limited. (Siemens and Halske.)

1897.

11051. Ceiling roses for electrical purposes. Theermann.

18161. Electric and other motor vehicles. Sayer.

19380. Conduits for electric or cable tramways or railways. Griffiths.

21100. Alternating electric current generators. Lake. (Fairbanks.)

21195. Continuous-current dynamo-electric machine. Badger.

21051. Electrical alarms. Hettmann.

22217. Shielding devices for electric meters. The British Thomson-Houston Company, Limited. (Thomson.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	11¼
Brush Company, Ordinary	2	1⅝-1¾
—— Non. Cum., 6 per cent. Pref.	2	2⅛-2⅜
—— 4½ per cent. Debenture Stock	100	107-111
—— 4½ per cent. 2nd Debenture Stock	100	98-102
Callender's Cable Company, Debentures	100	108-113
—— Ordinary	5	7-8
Central London Railway, Ordinary	10	9¾-10¼
——	6	5¾-6
Charing Cross and Strand	5	12-13
Chelsea Electricity Company	5	10½-10⅝
—— 4½ per cent. Debentures	100	113-116
City of London, Ordinary	10	27-28
—— 6 per cent. Cumulative Pref.	10	17-18
—— 5 per cent. Debenture Stock	100	131-136
City and South London Railway, Consolidated Ordinary	100	69-71
—— 4 per cent. Debenture Stock	100	138-140
—— 5 per cent. Pref. Shares	10	15½-16
County of London and Brush Provincial Co., Ordinary	10	13¾-14¼
—— 6 per cent. Cum. Pref.	10	15¾-15⅞
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1⅞ 2⅛
—— 5 per cent. Debentures	—	89-94
Edison and Swan United Ordinary	2	2⅛-2⅜
—— 5 per cent. Debentures	5	4-6
Electric Construction, Limited	2	2⅛-2⅜
—— 7 per cent. Cumulative Pref.	2	3⅛-3⅜
Elmore's Copper Depositing	1	⅛-¼
Elmore's Wire Company	2	⅛-¼
W. T. Henley's Telegraph Works, Ordinary	10	20-21
—— 7 per cent. Preference	10	18½-19⅛
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	2¼-2⅜
—— 7 per cent. Preference	5	11-11½
India Rubber and Gutta Percha Works	10	22-23
—— 4½ per cent. Debentures	100	103-107
Kensington and Knightsbridge Ordinary	5	14½-15½
—— 6 per cent. Pref.	5	8-8½
London Electric Supply, Ordinary	5	2-2½
Metropolitan Electric Supply	10	18¾-19½
—— 4½ per cent. First Mortgage Debenture Stock	100	118-122
National Telephone, Ordinary	5	6¼-6½
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	14-16
—— 5 per cent. Non. Cum. Third Pref.	5	6-6½
—— 3½ per cent. Deb. Stock	100	104-109
Notting Hill Company	10	16½-17½
Oriental, Limited, £1 shares	1	1⅛-1⅜
—— £5 Shares	5	8¼-8½
—— £4½ shares	4½	7¼-7½
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	104-106
South London Electric Supply, Ordinary	2	2⅛-2⅜
St. James's and Pall Mall, Ordinary	5	16½-17½
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	36-39
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	8	12⅜-13
Westminster Electric Supply, Ordinary	5	15-16
Yorkshire House-to-House	5	8-8½

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NOTES.

Concert.—A most successful concert was given in connection with the Telephone Athletic Association last Monday evening in the King's Hall, Holborn.

Telegraph Extension.—The Eastern Extension, Australasia, and China Telegraph Company have notified that their cable system from Manila has been extended to the islands of Panay (Iloilo), Negros, and Zebu.

Exhibition in Peru.—The Peruvian Government will open at Lima on December 9 a permanent exposition of mining, agricultural, electrical, and other machinery. The intention is the promotion of trade with foreign countries.

Prize Distribution.—The annual distribution of medals, prizes, and certificates to the students of the evening classes and of the day college for men in connection with the South-West London Polytechnic took place last Saturday evening in the presence of a large company. Mr. R. C. Antrobus, chairman of the governing body, presided, and the distribution was made by Sir Henry Roscoe.

Lord Kelvin's Patents.—At a joint meeting of the Glasgow University Physical and Engineering Societies last week a lecture was delivered by Mr. Magnus Maclean, D.Sc., on "Lord Kelvin's Patents." The lecturer described some of the 45 patents which have been taken out by Lord Kelvin during a period of about 36 years. A large number of instruments invented by Lord Kelvin were shown, and the lecture was illustrated by numerous lantern slides.

A New Electric Railway Motor.—The *Financial Times* says that a trial has been made at Chicago of an electric motor for railway use, built on a new system. The motive power in this system is supplied by a gasoline engine, which operates the dynamo. Any extra power which may be required for starting or on heavy grades is supplied by a storage battery. The engine runs continuously. It is claimed that this utilisation of all power generated effects an appreciable economy in operation.

Private Bill Legislation.—The time expired on Tuesday evening for depositing at the Private Bill Office of the House of Commons plans and other documents in relation to the private Bill legislation of next session, and at the proper hour it was found that plans in respect of the following had been deposited: railways, 62; tramways, 15; miscellaneous, 85; general provisional orders, 87; electric lighting provisional orders, 86—total, 335. The deposits at this time last year were: railways, 67; tramways, 19; miscellaneous, 61; general provisional orders, 91; electric lighting provisional orders, 55—total, 293.

Iron and Steel Institute.—The council of the Iron and Steel Institute have accepted an invitation from the Association of Swedish Ironmasters to hold the autumn meeting of the institute next year in Stockholm. The meeting will be held in August, and in view of the large quantities of Swedish iron and ores consumed in this country, there is no doubt that it will prove a very popular meeting. This is not the first occasion that the Iron and Steel Institute has held its autumn meeting in other countries, previous meetings having been held at Belgium, France, Germany, Austria-Hungary, Spain, and the United States.

The Depression in the Chemical Industry.—We briefly referred in our issue of November 19 to the fact that a number of persons employed in the chemical industry of Cheshire had been discharged owing to the great depression. We now learn that last week the old bleach plant at the works of Brunner, Mond, and Co., Limited, Northwich, was stopped from the same cause. A number of men have consequently been thrown out of employment. Short time is also being worked in many departments. The trade with America, it is stated, continues most unsatisfactory; and the whole English chemical industry is probably feeling the effect of tariff more than any other trade; Middlewich is suffering acutely.

Austrian Tramways.—The correspondent of the *Financial News* says that the Austrian Electric Company is about to make a fresh issue of shares, which will have the effect of increasing its capital from £600,000 to £800,000. The shareholders are to be offered the new scrip at 132½ per cent. The increase has been brought about not only in consequence of the steady growth of the business, but also because of the transformation of the Vienna Tramway Company into an electric company. The Anglo Bank conducts the business of the company. Mr. Siemens, of Siemens and Halske, who are the largest shareholders in the Electric Company, was recently in Vienna, and took the opportunity to confer with Dr. Lueger, the burgomaster.

Additional Uses for Tramways.—The draft order relative to the proposal before the Indian Government for powers to establish a tramway at Calicut provides for the use of the tramway for scavenging and other municipal services. The Municipal Council may have the use of the tramways for six hours out of the 24, so long as the ordinary traffic is not interfered with, and so long as suitable engines and carriages are provided. The promoters have power to use "animal, steam, electricity, or any mechanical power," and the Municipal Council must use the same motive power as that used by the promoters, but at the same time they may call upon the promoters to provide motive power and carriages for removing refuse and scavenging stuff at the rate of 8 pies (about 1d. English) per ton per mile to the extent of 100 tons and no more in every 24 hours.

What is a Motorcar to be?—The second session of the Self-Propelled Traffic Association of Liverpool was opened on Monday, when Mr. Beaumont delivered an inaugural address. Referring to the progress which motor vehicles had made during the past year, he said what had been accomplished in this country was of great importance, though it had not yet made much show. On the Continent motor carriages for heavy traffic appeared to have made some progress, and he took it as proved that motor goods-vans for loads of from 10cwt. to 20cwt. were now workable and economical, and improvements would only be in detail as might be indicated by continued experience. The conclusion he came to was that weights considerably less than 10 tons per motorcar were advisable, or that a form of vehicle with six or eight wheels must be designed in order to reduce the wear and tear of roads.

The Tramways of the Future.—The second of the present series of popular science lectures, under the auspices of the Portsmouth Municipal Technical Institute, was held last week, when Dr. J. A. Fleming, M.A., F.R.S., lectured to a large audience at the town hall on "Electrical Inventions during the Reign of Queen Victoria." Dr. Fleming's address was an interesting and comprehensive sketch of the electrical discoveries of the last 60 years and an explanation of the principles underlying them. He said that England was very much behind in the matter of electric trams, partly owing to legal matters, but in the next 10 years he hoped to see as much progress in electrical traction as the last two years had made in electric lighting.

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The great solution of the inter-municipal travel question consisted of laying down extensive systems of electric trams, which would work from one common station, and with one common control, and, if possible, in connection with the electric lighting of the town.

The Motorcar Meet.—The second annual meet of the Motorcar Club was fixed this year for last Monday at Whitehall-place, and in all respects the results must be considered more satisfactory than on what might fittingly be termed "Emancipation Day" last year. In the machines themselves great improvements have been effected during the past 12 months, as the result of trials which before that time were impossible, and the mishaps were practically nil. A run was made from the Hôtel Metropole to Sheen House, where several races were carried out, after which the return journey was made to London, followed by a dinner in the evening at the Whitehall Rooms, presided over by Mr. Harry J. Lawson, the president of the club. This year's meet has created a decidedly better impression on the public mind, besides which the novelty has greatly worn off. In the procession there were about 40 motor vehicles of various kinds, including some electric cabs, and a double victoria made by the Accumulator Syndicate.

Accidents at Hartlepool.—Two accidents occurred at Hartlepool last week in connection with the electric trams. In the first, which was a collision between two of the cars, a woman sustained injuries to which she has since succumbed, and in the second considerable damage was done by a broken wire. From the accounts which have reached us, it does not appear clear whether it was the trolley wire which snapped, or another wire which was above it, but whichever it was, the result was the same. A horse attached to a cab came in contact with the charged wire, and was thrown violently on its side. A local report says that the animal was "enveloped in blue flame," but we relegate that statement to other quarters! In five minutes the horse expired, but the driver escaped with nothing worse than a severe shock; and the only other person to receive injury was another cabman who happened to come in contact with the escaping current and was consequently somewhat surprised at the sensation.

Permanent Carbons.—The *Elektrotechnische Anzeiger* publishes an account of a Russian patent for the manufacture of carbons for arc lamps. These carbons are composed of the purest possible carbon and carbide of silicon pulverised very finely, mixed and united with a binding material, such as tar. A mixture of 90 per cent. of carbon and 10 per cent. of carbide of silicon is found to be a very good proportion, but it may be varied. They can also be made with a core of carbide of silicon, or with threads of the latter combined with some such conductive body as carbon. Since carbide of silicon is only formed at about the temperature of the voltaic arc, it does not contain volatile ingredients, and it has the highest power of resisting oxidation of all known bodies. It develops light of a greater intensity, and in consequence it appears to be very well adapted for the purpose, but as carbide of silicon does not itself conduct electricity, it can only be used in the voltaic arc in conjunction with carbon.

Underground Telephone Wires.—The Commissioners of Sewers of the City of London have issued a printed summary of their minutes and correspondence in regard to underground telephone wires, and request attention more particularly to one portion which relates to the action of the Post Office authorities in providing wires for the use of the National Telephone Company without having first obtained the consent of the Commissioners, as the local authority, to the opening of the public ways for that specific purpose. It is pointed out that an easement under the streets is thus given by a public department to a trading company without the consent of the local authority, who are thereby deprived of the opportunity of imposing any conditions for the protection or advantage of the public—a practice that has never received the sanction of Parliament. Under the heading of "Legal Intelligence" will be found a report of the case brought by the Post Office authorities against the Commissioners of Sewers of the City of London in reference to underground wires. The Post Office won the day, but there will probably be an appeal.

Mr. Bryce and the Telegraphists.—A deputation of Aberdeen telegraphists waited on Mr. Bryce, M.P., last week with reference to telegraphists' grievances, and especially with a view to enlisting Mr. Bryce's support for the motion to be proposed by Mr. Sam Woods, M.P. In reply to the deputation, Mr. Bryce said that he found himself unable to go so far as some of the speakers in thinking that the right of Government servants as regarded combination to strike ought to be exactly the same as that of other workmen. That was a very large demand to make, because, in the first place, the Government servants had a permanency, which other workmen had not. In the second place, there were pensions in many Government departments. Other employés of private employers had none. The business of telegraphy was of the utmost possible importance to the country. Any sudden or universal strike of all the telegraphists would be such a calamity that it could not be looked upon in the nature of a strike, in the same way as that of the engineers. As to the Newcastle incident, he held that telegraphists were wrong in passing a resolution which suggested a general strike, and he was not surprised that the Department reprimanded them. Mr. Bryce defended Lord Tweedmouth's Commission from the charge of partiality.

An Electric Forge.—It is interesting to read that Mr. George D. Burton has succeeded in evolving a satisfactory device for smelting ores and heating metals for forging by utilising the principle of developing heat, by the introduction of an abnormal resistance in an electric circuit. An illustrated description of this electric forge, together with electric furnaces or ore reducers, has appeared in the pages of the *Electrical World* of New York. The latter device does not interest us in this country to the same extent as the forge does, but it is equally ingenious, and, we believe, has been found equally effective. The forge consists essentially of a tank containing an aqueous solution of some salt, preferably sodium carbonate and borax as one electrode, and an insulated metallic bar or rest for the other. The work to be heated being placed upon the rest, and the other end brought into contact with the surface of the liquid, an arc is produced at the point of contact with the solution, accompanied by great heat, the piece to be worked coming to a white heat in a very few seconds. The heating effect can be confined to the end of the rod or piece to be worked, or extended over a length of several inches. The piece being heated is continuously in sight, and with reasonable care melting of it is impossible. There is practically no oxidation, and the work is kept clean.

The Success of the Polytechnics.—From a report on the commencement of the session at the Polytechnic, published in the *Technical Education Gazette*, we obtain the satisfactory information that notwithstanding the opening of four new large polytechnics during the past four years, not only has there been no diminution in the number of students attending the older institutions, but every one of the nine institutions shows an increase in the number of class entries for the present session. It is estimated that

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altogether there are now 18,000 individual students attending the evening classes. The great demand that exists for evening instruction in electrical engineering is shown by the fact that in both the two polytechnics in the south-west district of London (the Battersea, and the South-West London at Chelsea), the number of students has increased with remarkable rapidity. In the Battersea Polytechnic the entries for electrical engineering were 38, and for electrical fitting they were 21; this year they are 79 and 69 respectively. As regards the institution at Chelsea, the entries last year for electrical engineering were 122 and for electrical fitting 69, while this year they have gone up to 192 and 108 respectively. It is satisfactory to find that neighbouring polytechnics do not compete with one another, and are each able to keep pace with the genuine demand which exists in their own districts.

Parabolic Reflectors.—We have received from Mr. Cowper-Coles an interesting statement of his process for manufacturing parabolic mirrors for searchlights, which mirrors have recently been tested with satisfactory results. Up to the present time glass has been the material exclusively used, as it was found impossible to get the required surface and stiffness with spun, stamped, or cast metal moulds. Another difficulty was also experienced in getting a suitable metal that would not tarnish under the trying conditions of an enclosed arc lamp. In the Cowper-Coles process the moulds are made of or covered with wax, which is polished by friction. On this surface a layer of silver is deposited chemically, and also polished. A film of palladium is next put on to the silver by means of an electrolytic bath, and finally the whole is backed with copper, thrown down as rapidly as possible at first, by the aid of a powerful current, the object being kept in motion the while. The mould is then removed, and the reflector either heated so as to cause the silver and palladium to alloy, or the former is dissolved away by the action of potassium cyanide. One of these reflectors has recently been tried at Portsmouth with satisfactory results, for after firing several shots through the reflector the beam was but little affected. On the other hand, the first shot that was fired at a glass reflector completely destroyed it. The War Office have for some time been trying this reflector, and have now ordered six 3ft. reflectors.

An Electric Mail Box.—A Swiss electrician has invented an electric mail-delivery box, which is now in use in several of the larger buildings in Geneva. The box has a compartment for each of the storeys of the building, and when the letters are deposited on the ground floor the carrier delivers them as required. The deposit of a single letter makes an electric contact, which starts a bell going on the respective floor, which does not cease ringing until the letter is taken out. At the same time it opens the faucet of a tank on the roof of the house, which causes water to flow into the cylinder forming the counterweight of the mail-box elevator, until the weight is heavier than the box, when the box ascends, and the flow of water ceases simultaneously. As the box passes each storey, the mail intended for it—letters, papers, and small packages—falls into boxes in the corridor on that floor. This is performed very reliably by a little spring at the bottom of each compartment in the elevator mail box, which causes the bottom of the compartment to catch for a moment, and the release throws out even a single piece of paper thinner than a postal card into the stationary box provided for its reception. When the box has passed the uppermost floor, the cylinder filled with water strikes a bolt provided at the bottom, which allows the water to flow out, and by its own weight the box descends to its place on the ground floor. Should by any mischance a single piece of paper have remained in the elevator, upon striking the bottom it will at once go through the same series of movements as before.

Lightning Effects on Coherers.—Dr. E. English, of Stuttgart, has written to the *Elektrotechnische Zeitschrift* on this subject, and we learn that he has frequently had occasion to observe the influence of lightning on the coherer. He used Prof. Oberbeck's coherer, which consisted of a brass tube 3cm. long and 1cm. wide, filled loosely with aluminium filings, through the axis of which a platinum wire was passed. A flash of lightning affected the coherer immediately, and its resistance fell from some hundreds of thousands to thirty ohms. It was placed in an ordinary room, and was entirely unconnected with any wire. When the coherer was connected with a lightning conductor or with gas tubes, disturbances were noticeable which were simultaneous with thunderstorms in places from six to ten miles distant. At the same time the electroscope was not affected at all, and did not show anything. If it is desired to enlarge the area of observation of thunderstorms, it is necessary to increase proportionately the size of the conductor connected with the coherer. This is another proof, says Dr. English, of the theory that in this case we have to deal with very slow waves, a view which corresponds with the experiments made in the laboratories. He goes on to say that, as far as he could observe, not all lightning flashes which fell near the Physical Institute, where his observations were carried out, affected the coherer. Sheet lightning did not affect it at all, but discharges of electricity from one cloud to another were noted as frequently as flashes between clouds and earth. That single flashes are of an oscillatory nature has been proved without any doubt by photography showing single flashes separate from each other.

The Engineering Dispute.—Four conferences have been held during the past week between the representatives of the masters and men at Westminster Palace Hotel. The men's representatives, without prejudice to the right of discussion of details, and subject to the votes of their members being taken on the whole question hereafter, have accepted the following memorandum of the employers' representatives: "That while disavowing any intention of interfering with the proper functions of the trade unions, they will admit no interference with the management of their business, and reserve to themselves the right to introduce into any federated workshop, at the option of the employer concerned, any condition of labour under which any members of the trade unions here represented were working at the commencement of the dispute in any of the workshops of the federated employers. The discussion and mutual settlement of matters of detail which illustrate the above general principle shall be at once proceeded with at this conference. Nothing in the foregoing shall be construed as applying to the normal hours of work or to general rises and falls of wages." This is a decided step towards a final agreement. On Tuesday the sitting was devoted to the consideration and discussion of the application of the general principle agreed to last Friday to certain of the existing conditions of labour. The subjects selected were freedom in the employment of labour and piecework. These questions are still being discussed, and we have heard no further decision as we go to press.

Three-Phase Traction.—The first trial trips on the electric railway up the Gorner Grat, near Zermatt, were carried out last week in the presence of the inspectors of the Swiss Railway Department. The section already completed has a length of 1,600 metres and a gradient of 12 per cent. The tests gave complete satisfaction, both

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the ascent and descent of this gradient being effected without the slightest difficulty, the motors holding the locomotive perfectly to its proper speed. Starting on the maximum gradient with a fully-loaded train was also effected with great facility. It will be remembered that this is a rack railway, the total length being 9·8 kilometres (about six miles) and the maximum gradient 20 per cent. The power is derived from the Findelenbach, which drives four turbines of 250 h.p. each, coupled directly to three-phase alternators of 5,000 volts and 40 $\frown\!\smile$. Transformers are placed in the power-house itself for feeding the line as it passes the building, and two other transformer stations are provided. The tension of the trolley line is 550 volts. Each locomotive is equipped with two three-phase motors of 90 h.p. each, driving the main pinions by spur gear. Owing to the property of three-phase motors, by which they will act as generators and take up the full power which they are designed to give out as motors when driven at 2 or 3 per cent. above the speed of synchronism, the locomotives will, in descending, give power back to the line. In case only descending trains should be on the line, the surplus power will be taken up in a water resistance in the power-house. The contractors for the whole of the electrical equipment are Messrs. Brown, Boveri, and Co., who, in the well-known Lugano tramway, were the first to apply the three-phase system directly to traction. They have also supplied the electrical parts for the Jungfrau railway, where their system is to be adopted, and are now engaged on the equipment of the line from Stansstaad to Engelberg, which is to be running next spring.

Electrolytic Dissociation of Alcohol.—In the *Journal* of the Chemical Society is published an abstract of a paper describing the methods employed by Mr. Giacomo Carrara in electrolytically dissociating methylic alcohol and water dissolved in it. The author carefully purified methylic alcohol by dehydration with copper sulphate and barium oxide, subsequently distilled it from a few pellets of sodium, and then distilled it under 20mm. pressure from 2 per cent. of phosphoric anhydride. The electrical conductivity of the sample thus obtained was determined by Kohlrausch's method, the alcohol being distilled into the flask containing the electrodes; a large number of determinations were made under various conditions, and as the end result the author states the electrical conductivity of methylic alcohol to be $0{\cdot}072 \times 10^{-10}$ at 25deg., a much smaller value than that given by Völlmer—namely, $1{\cdot}22 \times 10^{-10}$—which is the smallest value previously recorded. It is concluded that methylic alcohol is partly dissociated and about twice as much so as water; one gramme molecule of methylic alcohol is dissociated in about 5·5 million litres at 25deg. The electrical conductivity of methylic alcohol is not affected by the addition of 0·23 per cent. of benzene, but falls to about two-thirds on adding 0·71 per cent. of benzene; the electrical conductivity of the alcohol is thus due to the presence of an electrolyte which, in accordance with the general rule, has a lower conductivity in a mixture of solvents. It is further shown that water is dissociated in methylic alcohol solution, and in very dilute solutions the ionic concentration is proportional to the square root of the total concentration of the water. In very dilute solutions, the dissociation of the water is always rather greater than the electrolytic dissociation of water in aqueous solution; that dilute solutions of water in ethylic alcohol show the contrary effect to this, is probably due to the much less considerable dissociating power of methylic alcohol.

Guttapercha.—Dr. Eugene F. H. Obach delivered the first of a series of three Cantor lectures on "Guttapercha" at the Society of Arts on Monday last. The lecture was devoted particularly to the history of guttapercha, and the lecturer referred particularly to the way in which the Society of Arts in the early days had aided in the development of the guttapercha industry. It was in 1847 that Mr. Thomas Lobb first sent specimens of this substance to Sir William Hooker at Kew, and in the same year Dr. W. Montgomery forwarded samples of guttapercha to the Society of Arts. It was these latter samples which fell into the hands of the electrical engineers of the day, and which led Dr. William Siemens and his brother in Germany to try guttapercha for insulating electric cables for submarine work. It is worthy of note that the Society of Arts in 1853 awarded their gold medal to Dr. Montgomery for the services he had rendered in this respect. Dr. Obach next proceeded to describe the various species of trees which yielded guttapercha, and gave some most interesting analyses of the value of the products from these respective sources. A map showing the distribution of the trees in the countries round Singapore, prepared by the lecturer, demonstrated how exceedingly local this distribution was. He believed from the depths of the straits and seas in between these lands that they originally formed part of Asia, and that the deep sea surrounding them proved this fact. The properties of guttapercha were fully described, and the action of the various acids and alkalies was shown to the audience by a number of vials in which inch cubes of guttapercha had been immersed for a certain length of time. Treating afterwards of the value of guttapercha as an insulator, Dr. Obach referred to a number of analyses extending over a great length of time, and showed that there was a great difficulty in obtaining uniformly good material in the present way that it was collected. The lecture was profusely illustrated by diagrams and slides. An item of amusement was formed by the correction of a mistake originally made by Sir Wm. Hooker, who mistook a section of a stick of guttapercha for a section of a branch of a guttapercha tree.

Lord Reay on Technical Education.—Lord Reay, in his capacity of president of the Scottish Association for the Promotion of Technical and Secondary Education, delivered a forcible and important speech at the annual meeting, which was held in Edinburgh on Saturday. He dwelt upon the urgent necessity of paying more attention in this country to organising and systematising technical education, and said that while the Victorian era had been rich in men of the highest scientific eminence, other nations not possessing men of equal eminence had enriched themselves by the teaching of the men who filled such glorious pages in our history. In chemistry, in physics, in electricity, in geology, in astronomy, the most illustrious names of Scotsmen and Englishmen could be mentioned, but when it came to the adaptation of their teaching in the school, in the workshop, on large landed estates, they had to go to Germany, to the United States, to Switzerland, and to Belgium. The reason was, as Prof. Mahaffy had recently declared, that the "social estimate" which we had adopted of the higher education had forced our young merchants, young manufacturers, and young landowners into the channels, not of a *bona fide* arts course, but of a sham classical education. Our system of education ought to be worked on entirely different lines. No spasmodic efforts here and there to form science classes, but technical schools which led to technical colleges, on a carefully graded system, were needed. While the greatest activity prevailed in the technical schools and engineering works of the Continent and of America, we were engaged in the most calamitous and suicidal industrial war of modern days. The Education Department would have to deter-

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mine clearly the lines of demarcation of the various forms of education which it would support. In the United States, Germany, France, and Switzerland, public money was ungrudgingly given to technical schools, and there was no reason why in this country there should be so much hesitation. The cause of the success and progress of Continental industry was due to the keen sense of competition, and to the widespread conviction that all production must be placed on a scientific basis. Science there was not considered as a luxury, but as a powerful agent of economic production. The sooner we realised that our very existence as an industrial nation was threatened, the better. Lord Reay was unanimously re-elected president of the association.

From Steam to Electricity.—In a paper entitled "Application of Electricity to Railroads now Operated by Steam Power," which Mr. N. H. Heft read before the American Street Railway Convention, the author gives some interesting descriptions of the conversion from steam to electricity on lines with which he has been connected. He believes that a good track is the foundation of a good system, and in reconstructing the track great care should be taken in bonding the rails so thoroughly as to make the path of smallest resistance back to the station. To the author's mind, nothing is more certain than that carelessness about making a track return circuit is a most serious mistake, and that carelessness about testing and maintaining joint connections is another. He has learned the lesson, which was taught us at so early a date by the Underground Railway in London, of the importance to any transportation agency working in a thickly-populated territory of uniform fares and a frequent and regular train service—a service which requires no time-table to enable people to know when cars may be found in waiting. The great advantage electric trams have over steam cars is that, owing to the tremendous accelerating power of properly-designed electric motors with rotary motion, as compared with the reciprocal motion of steam locomotives, the trains can keep to their time-tables under most trying circumstances, a thing which the steam engine was not capable of in the same degree. The type of car which the author uses both on the Nantasket and on the Hartford-Berlin lines, is very heavily built, but he does not consider it by any means the final type, and even hints at combination cars. It contains 16 cross-seats, capable of seating 96 passengers, and the entrance is from either side with three steps. Each car has two heavy railroad trucks, one of which is equipped with two 125-h.p. motors. The total weight of the motorcar is 32 tons, and the trailer car of the same type weighs 25 tons. The motors have often been in service for several consecutive days, making 324 miles each day without apparent injury, but the author has found it beneficial to blow out the motors several times during the day by means of a blast of air from a hose pipe connected to the brake reservoir, though he admits that this is, at best, but a makeshift. As regards the merits of the overhead and third rail systems, Mr. Heft says their experience inclines them towards the latter, on account of the destruction of trolley wheels by arcing at starting and during acceleration.

"Spark" Telegraphy.—Prof. Slaby recently at a technical college in Berlin gave an interesting and minute report of his experiments with telegraphy without wires, or, as he wants it to be called, "spark telegraphy." He mentioned an experiment made by him, with the assistance of Dr. Dietz and Count Arco, at which he was enabled to send through one wire two different telegrams simultaneously without either interfering with each other. He explained that the continuous current used by the Telegraph Department for the carrying of messages is conducted along the middle of the wire, and he proved with his experiments that electric waves on their way through free ether are attracted by wires which come in their way, and that they travel along those wires with increased velocity without influencing the interior, or core of the wire. In making these observations he succeeded in sending a message along the outside of the wire, while another message was proceeding through the centre by the continuous current. Both messages arrived at the same time, each being perfectly distinct. Prof. Slaby says that in conjunction with Dr. Dietz he made many experiments with "spark" telegraphy before Marconi's inventions became known, but he did not achieve any important results. After his return, however, from England last winter, where he witnessed some of the experiments of the Marconi system, he experimented still further. The Emperor of Germany was present at these experiments, and put a number of sailors and the large Royal gardens at Potsdam at the disposal of Prof. Slaby. The receiver was erected at the naval station and the transmitter on Peacock Island. The first experiments gave no result, because the coherers used were a great deal too sensitive and contained, among other things, too much silver, and were affected by the electricity in the atmosphere, and in consequence were constantly affected even when no signals were sent from the sending station. Further experiments showed that the results increased in the same measure as the sensitiveness of the coherer decreased. Prof. Slaby uses now very rough and jagged nickel filings which have been very carefully cleaned and dried. As the receiving station could not be seen from the island, the sending station was removed to a church a little farther away, and the radiator was put between the columns of the portico, while the mast was erected on the spire, which carried the wire used to receive the electric waves. The experiments went very well. When the sending apparatus was put back a little further into the church, and the wire was put for about a length of two yards parallel with the stone slabs of the floor, and a yard and a-half above it, it ceased to work properly, because the waves seek the earth. Hence one must not bring the wire too near to the earth, or to lay it parallel when near the earth. The experiments made in the presence of the Emperor under these conditions were very favourable. When the sending apparatus was moved back to the island, it was found that trees near the wire proved an obstacle because they received the waves. Therefore, the professor says that it is best to arrange the wires in such a manner that the wires on the receiver and on the transmitter can be seen from each other. Even the sail of a little boat or the smoke from a steamer make small interruptions, which make the words more or less indistinct. The waves get through impedimenta, and even through buildings, but there is always much loss. In order to make the wire which was placed on the island more visible from the mainland, it was lengthened from 25 to 65 yards, and placed upon a boat on a river. That did not remedy matters, but when the wire on the receiver was also lengthened to 65 yards very good results followed, showing that the length of the wire is of great importance. Therefore the name "wireless telegraphy" is incorrect, because with this "spark telegraphy" wire is absolutely necessary. On the other hand, it is immaterial that the wire should be placed high up in the air; and this discovery seems to have demonstrated that horizontal wires are sufficient, but that it is necessary to have the same exactly parallel. All these experiments were conducted over a distance of about three miles.

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NOTES ON ACCUMULATOR CONSTRUCTION.

BY DESMOND G. FITZ-GERALD.

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XXXII.

It will be instructive to note the construction of one of Faure's early cells, and the results obtained with it in an eight hours' run, with a view to gauge the extent of our present progress. In the cell I have in view, the plates were 16in. by 12½in., and the number (n) was 16, an even instead of an odd number (see Section I.). These plates were coated with about 50lb. of active material, originally, I believe, in the form of red lead. The peroxide supports were 80 mils, and the spongy-lead supports 40 mils, in thickness, but the quantity of active material was about the same on each surface, say 25lb. = 400oz. The weight of metallic lead (Section III.) was, therefore, 400 × ·906 = 362oz., roughly, on the spongy-lead supports. Allowing ·53oz. per ampere-hour, this would, according to our present views, correspond to $\frac{362}{\cdot 53} = 683$ ampere-hours. The coated plates were wrapped first in parchment paper and then in stout felt. The electrolyte was water acidulated with one-tenth of its weight of sulphuric acid; its weight was 16lb. But, as we shall see by-and-by, this quantity of acid, if we allow 5 per cent. of H_2SO_4 in the residual acid, with a view to prevent too great a fall in conductivity, corresponds to only 91 ampere-hours. The total weight of the cell was about 135lb. Now, the period of discharge being eight hours, and the average current of discharge 22 amperes, the total output of current was 176 ampere-hours (instead of 683). Amongst the causes of the deficiency in output was, of course, the insufficiency of acid, for at the end of the discharge the electrolyte must have been almost pure water. Even in our day the quantity of acid of given initial and final specific gravities corresponding to a given current output is seldom *calculated*, but is somehow arrived at, more or less approximately, by rule of thumb.

The specific rate of discharge, or the rate per pound of cell, was thus:

$$\frac{\text{Amperes}}{\text{lb.}} = \frac{22}{135} = \cdot 163 \quad . \quad . \quad . \quad . \quad \text{(III.)}$$

The specific capacity, or the capacity per pound of cell, was:

$$\frac{\text{Ampere-hours}}{\text{lb.}} = \frac{176}{135} = 1 \cdot 3 \quad . \quad . \quad . \quad \text{(IV.)}$$

Now, in order to ascertain the work done in the portion of the circuit external to the cell (from which the useful work or the available mechanical work can be calculated) we require to know the difference of potentials (P.D.) at the battery terminals during the discharge. Without this datum, we cannot calculate what weight of battery will give us a horse-power electrical or a horse-power mechanical in the external portion of the circuit. But this P.D. depending not only upon the E.M.F., but also upon the ratio of the internal to the external resistances in the circuit, is constantly varying; and, although its mean value under specified conditions may be arrived at, this cannot be taken as a constant in any formula for weight of battery to give a horse-power or a horse-power hour, electrical or mechanical. On the other hand, it is very desirable that we should have such formulæ, even if the values they give be only approximate minima—so long as we are guarded from being misled by them.

Now if we assume that a lead accumulator is not in practice run down until the E.M.F. falls below 1·8 volt, and that the mean E.M.F. is 1·9 volt, then a current of 393 amperes will be equivalent to a horse-power electrical expended over the whole circuit, and 393 ampere-hours will be equivalent to a horse-power hour expended over the whole circuit. Thus, 393 amperes × 1·9 volts = 746·7 watts, or approximately 1 h.p. electrical; and 393 ampere-hours × 1·9 volts = 746 watt-hours, or 1 horse-power hour. When, therefore, the ratio of the external to the internal resistance is very high, the following equations may be taken as giving the minimum weights of cell which can supply the horse-power electrical and the horse-power hour electrical respectively:

$$\text{Weight per horse-power electrical} = \frac{393}{\text{sp. rate of disch.}} \text{ lb.} = \frac{3 \cdot 5}{\text{sp. rate of disch.}} \text{ cwt.} \quad \text{(V.)}$$

$$\text{Weight per horse-power hour} = \frac{393}{\text{sp. capacity}} \text{ lb.} = \frac{3 \cdot 5}{\text{sp. capacity}} \text{ cwt.} \quad . \quad \text{(VI.)}$$

Thus the minimum weight of the above-mentioned cell that would at the given rate of discharge yield a horse-power electrical is:

$$\frac{3 \cdot 5}{\cdot 163} = 21 \cdot 5 \text{cwt.} = 1 \text{ ton } 1 \text{cwt. } 2 \text{qr.}$$

And the minimum weight that would yield a horse-power hour of work at the given rate of discharge is:

$$\frac{3 \cdot 5}{1 \cdot 3} = 2 \cdot 7 \text{cwt.}$$

The present Lord Kelvin, whose letter in the *Times*, dated June 6, 1881, first drew attention to the "wonderful box of electricity," which was "a witch," obtained a better result than this, and one that, expressed in foot-pounds, struck the public ear as being indeed marvellous. Within the weight of 165lb., or 1·473cwt., he obtained 2,000,000 foot-pounds of work, nearly—*i.e.*, one horse-power hour. In these days we expect to obtain the same work from little over half a hundredweight of accumulator. But the above reminds me that the following equivalent values may be found useful:

One watt-hour (·5263 ampere at 1·9 volts) =	
	367 kilogrammetres.
	2,653·2 foot-pounds.
	36,000 meg-ergs.
	3,600 joules.
	·00134 horse-power hour.
	867 calories of Dulong (gramme Centigrade).

The importance of Faure's invention was exaggerated by many and denied by some. Thus, referring to some writings of mine, *La Lumière Electrique*, in August, 1881, remarked as follows: "What we have read in certain English journals shows either that the writers were unacquainted with the Planté battery, or that they must have had very badly-constructed ones; since all that can be said of the Faure battery is applicable also to the Planté battery, even including the calculations and the duty indicated by Mr. Fitz-Gerald. The two batteries, in fact, are in our view identical; and we should be glad if Mr. Fitz-Gerald would point out to us in what respect they differ with regard to the reactions produced." To which I replied: "There is no difference in kind, but only one of degree. Both batteries, when charged, consist of a plate of lead coated with a layer of the same metal in a spongy condition, and alloyed with hydrogen, and of a second plate of lead coated with a layer of peroxide of lead. But in the Faure modification of the Planté secondary couple these layers are considerably thicker, and the duration of the current through a given resistance is, therefore, considerably longer than in the original form of the couple. The Faure battery gives a better result than its prototype, for the same reason that a Planté cell that has been long in use gives a better result than one that has been freshly constructed—viz., because there is a greater thickness of convertible material. The Faure battery is, in fact, an improvement upon the Planté cell—an improvement in virtue of which the lead secondary couple has become in great measure adapted to the requirements of practice. I think that no one is inclined to underrate the claims of M. Planté in connection with this form of secondary battery, and I am sure that M. Faure himself is not inclined to overrate his own improvement. Cannot we render due justice to both workers?"*

Prof. Oliver Lodge, in one of his papers which first appeared in the *Engineer*, gave practically the same opinion as follows: "A Planté and a Faure cell—though the process, and more especially the time, of formation is

* The *Electrician*, September 3, 1881, p. 249.

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different—are, when formed, pretty much the same thing, and consist of two plates of lead, one coated with black (? brown) peroxide of lead (PbO_2), the other with a spongy material consisting of metallic lead in a fine state of division and more or less alloyed with hydrogen."*

XXXIII.

It should be here noted that the view taken above, by Prof. Lodge as well as by myself—viz., that the metallic layer on what is called the negative plate is an alloy of lead and hydrogen—has not been confirmed by the analysis of this spongy material. M. Darrieus, who has devoted some attention to this question, states, in his paper read before the International Society of Electricians in June, 1893, that "the active material is spongy lead, containing a small quantity of sulphate of lead, and, at the commencement of the discharge, some traces of occluded hydrogen." According to this investigator, however, the active material is not ordinary lead in a fine state of subdivision; but is an allotropic modification possessed of peculiar properties. Like the electrolytically-deposited antimony obtained by Dr. Gore, and certain products obtained by M. Schutzenberger in his researches on the molecular conditions of metals, this allotropic modification of lead would evolve heat in passing into the ordinary condition.

XXXIV.

As may well be supposed, it was not long before the perishability and consequent futility of the diaphragms, or linings of felt, asbestos-cardboard, indiarubber, etc., became recognised. The device of constructing the lead conducting supports in such manner as to partly enclose and retain more or less securely the active material without having recourse to a diaphragm occurred within the year 1881 to several inventive minds. But priority in this direction must, I think, be given to Joseph Wilson Swan, whose first patent relating to secondary batteries is dated May 24, 1881, No. 2,272. The specification is brief, but constitutes a good example of what such a document should be. The object of the invention is stated to be that of facilitating the construction of secondary voltaic piles or batteries, and the invention aims at the production of plates having surfaces suitable for holding spongy lead or lead in a finely-divided form. In carrying out the invention, plates of lead are prepared having a cellular, corrugated, or grooved surface or surfaces of such a character as to be capable of retaining in the cells, grooves, corrugations, or interstices spongy or finely-divided lead. The drawings illustrate (1) a support constructed with hexagonal cells or cavities—similar to those of a honeycomb—for the retention of spongy lead, and it is stated that the outer surfaces may also be covered or coated with the active material, thus realising an "embedded contact"; and (2) a plate with grooves to be filled with the active material; and it is stated that the outer surfaces of the ridges may also be covered or coated with the material. The claim is simply "constructing the plates of secondary batteries, or apparatus for storing or conserving electricity, with cells, corrugations, grooves, or interstices substantially as and for the purpose described." Not much room, one would think, is here left—except for patents claiming details, or sub-patents—for those following in the same direction.

It is curious that this invention, of such early date, should have remained comparatively unnoticed by the scientific Press, more especially on the Continent, whilst that of Volckmar, which was not patented—so far as I can ascertain—until more than four months subsequently to the above, received very extended notice.

XXXV.

In September, 1881, two patents, both for improvements in secondary batteries, were taken out by John Scudamore Sellon. The former of these is numbered 3,926, and recites that in carrying out the invention plates are formed "with suitable perforations, or roughened, serrated, or indented on their surface or surfaces," and such perforated plates may be constructed with corrugations, grooves, etc. "Into, on, or against such or other surfaces or irregularities," the inventor places or introduces a layer of metal, metallic salts, oxides, or compounds, and the same may, if necessary, be retained in the desired position by means of sheets of felt or other porous material. The claim is for "the use in the construction of secondary batteries of perforated plates or sheets roughened, serrated, or indented, composed of lead, platinum, or carbon, upon, in, or against which plates spongy or finely-divided lead or oxides, or other (*sic*) salts or compounds of lead, or other suitable substances or compounds, are, or may be, held or retained substantially as and for the purposes described." The latter of these two patents is No. 3,987, which claims: (1) the use in secondary batteries of plates, elements, or supports, constructed or composed of alloys of lead with antimony; and (2) the employment of plates or elements composed of perforated strips, tubes, pieces or woven fabrics of lead or of the above alloy, either separately or combined and affixed to, supported by, or strung upon rods, bars, or pieces of carbon, lead, or other suitable metal.

The substitution for soft lead of the hard antimony alloy, the plates made from which are comparatively rigid, is a suggestion of considerable importance. The proportion of antimony preferred by the inventor varies from 5 to 25 per cent., "but a greater or less percentage may be employed." I have found, however, that when the percentage is high, antimony dissolves out from the peroxide support and becomes deposited on the spongy lead. The effect is to improve the capacity but to shorten the life of the peroxide plate, and, apparently, to increase local action upon the spongy lead. Much difference of opinion exists as to the comparative incorrodibility of pure lead and of alloys of lead with antimony in varying proportions.

* The *Electrician*, June 21, 1882, p. 130.

INSTITUTION OF CIVIL ENGINEERS.

At the ordinary meeting on Tuesday, November 30, Mr. J. Clarke Hawkshaw, member of council, in the chair, the paper read was on "The Law of Condensation by Steam," by Messrs. Hugh L. Callendar, M.A., and John T. Nicholson, B.Sc.

In the discussion of steam-engine trials it had generally been assumed that the rate of condensation of steam on a surface was practically infinite, so that any surface in direct contact with the steam was immediately heated to the saturation temperature corresponding with the pressure of the steam. It had also been supposed that the amount of condensation under any given conditions was limited, either by the resistance of the film of condensed water to the passage of heat, or by the capacity of the metal or of the circulating water to carry off the heat. In many cases condensation was diminished by films of oil or grease, or by accumulations of air, or by other incrustations or deposits, but these were not considered in the paper.

The authors found, on the contrary, as the result of their experiments on a steam-engine running under normal conditions, that a practically clean and dry metal surface was not immediately heated to the temperature of the saturated steam in contact with it, that the rate of condensation of steam was not infinite, but finite and measurable, and that the amount of condensation in any given case was limited chiefly by this finite rate of condensation, and could be calculated in terms of it.

The cyclical variations of temperature in the metallic walls of the cylinder, with each stroke of the engine, were measured by means of thermo-couples inserted at various distances from the inner surface. It was possible thus to deduce the amount of heat absorbed and given out by the metal, and to infer the quantity of steam condensed and re-evaporated at different points of the stroke. The temperature cycles of the steam were simultaneously measured by a very sensitive platinum thermometer. The observations showed that the temperature of the steam in different parts of the cylinder differed in a systematic way from the saturation temperature as deduced from indicator diagrams.

In order to deduce the condensation from the observed temperature cycles, it was necessary to determine the conductivity and specific heat of cast iron. A series of experiments were made upon a 4in. bar of cast iron, and the

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result found for the conductivity was nearly 30 per cent. smaller than that generally assumed.

At the lowest speed of the experiments—namely, 45 revolutions per minute—the temperature of the surface of the metal at the end of the admission period was found to be never raised higher than within 20deg. F. of the temperature of the steam, and the rate of condensation at any moment was simply proportional to the difference between the temperature of the steam and the surface. The numerical value found for the rate of condensation was 0·74 B.T.U. per second per square foot of surface per degree F. of difference between the temperature of the steam and the surface. This was equivalent to the condensation of 27lb. of steam per square foot per hour at 300deg. F., for a difference of temperature of 10deg. F. Assuming this law, the total amount of condensation at any point of the stroke could be inferred by measuring the "condensation areas" on the temperature-cycle diagram—*i.e.*, the areas included between the curves representing the temperatures of the steam and of the metal surface.

To compare the results thus found with the missing steam deduced from the indicator diagrams and the feed measurements, the leakage of the valve and piston was determined as nearly as possible under the conditions of running. It was found to be proportional to the difference of pressure and nearly independent of the speed through a considerable range. The usual test for leakage with the valve stationary was found to be of little or no value. From a comparison of leakage tests, it was inferred that a valve in motion, however well fitted, was subject to leakage of a definite type. The leakage took place chiefly in the form of water, by condensation and re-evaporation on the moving surfaces, and was directly proportional to the perimeter of the ports and inversely to the width of the bearing surfaces. The amount of condensation observed during the admission period in a single-acting non-condensing cylinder 10·5in. in diameter, with a stroke of 12in., was only 20 per cent. of the feed at a speed of 100 revolutions per minute. The smallness of this result was probably due to the early compression and dryness of the steam supply. It was found that re-evaporation was completed very quickly, and that the walls were dry for the greater part of the cycle. It was inferred from the form of the temperature curves and from other evidence that the rate of re-evaporation was the same as that of condensation.

From the form of the law of condensation it was possible to make an important theoretical deduction with regard to cases in which re-evaporation was incomplete, and the walls remained wet throughout the whole cycle. Under these conditions the mean temperature of the walls should be the same as the time average of the temperature of the steam to which they were exposed, and the cyclical condensation was the maximum possible for the given steam cycle. If the extent of the clearance surfaces was known, this limiting value of the condensation in any case might be easily deduced from the indicator diagram. If the surfaces were dry during part of the stroke, the condensation was less than the limit, and it was necessary to know the mean temperature of the clearance surfaces in addition. Upon these views of the nature of condensation and leakage, the missing quantity of steam, W, in pounds per hour might be expressed by an equation of the general type, $W = S\ (t'—t^\circ) + L\ (p'—p'')$,—where the first term represented condensation and the second term leakage, S being the equivalent clearance surface in square feet, and $t'—t^\circ$ the mean difference of temperature, in degrees F., between the walls and the steam during admission reduced to one-half cut-off. L, the rate of leakage per pound difference of pressure $p'—p''$, might be taken to vary approximately as the product of the diameter and the square root of the normal piston speed, for engines of different sizes. It would appear from this formula that the effect of leakage on the performance was relatively more important in small engines and at high pressures, and that the loss due to condensation was most effectively reduced by increase of piston speed.

As an indirect verification of this law of condensation, the temperature of the clearance surface in cases in which water was present in the cylinder was measured, and was found to agree with that of the mean of the steam cycle. The amount of condensation was also correctly calculated in several cases of public tests in which sufficient data were available. The rate of condensation deduced was also directly verified by an entirely different method. The experiments gave approximately the same rate of condensation, and appeared to show that the water-drops condensed on the metallic surface, owing probably to their rapid action, did not appreciably diminish the rate. Assuming it possible to estimate the condensation occurring in any given case by the method indicated, from a knowledge of the indicator diagram and of the temperature and area of the clearance surfaces, it then became possible to determine the amount of leakage under the actual conditions of running.

INSTITUTION OF ELECTRICAL ENGINEERS.

The ordinary meeting of the Institution was held on Thursday, November 25, at the Institution of Civil Engineers, Great George-street, Westminster, the president (Sir Henry Mance) in the chair.

Accumulator Traction on Roads.

Discussion was resumed on the paper on this subject by Mr. L. Epstein (member).

Mr. E Manby wished to add a few remarks to what he said at the last meeting. A single motor working under 250 volts went 130 miles with one charge. The battery comprised 144 cells, weighing 2,200 kilos, or nearly 5,300lb. The weight complete was 77lb. per kilowatt-hour. The batteries were charged *in situ* at the rate of 60 amperes. The efficiency was said to be very high, and to exceed 90 per cent. With reference to Mr. Epstein's remarks on what might be expected from an accumulator in ordinary traction, he made a few observations. Mr. Epstein said that an ideal battery should not require handling, and should be treated as an indivisible unit. The Dresden batteries fulfilled these conditions. Their capacity was said not to have been impaired at all during the seven months' trial, and to require very little supervision and very little upkeep. Mr. Epstein assumed that the life of a battery depended on the number of charges. Of course, those batteries would show considerable difference from others, as in practice they had only been charged once a day, and they had got a very large mileage under those conditions, so that instead of 750 days, as Mr. Epstein stated in his paper of what might be expected of a battery, they would actually work 1,500 days without renewal. However, they had only been tried for about six months, and although their efficiency had not been impaired so far, time would show whether they would develop that result. The hauling car weighed, with battery complete, when fully occupied by passengers, about 12 tons, and hauled another carriage weighing 5½ tons; it thus was said to have developed nearly 69 kilowatt-hours, or about 30 watt-hours per ton-mile, whereas Mr. Epstein assumed that 80 watt-hours would be the proper proportion per ton-mile; but, of course, that depended on other conditions besides the merits of the battery. One other trial was made at Dresden on specially-selected parts of the tramway, where the gradients were 1 in 23, and some very sharp curves, and the actual output was equivalent to 66 watt-hours per ton-mile hauled.

Prof. Ayrton said that Mr. Epstein had given them some particulars of the Hanover trams, but he thought it would be interesting if he would add to that the proportion of length of line where the cars received current from a trolley wire and from accumulators, so that they could compare the success of the one with the success of the other. When he was asked some eight months ago to advise on this question, he advised against the probability of the use of accumulators being commercially successful with ordinary road traction, but he should be very glad to be proved in the wrong in this respect. They wanted to have all the facts before them, because the time had gone by for the Edison inference that "the natural capacity of man for lying comes out in any reference to accumulators." The calculations that Mr. Epstein made as to the weights of accumulators, etc., depended on two things: they depended on what was the storage capacity of an accumulator, and what was the resistance per ton to traction on an ordinary road. As regards the first point, a great many experiments had been conducted for some years past in his laboratory on all kinds of accumulators, each experiment lasting several months, charged day and night so as to get the real history. A few days ago a pamphlet was put into his hand issued by the Lamina Company. In that pamphlet tests were given, but no details as to how they were made. He was struck with one statement in one particular report, which said that with these Lamina accumulators working under normal conditions, 14 watt-hours per pound per gross weight was the storage capacity, which was as good, or perhaps better, than any other accumulators with equal durability. He rubbed his eyes when he saw that, because he had never succeeded in getting more than half that result. Then he turned to the prospectus of the company, and he found that they themselves did not claim half as much storage capacity for their own accumulators as had been vouched for in the pamphlet. On the other hand, they had heard from Mr. Manby that the accumulators used in Belgium agreed with that statement, for they had approximately the same storage

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capacity—viz., 13 watt-hours per pound. He was not quite clear whether the figures Mr. Manby gave when he spoke of 77lb. per kilowatt meant 77lb. gross weight, or the weight of the plates. [**Mr. Manby:** Gross weight.] Well, that worked out at about 13 watt-hours per pound and the best results he had ever obtained himself were more like half that. The Lamina Company claimed six watt-hours per pound, and the best results he had obtained were eight watt-hours per pound. With regard to the question of the resistance to traction, Prof. Ayrton gave some results of experiments with bicycles and tricycles. It appeared that a bicycle on a concrete road required a tractive force of about 30lb. per ton with a speed of about 5½ miles. On longer lengths where they could get higher speeds, on an ordinary macadamised road a speed of 12½ miles seemed to be about 43lb. per ton. Experiments made on a very good macadamised road slightly wet, and with a very slight wind, showed that about 62lb. per ton was required with a speed of between 10 and 12 miles an hour going against the wind, and about 40lb. per ton going with the wind. To compare those figures with motorcars they must take into consideration such things as the good gearing of bicycles and also the extra friction in the axles of larger vehicles, but he should think Mr. Epstein's estimate of 60lb. was not excessive at all. With regard to carrying accumulators on a dummy car, he did not quite agree with Mr. Epstein's figures. A passenger car of 52 persons weighed at least eight tons when loaded, and sometimes nine, and they wanted at least 12 h.p. to propel that at eight miles an hour. Taking 60lb. per ton resistance, they wanted at least 12 h.p., and if they took the best accumulators of eight watt-hours per pound gross weight, he had come to the conclusion that they would want five tons of accumulators, which, with the dummy weighing three-quarters of a ton, made a total of 5¾ tons. Of course, the more accumulators they put on the dummy, the more weight they had to pull, and so the thing went on increasing. To get the actual result of eight miles an hour with a car of 52 passengers, with the best accumulators, he thought Mr. Epstein's estimate should be doubled. In conclusion, he asked why it was necessary to go to America for the motors for the London electric cabs? Why was it not possible for English engineers to supply what was wanted? He thought that was a matter which English electrical engineers should consider very seriously.

Mr. Thomas Parker said the difficulty of the question of accumulator traction for roads was that it took a great deal of time to get experience of accumulators. There had been a great deal said about the Birmingham trams, a system which was designed by him. In 1891 he was asked to construct a locomotive with accumulators to compete on the Birmingham lines with the steam tram motors. That locomotive was constructed, and for months it held its own against the other motors. It was about eight tons weight, and its accumulators were all fixed and were charged *in situ*. Its success determined the Birmingham Tramway Company to put down a station so as to extend the electric tram system, but there were several points imposed which, in his opinion, had been the cause of the failure of the system. In effect they had to adapt their motors to the existing cars, instead of being able to adapt the cars to the motors. Then, again, they were to run at too high a speed, and, in his opinion, the cost of the installation was very abnormally large. Given a free hand, he believed the tramway would have been successful. His son had been building a car weighing 24cwt. to carry nine people, and he had found by experiment with it that the traction required on a good macadam road was not so much as it was on a road paved with granite setts. He used solid rubber tyres, and the resistance was about 40lb to 45lb. per ton. The car did not vary in speed more than 6 or 8 per cent. on the road.

Mr. E. Wilson confined his attention to the words in the paper, "The weight of an electrical . . . 2,812 watts respectively." About six months ago he carried out, in the Siemens Laboratory, King's College, London, a series of experiments upon traction-type cells for the purpose of a small work entitled "Electrical Traction," and he had to thank Mr. H. H. Hodd for the assistance he gave him in the experiments. Those experiments were given in full in the book, and he had extracted the results in the following table, which referred to an Electrical Power Storage Company's Faure-King traction-type five-plate cell. The cell was fully charged when delivered The two positive plates measured each 7¼in. by 8in., and had a thickness of ¼in., not including the perforated envelope in which they were placed. They weighed, with lug, when just taken out of the acid, 7lb. 7oz. The total weight of the cell in ebonite case and acid was 21lb. 2oz. The specific gravity of the acid in the fully-charged cell was 1·275 Tests Nos. 5 and 7 in the table showed for a net drop of about ·2 volt with current passing a work efficiency of about 72 per cent., which agreed with Mr. Epstein's figures. Those tests had been made upon new cells, and therefore no conclusions could be drawn as to the life of such plates, and further, tests made upon isolated cells might not represent the average results which would be obtained from many. The table referred to was as follows:

No. of Test.	5. Discharge.	6. Charge.	7. Discharge.
Volts, initial, without current	—	—	2·18
Volts, initial, with current	2·04	2·135	2·02
Volts, final, with current	1·85	2·6	1·85
Amperes constant at	15	17·8	14·9
Total time of test	5 h. 20 m.	5 h. 30 m.	5 h. 15 m.
Ampere-hours	80	97·9	78·2
Watt-hours	157	228	155
Quantity efficiency	82·0	—	89·7
Work efficiency	68·8	—	76·1

It was interesting to see what weight of those storage cells would fulfil the conditions laid down by Mr. Epstein. Taking the lower rate of discharge, at 2,208 watts for five hours, the watt-hours would be 11,040. The Faure-King type cell, to which he had just referred, when working under the conditions given in the table, gave 156 watt-hours. Therefore $\frac{156}{21} = 7{\cdot}43$ was the work in watt-hours per pound of total weight of cell. Dividing this into 11,040 should give the total weight of a battery of these cells to fulfil the conditions put down. $\frac{11,040}{7{\cdot}43} = 1,490$lb. as against Mr. Epstein's 1,000. This made no allowance for diminished capacity after continued working if such existed in that cell. The number of such cells would be $\frac{1,490}{21} = 71$, and since 2·6 volts were required for the fully charging of the cell at the rate given in the table, the total charging volts would be $2{\cdot}6 \times 71 = 185$ if the cells were kept in series. The number of 71 cells could be considerably reduced if their capacity were increased, and still give currents convenient to deal with in motor and controlling apparatus. This was important, since the weight of an equivalent battery, so far as work was concerned, came out smaller, and the limiting conditions were naturally the currents to be dealt with. Taking a larger size of the Faure-King type, with a nine-plate instead of a five, the cell was capable of discharging 150 ampere-hours at 30 amperes, the time being, as before, five hours. Its weight was 35lb. complete with acid, as against 21lb. in the five-plate cell. They had watt-hours per pound $= \frac{300}{35} = 8{\cdot}57$ as against 7·43. Also $\frac{11,040}{8{\cdot}57} = 1,290$lb. as against Mr. Epstein's 1,000. The number of such cells would be $\frac{1,290}{35} = 37$, and allowing 2·6 each, the voltage would be 96 if the cells were charged in series. Under these conditions the 1,000lb., as given by Mr. Epstein, seemed low, but he might have assumed different conditions of working. He thought it would add to the value of the paper if the author would give exact details as to number of cells and the conditions of working. The experiments which he had made on the Chloride Electrical Storage Syndicate's cell, representing the Planté type as against the pasted type, showed the same character of results, but with somewhat greater weight. Mr. Epstein's higher rate quoted—namely, 2,812 watts—would naturally increase the weight of the battery, and make the difference greater than he (Mr. Wilson) had shown. It was premature to discuss which type of cell would eventually survive for traction purposes. Another year's experience would no doubt go a long way towards settling this point, but the cell of the future must be capable of being over-discharged without injury.

Mr. Cuthbert Hall thought it was important to point out that the charging at constant potential gave a more efficient result than charging at constant current. He attributed this to the fact that in charging at constant current at the end of the charge a very large amount of the energy was expended in producing gas, whereas in charging at constant potential and allowing the current to drop at the end very little gasing took place, and the plates are capable of absorbing the whole current at the end of the charge.

Mr. Raworth said he appeared in the character of one who wanted to learn. His experience with accumulators ceased some eight or nine years ago. With regard to the effect of vibration on the accumulators, there was a case on record, and it was constant, which absolutely settled the point. It was that of the cells which had been used by the London, Brighton, and South Coast Railway Company for lighting their carriages, and they had the most violent shaking it was possible to get! It was a well-known fact that those cells had not been deteriorated by the shaking to which they had been exposed.

Mr. Swan said that it was satisfactory to find that not only in the manufacture but in the use of secondary batteries Mr. Epstein had pointed out several causes of failure, more particularly in reference to the not great success which attended the Birmingham experiment. Several of the causes which led to the incomplete success there were of a remedial kind, due to the imperfect mechanical arrangements. He quite concurred with Mr. Epstein in subjecting cells when they were being charged to a constant potential, because it shortened the time of charge, and, therefore, was useful in traction. It was a remarkable fact that, notwithstanding it was 16 years ago that they had the great invention of the storage of electrical energy brought over from Paris, when it seemed to be quite a question whether the Planté type of cell could compete with the Faure type of cell, now they found the Planté type creeping up again, and to have commended itself for several points of superiority. It was remarkable that, notwithstanding the experience of the last 16 years, they were still debating the point whether the Faure type or the Planté type was the right one. He noticed that some of the chief English makers of batteries had come to the conclusion that, after all, the Faure type was better for the positive plate. He claimed for the late Mr. Tribe whatever credit or honour there was in the origination of that type of cell.

Mr. Tremlett Carter found that the method of rearranging the cells had on many occasions been adopted for traction work, and only the other day he came across a motorcar in London in which 40 cells were arranged in groups of 10, by which means they could avoid sending the excessive current used in starting through all the cells.

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Mr. Holroyd Smith said the merits of no battery could possibly be ascertained by a few tests, and he thought no inventor of batteries should make any statement whatever as to the mile running that his battery would produce. His statements should be confined to the discharge of that battery at varying rates of discharge, and to the duration of it. As to tractive force, he never took it at less than 100lb., and he believed in practice that would be nearer the mark for road carriages, not only to maintain them at a certain speed but also because of the force required to start, which in London streets, where stoppages were very frequent, was an important consideration. He did not agree with varying the speed by varying the coupling, because of the varying discharge it entailed. The only safe way was to use every cell in the car.

Mr. J. Brown (Belfast) directed the attention of the association to the fact that the difference of opinion in regard to the tractive force was largely due to the difference in the quality of the roads where the force had been tried. Firstly, the force varied in some degree with the velocity at which the carriage ran; it also varied in proportion to a constant which varied from 2 on a very good wooden pavement to 14 on pavement such as they had in Ireland. If anyone in Ireland invented a motorcar to run on the roads they had there, they could certainly be sure that it would run anywhere. When people spoke of a macadamised road, nobody knew what it meant; there was a wide difference between such roads. People seemed to think a five or six hours' discharge was absolutely essential, but a private carriage would not be used more than an hour or so at a time, and therefore they could limit the length of discharge in that proportion.

At this point the **President** adjourned the discussion on account of its importance, and hoped at the next meeting—a special meeting to be called for the purpose—they would hear something about gearing and the other parts of accumulator traction.

ANNUAL GENERAL MEETING.

The annual general meeting of the Institution, at which members and associates only are admitted, will be held at the Institution of Civil Engineers, Great George-street, Westminster, on Thursday evening, December 9, at eight o'clock, to receive the annual report of the Council and the statement of accounts and balance-sheet for the year ending September 30, 1897. The election of Council and officers for the year 1898 will also take place, the ballot list closing at 8.30 p.m. The list given in our issue of the 11th ult. holds good, as no other names have been submitted. The Council will also make a proposal in reference to remuneration in the form of a pension to be given to the secretary on his retirement after 20 years of service.

The following is the statement of receipts and expenditure for the year ending September 30, 1897, together with the general balance-sheet:

Receipts.	£	s.	d.
Annual subscriptions	£3,278	8	6
Entrance fees	352	4	0
Publishing fund	1	1	0
Advertisements in the *Journal*	75	0	0
Dividends on investments—premium fund, £6. 19s.; telegraph jubilee fund, £5. 2s.; life compositions, £107. 13s. 10d.; general fund, £71. 17s. 4d.; income tax recovered, £27. 7s. 4d.	218	19	6
Interest—cash on deposit	2	17	10
	£3,928	10	10

Expenditure.	£	s.	d.
Salaries and clerical assistance	843	7	6
Accountant's fees	15	15	0
Shorthand reporter	44	2	0
Attendance, refreshments, and petty expenses connected with evening meetings	61	9	6
Printing, illustrating, and advertising *Journal*, and cost of abstracts, £799. 9s. 6d.; less cost of copies taken into stock, £60	739	9	6
General printing and stationery	190	5	11
Insurance	9	15	0
Petty expenses connected with the library	0	16	0
Office rent, electric light, and firing	329	6	5
Postage of *Journals*, notices of meetings, etc., £291. 14s.; general office expenses, £60. 18s. 11d.; cost of illuminated address to H.M. the Queen, £20	372	12	11
Willans memorial trust—moiety of cost of deed	3	14	0
Petty expenses of local hon. secretaries	1	13	2
Bank charges	1	5	11
Conversazione expenses (irrespective of printing and postage)	213	1	0
Premiums	21	6	0
	2,847	19	10
Balance carried to general fund, being excess of receipts over expenditure	1,080	11	0
	£3,928	10	10

The life compositions account shows investments amounting to £3,645. 10s., while the Salomons scholarship fund stands at £2,126. 19s. 3d. The building fund account has now reached a grand total of £4,639. 13s. 7d. The following is the general balance-sheet up to September 30, 1897.

Liabilities.			£	s.	d.
Premium fund			213	0	3
Telegraph jubilee fund			163	8	0
Life compositions—balance uninvested			131	6	5
Subscriptions received in advance—on account of 1898, £10. 3s.; ditto, 1899, £1			11	3	0
Salomons scholarships—balance of income account			68	19	4
Building fund—balance uninvested			63	15	11
General fund—balance as per last account	£4,428 19 8				
Add estimated value of books, etc., presented	39 13 0				
Add excess of receipts over expenditure (as above)	1,080 11 0				
	5,549 3 8				
Less amount transferred to building fund account (as above)	1,000 0 0				
			4,549	3	8
			£5,200	16	7

Assets.			£	s.	d.
Investments—premium fund			213	0	3
Investments—telegraph jubilee fund			163	8	0
Investments—general fund			2,308	10	7
Furniture as per last balance sheet	£200 0 0				
Add new bookcases since purchased	18 10 0				
			218	10	0
Stock in hand of Institution *Journals*, Ronalds' catalogues, etc —as per last balance-sheet	451 12 7				
Cost of additions in 1897	60 0 0				
	511 12 7				
Less amount realised during the current year	102 0 7				
			409	12	0
Books, pictures, etc. (other than the Ronalds library)	1,144 9 6				
Add value of books and periodicals since purchased, and cost of binding	22 18 1				
Ditto, presented	39 13 0				
			1,207	0	7
Sundry debtors for advertisements in the *Journal*			12	10	0
Suspense account (Cooke's manuscripts)			49	3	11
Balance at bankers	595 14 8				
Petty cash balance	23 6 7				
			619	1	3
			£5,200	16	7

The statement is signed by Mr. A. Stroh, honorary auditor, and is certified as correct by Messrs. Wagstaff, Blundell, Biggs, and Co., chartered accountants.

BILLS, 1898.

Amongst the private Bills to be introduced into Parliament during the coming session we note the following:

Railways.

Caledonian Railway.—Widening of railways in county of Lanark and new station on Glasgow Central Railway; powers to work Glasgow Central Railway, Tollcross Railway, and other railways by electric power; agreements as to supply of electricity; purchase and amalgamation of Crieff and Comrie Railway.

City and Brixton Railway.—Construction of railway from the City and South London Railway, in the parish of St. Saviour, Southwark, to Brixton-hill, to be worked by electrical power; generating station, etc.; working and other arrangements with the City and South London Railway Company.

City and South London Railway.—Power to make sidings at Clapham, etc.

Manchester Carriage and Tramways.—Use of mechanical power and adaptation of tramways for that purpose; construction of works for generating and supplying electricity or other motive power.

Metropolitan Railway.—Further powers to company as to works and lands in counties of Middlesex, Buckingham, and Hertford; powers as to working railways of company, and Metropolitan District Railway Company, and Metropolitan and District Railways Joint Committee by electrical power, and agreements with reference thereto; lands for generating stations; provisions as to lease from South-Eastern Railway Company to said companies of lands at Cannon-street Station.

New Cross and Waterloo Railway.—Construction of underground railway from New Cross-road, under the Old Kent-road, New Kent-road, and Waterloo-road; electric or cable power; agreements with the London and South-Western, Baker-street and Waterloo, and Waterloo and City Railway Companies.

Paddington and Charing Cross Railway.—Construction of underground railway from Paddington to Charing Cross;

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electrical power; generating station; agreements with the Great Western and South-Eastern Railway Companies, and the London County Council, and other local authorities; incorporation of and amendment of Acts.

TRAMWAYS.

The list of Tramways Bills to be introduced includes 15, as follows: Blackpool and Fleetwood Tramroad (Tramway Extension); Blackburn Corporation (Tramways, etc.); Burnley Corporation (Tramways, etc.); Bristol Tramways; Bristol Tramways (Electrical Powers, etc.); Clontarf and Hill of Howth Tramroad; Devonport, Plymouth, and Stoke Tramways; Folkestone Electric Tramways; Great Orme Tramway and Tramroad; Hastings and St. Leonards Tramways; London County Council (Westminster Bridge and Embankment Tramways); London United Tramways; London County Council (Northern Tramways); Norwich Electric Tramways; Portsmouth Corporation Tramways. Amongst these are two for the London district, one by the London United Tramways Company, which will include the construction of eight tramways in the counties of London, Middlesex, and Surrey. Some of these proposed lines, together with sundry junctions, are designed in connection with tramways already possessed by the company, in the Uxbridge-road and the Kew Bridge-road. Either animal power or electrical power is to be employed, the latter to be on the overhead system or otherwise. Electrical depôts are proposed at Shepherd's Bush, Chiswick, Richmond, and Acton. The Bill is to empower the company on the one hand, and the Central London Railway Company on the other, or any other company or authority, to enter into agreements for the supply of electrical energy. The Woolwich and South-East London Tramways Company will apply for power to construct certain tramways in Plumstead and Woolwich. Powers are sought to work the company's existing and new tramways by animal, electrical, and other mechanical power.

ELECTRIC LIGHTING PROVISIONAL ORDERS.

The following is a complete list of the provisional orders for electric lighting which will be applied for in the ensuing session: Aldershot Urban District Council, Airdrie, Aston Manor, Bridgwater Corporation, Burslem, Bermondsey, Barnes, Brechin, Buxton; Bermondsey, Rotherhithe, Greenwich, and Lewisham; Bethnal Green, Poplar, and Whitechapel; Birkdale, Bolton Corporation (Suburban), Batley Corporation, Chichester, Chislehurst, Colne Corporation, Chorley Corporation, Crewe, Dartford, Doncaster Corporation, Darlington Corporation, East Stonehouse, East Ham, Gravesend; Greenock, Port Glasgow, and Gourock; Hamilton, Holborn and St. Giles, Hornsey Urban District Council, Hereford, Holborn District, Hove Urban District Council (Aldrington), Hastings Corporation, Ilfracombe, Ilford, Kingswinford, King's Norton Rural District Council, Leigh-on-Sea Urban District Council, Leatherhead Urban District Council, Lewisham, Lewes, Lowestoft, Melton Mowbray, Metropolitan Electric Supply, Margam, Marylebone, Montrose, the Midland Electric Corporation for Power Distribution, Marylebone, St. Marylebone, Mitchelstown, Middlesbrough, Maidenhead, Norwich (Extension), Nuneaton, Ossett Corporation, Oldbury (Urban District Council of), Preston (Extensions), Partick, Perth, Peterborough, Prescot District, Penarth, Ramsgate, Rawmarsh, Rotherham Corporation, Ryde, Rothesay, Royal Leamington Spa, Rochdale Corporation, Stourbridge, St. Annes-on-the-Sea, Shrewsbury, St. Albans, Smethwick (Urban District Council of), St. Giles District, Stoke-upon-Trent, Warrington Corporation, Whiston Rural District, Weston-super-Mare, Weymouth and Melcombe Regis, Westgate-on-Sea, Willesden, West Bromwich Corporation, Weymouth and Melcombe Regis (Corporation).

The following gas companies are also applying for electric powers: Blackpool (Corporation), Drogheda, Enfield, Halifax (Corporation), St. Helens (Corporation), Southampton, Southend-on-Sea, Thanet, Tottenham and Edmonton, Waterford, and Yeovil (Corporation).

The Royal Society.—The annual meeting of this society was held on Tuesday at Burlington House. The president, Lord Lister, delivered the anniversary address; the various medals were presented, and the officers and council for the ensuing year were elected as follows: President, Lord Lister; treasurer, Sir John Evans; secretaries, Prof. Michael Foster, Prof. Arthur William Rücker; foreign secretary, Sir Edward Frankland; other members of the council, Prof. William Grylls Adams, Prof. Thomas Clifford Allbutt, Sir Robert Stawell Ball, Rev. Thomas George Bonney, Prof John Cleland, Prof. Robert Bellamy Clifton, Prof. James Alfred Ewing, Alfred Bray Kempe, John Newport Langley, Joseph Larmor, Prof. Nevil Story Maskelyne, Prof. Raphael Meldola, Prof. Edward Bagnall Poulton, William James Russell, Dukinfield Henry Scott, Prof. Walter Frank Raphael Weldon. The anniversary dinner of the society took place in the evening at the Hôtel Métropole. Lord Lister presided, and among the speakers were the Duke of Devonshire, the United States Ambassador Prof. Forsyth, and Lord Kelvin.

TELEGRAPHIC STATISTICS.

We have translated the following tables of telegraphic statistics from the *Journal Télégraphique*, which magazine is published by the International Telegraphic Bureau. From it the relative progress of the various countries in telegraphic developments can be seen. We reserve our comments on the same till our next issue:

REMARKS AND REFERENCES.

GERMANY.—(1) Not including 31,582 kilometres of railway lines having some 120,239 kilometres of wires nor the 461 kilometres of wire in the German African Protectorates. (2) These include 10 telegraphic offices in the German African Protectorates. (3) In all the sending offices all postmen and rural officials are obliged to receive telegrams for dispatch. (4) That is to say, 13,135 telephone apparatus, 400 transmitters and 281 auxiliary apparatus for other systems. (5) The staffs of the post and telegraphs has been joined so that it is not possible to give special figure for the one department only. (6) These include 483 593 service telegrams for the railways. (7) Not including 62,714 international service telegrams. (8) The connection between the post and telegraph services does not permit of exclusive receipts and expenditure for the telegraph service only being given. (9) Census of December 2, 1895. (10) Not comprising the surface occupied by water.

AUSTRALIA.—(1) The staffs for post, telegraph, and telephone services united in one department. (2) No record has been taken. (3) Total of the establishment charges for the telegraphs and telephones since commencement.

AUSTRIA.—(1) Not including 16,430 kilometres of railway lines, comprising 43,142 kilometres of wires. (2) Not including 3,080 sets of apparatus belonging to the railways. (3) Telephones. (4) The figures cannot be given, as the post and telegraph staffs are united. (5) Court telegrams. (6) Of which 782,090 are for Hungary. (7) Of which 789,371 are from Hungary. (8) In the service telegrams are included the meteorological telegrams, the bulletins of the Bourse, the variation in the price of corn, etc. (9) The post and telegraph services being joined, separate figures cannot be given. (10) Census of 1890.

BELGIUM.—(1) The figures do not include either 379 kilometres of lines carrying 2,092 kilometres of wires placed along the canals or 1,192 kilometres of wires fixed by the railway companies or 57 kilometres of wire used for distributing correct time. (2) Not including 100 offices connected to the system, but which used for sending only are considered as dispatch offices only. Nor 58 exclusive stations established on the canals. (3) Not including two double translators. (4) Not including 117 telephones used to transmit telegraphs to the renters. (5) Not including 3,711 railway officials and civil engineers who use their systems for telegraphic messages. (6) In this number are included 2,792 telegraph messengers. (7) This figure represents the number of telegrams for the telegraph service. The total number of service telegrams is 3,093 322. (8) These figures only include the expenses of the telegraph, and they are approximate. (10) To December 31, 1896.

BOSNIA AND HERZEGOVINA.—(1) Including the railway companies' wires. (2) Including the instruments belonging to the railway companies. (3) Not including the staff of the railway companies. (4) Including 114,025 telegrams going to Austria and Hungary. (5) Including 95,569 telegrams from Austria and Hungary. (6) In this total are also given meteorological telegrams, Stock Exchange quotations, the price of corn, and of the Public Debt.

BULGARIA.—(1) Combined staff for post and telegraph. (2) The figures cannot be given owing to the post and telegraphs being one department.

COCHIN CHINA, CAMBODIA, AND BAS-LAOS.—(1) That is, two recorders and seven A B C. (2) The commission of telegraphic orders, etc. (3) The expenses of the post and telegraphs being merged in one total for the staff, they cannot be divided. The total cost exceed 950,000fr.

DENMARK.—(1) In these figures the State telephone lines, which were included in 1895, only are added. The total does not include 1,814 kilometres of railway lines, carrying 5,910 kilometres of wire. (2) Including eight Wheatstones and 175 telephones. (3) Besides 640 instruments in the offices of the railway companies. (4) Besides 13,866 meteorological international telegrams. (5) For the year from April 1, 1896, to March 31, 1897. (6) Census for 1890 not including the islands of Faroe and Iceland.

EGYPT.—(1) Including the lines and offices of the Eastern Telegraph Company and of the Universal Company of the Suez Canal. (2) Including 15 offices of the Suez Canal Company and six of the Eastern Telegraph Company. (3) Including the service telegrams of the railways and of the port of Alexandria.

FRANCE (the Continent and Corsica).—(1) Including 143 Baudot, 503 Cadrans, 2 Wheatstones, 6 152 telephones, and 362 miscellaneous instruments (2) Including administrative offices, 25,049, and managers of municipal offices, 1,045. The distinction between postal and telegraph services cannot be made. (3) This figure can be divided as follows: officials and employés, 55,653,700fr.; postmen and messengers of the post and telegraphs, 48,737,125. (4) The expenditure for the post and telegraphs on behalf of build-

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COMPARATIVE TELEGRAPHIC

—	Germany.	Australia.	Austria.	Belgium.
I. Conductor Network.				
(a) Length of the entire network in kilometres	135,862 [1]	9,444	32,672 [1]	6,370 [1]
(b) ,, conductors ,,	516,627	22,991	100,498	32,058
II. Offices.				
(a) Number of offices — Open for interior and international service	21,455[2]	254	4,780	1,002
,, interior service only	—		5	—
Total	21,455	254	4,785	1,002
(b) Number of offices — Belonging to the State	17,041	254	2 723	905
,, ,, railways or private companies	4,414	—	2,058	97
Signalling with telegraphic service	—	—	4	—
Total	21,455	254	4,785	1,002
(c) Number of offices — With permanent service	394	254	52	16
With complete or prolonged day service	14,331		468	223
With limited day service	6,730		4,265	763
Total	21,445	254	4,785	1,002[2]
(d) Number of receiving offices	17,332[3]	—	91	494
III. Apparatus.				
Number of instruments in use — Morse	16,607	376	4,107[2]	1,303
Hughes	584	—	231	77[3]
Other systems	13,836[4]	—	44[3]	512
Total	31,027	376	4,382	1,892[4]
IV. Staff.				
(a) Superior staff and administrative department	— [5]	20 [1]	— [4]	246
(b) Number of employés at offices		647		1,144[5]
(c) Second-grade staff		1,242		3 789[6]
Total	—	1,909	—	5 179
V. Telegrams.				
(a) Home service — Number dispatched and paid for	25,723,213	1,092,288	6,133,167	2,836,210
Number of free telegrams dispatched	1,391,582[6]	—	33,091[5]	3 016
Total	27,114 795	1.092,288	6,166 258	2.839 226
(b) International service — Number sent abroad	4,140,724[7]	10,100	2,310,260[6]	1,072.123
Number received from abroad	5,153,557	9,430	2,444,780[7]	1,135,583
Number transmitted from one frontier to another	1,211,392	97,601	1,123,651	527,919
Total	10,505 673	117 131	5,878 691	2,735 625
(c) Number of service messages	771,756	— [2]	1,168,684[8]	129,610[7]
Grand total of all telegrams	38 392.224	1,209,419	13,213,633	5,704,461
VI. Revenue.	Fr.	Fr.	Fr.	Fr.
(a) Net revenue from home service	— [8]	1,358 550	— [9]	1,647,276
(b) Net revenue from foreign service		1,200,757		2,049,663
(c) Sundry receipts		—		319,246[9]
Total	—	2,559,307	—	4,016,185
VII. Expenditure.				
(a) Working charges — Staff	— [8]	2,706 900	— [9]	4 564,487
Material and upkeep of lines and offices		2 191,950		577 821
Total expenditure on ordinary budget	—	4,898,850	—	5,142,308[9]
(b) First cost of network	— [8]	30,826,800[3]	— [9]	8,316,850[9]
VII. General Details.				
(a) Population of the country from census	52,279,901[10]	360,220	23,895,413[10]	6,495,886[10]
(b) Area of country in square kilometres	540,484[10]	2,339,870	300,024	29,456

ings, materials, wayleaves, heating, lighting, and other ordinary expenses reach 11,849,871fr. (5) Census of 1895.

France (Algiers).—(1) Including nine Baudot, 33 Cadrans, two Wheatstones, 34 telephonic apparatus, and 14 others. (2) That is, 70 superior staff, 732 office officials, and 94 heads of municipal offices. The distinction between postal and telegraphic services cannot be made. (3) These figures can be detailed as follows: Staff and telegraphists, 2,007,192fr.; postmen and messengers, 1,552,286fr. (4) The expenditure for the postal and telegraphic department for the purchase of buildings, material, wayleaves, heating, lighting, etc., was 677,292fr. (5) Census of 1895.

Great Britain and Ireland.—(1) Financial year from April 10, 1896, to March 31, 1897. (2) Including 36 032 kilometres of private wires and 78,439 kilometres of telephone trunk lines but not including pneumatic tubes and the railway company's lines. (3) Not including the offices of the Submarine Cable Company; all the offices accept both home and foreign telegrams. (4) The railway companies' offices also send private telegrams on behal fof the Government. (5) Of which 23 belong to individuals and companies. (6) Including 68 offices with permanent service during the week only. (7) Including 141 offices open temporarily for special occasions. (8) Offices with pneumatic tube connections are included in the total of 10,183. (9) Mostly sounders. (10) Of which 53 are used on cables between England and the Continent. (11) Including 436 automatic Wheatstones, 131 translators, 137 quadruplex, and 31 multiplex Delany instruments. (12) Including the apparatus on private lines. (13) Including 63,414 temporary employés. (14) The post and telegraph staffs are united, and cannot be numerically separated. (15) Including 27,734 telegrams at reduced cost sent for the railway companies. (16) Including the telegrams direct to the cable companies, which do not pass over Government lines. (17) No record has been kept. (18) The maximum number of telegrams sent in one week has risen to 1 874,606. The least number of words sent for the Press during one week was 13,471,618. (19) Including 3,220,575fr. for Press telegrams and 13,525fr. for telegrams sent at reduced rates for the railways. (20) Including 1,752,000fr. for the rent of special wires lent to the cable companies; also England's share in the income from the London-Paris telephones. (21) This total includes (a) for the 2,315.075fr. for the rent of private wires, and (b) 306.125fr. for the newspaper wires. (22) Including the cost of private telegrams. (23) Including the cost of establishing trunk telephone wires. (24) The cost of buildings and the amount spent by other departments on behalf of the telegraphs are not included (25) Besides the amount for annual expenditure for 1896, a capital sum of 253,270,500fr. was expended for the establishment of the system. (26) Estimated to March 31, 1897.

Hungary.—(1) Not including 51 kilometres of railways having 36,213 kilometres of wires, and also 10 kilometres of private systems having 121 kilometres of wire. (2) In 1,143 offices the telegraphic service is combined with the postal service. (3) In-

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STATISTICS FOR 1896.

Bosnia and Herzegovina.	Bulgaria.	Cochin China, Cambodia, and Bas-Laos.	Portuguese Colonies. Angola.	Denmark.	Egypt.	France. Continent and Corsica.	France. Algiers.	Great Britain and Ireland.[1]	Hungary.
2,841 } [1]	5,200	3,068	692	4,743 } [1]	4,172 } [1]	94,828	8,224	66,140 } [2]	21,302 } [1]
7,140 }	10,689	4,955	697	13,593 }	16,724 }	326,264	19,774	448,573 }	64,841 }
115	173	80	—	350	191[1]	11,901	436	} 10,183[3]	2,718[2]
3	—	7	13	175	75	—	—	}	—
118	173	87	13	525	266	11,901	436	10,183	2,718
81	140	79	13	282	245	8,010	328	7,878	1,152
37	33	7	—	239	21[2]	3 759	102	2,279[4]	1,498
—	—	1	—	4	—	132	6	26[5]	68
118	173	87	13	525	266	11,901	436	10,183	2,718
4	19	1	—	2	76	19	1	161[6]	39
5	42	2	3	166	190	889	58	9,853	391[3]
109	112	84	10	357	—	10.993	377	169[7]	2 288
118	173	87	13	525	266	11,901	436	10,183	2,718
1	—	1	—	—	—	—	—	74[8]	2,911[4]
179[2]	362	150	18	400	543	12,740	514	5,478[9]	3,925
2	1	7	—	—	—	789	23	77[10]	83
—	—	9[1]	—	183[2]	—	7,162[1]	92[1]	25,089[11]	218[5]
181	363	166	18	583[3]	543	20,691	629	30,644[12]	4,226
25	86	16	7	31	44	1,081	—	232	} — [6]
154[3]	586	173	45	551	281	26,094[2]	896[2]	51,466	
132[3]	845	224	26	293	378	6,258	191	93,002[13]	
311	1,517[1]	413	78	875	703	33,433	1,087	144,700[14]	—
153 711	926 654	176,974	5,377	577,062	906,499	34.665,170	1,413,314	71,427,252[15]	4,016,785
—	155 672	90,464	1,721	12 472	4,600	2,303,635	137,032	1,688,317	5,915
153,711	1,082,326	267.438	7,098	589,534	911.099	36,968.805	1,550.346	73,115,569	4,022,700
118,991[4]	83,084	10,247	—	324,028	15,433	2,636 262	28,981	4,271,043	1 156,702
100,153[5]	82,555	10,907	—	371,742	14,432	2 307 955	20 653	3,694,473	1,074,153
100,045	70,734	9,944	—	523 171	4,573	1 410,297	—	1,035,594	385,178
319.189	236,373	31,098	—	1.218,941	34 438	6 354,514	49.634	9,001,110[16]	2 616,033
39.824[6]	35 549	23,000	735	41 293[4]	1,470,748[3]	1,384 979	74 112	— [17]	508,272
512 724	1,354.248	321,536	7,833	1,849,768	2,416.285	44,708,298	1,674,092	82,116,679[18]	7,147,005
Fr.	Fr.	Fr.	Fr.	Fr.	Fr.	Fr.	Fr.	Fr.	Fr.
166 538	—	165,780	} 23,824	522,436	—	20,675 068	1.206,624	54,985,225[19]	} — [7]
162 846	1,115,952	96,960		798,743	—	8 005,944	116,317	9,165,400[20]	
40.960	—	29,895[2]		36.015	—	3 356,260	25.593	8,910,600[21]	
370.344	— [2]	292,635	23 824	1,357.194[5]	—	32.037.272	1,348,534	73.061,225	—
350,294	} — [2]	— [3]	57 217	1.256,023	—	104,390,825[3]	3 559,478[3]	55.685,050[22]	} — [7]
173 336		129 000	6 025	315,025	—	75,060,451[4]	1,776,187[4]	13.334,700[23]	
523 630	—	—	63.242	1.571.048[5]	—	179.451,276	5 335,665	69.019.750[24]	—
3,760	— [2]	—	—	441,306[5]	—	—	—	4 635,375[25]	— [7]
1,568,092	3,153.259	3,796,513	19,400.000	2,172,380[6]	—	38,517,975[5]	4,429,421[5]	39 549,722[26]	17,463,791
51,160	97,929	279,800	1,255,775	38,302	—	536,408	595,308	314,950	322,304

cluding 199 offices with service when required. (4) Postal offices without telegraphic service. (5) Telephones. (6) The postal and telegraphic departments being united, the telegraphic staff cannot be separated. (7) These figures cannot be given for the same reason.

INDIA (Indian Office).—Financial year from April 1, 1896, to March 31, 1897. (2) Not including 3,510 kilometres of railway companies' system with 11.264 kilometres of wire. (3) Including 2,689 railway and canal offices. (4) Cadrans (A B C). (5) Of which 120,068 concern the postal service. (6) The conversion into francs is at the rate of 1 rupee = 1·535fr. (7) Census of 1890-91, including the native and protected states, but not the French and Portuguese possessions.

INDIA (Indo-European Office). — (1) Head office. (2) Not including seven head offices.

ITALY.—(1) For year from July 1, 1895, to June 30, 1896. (2) Not including 3,432 kilometres of lines used exclusively by the railway company, having 37,938 kilometres of wire. (3) Not including 524 offices open only for State or railway purposes. (4) Including 160 belonging to the railway company. (5) Of which 11 are used only for urgent telegrams, 58 for temporary use, and 158 belonging to the railway companies. (6) Of which 1,394 belong to the railway company. (7) Telegrams can be given in at all post offices. (8) Including two duplex Morse. (9) Including eight duplex sending instruments. (10) There are 22 automatic Wheatstones, 90 Wheatstone receivers, four duplex Baudot, and 11 quadruplex. (11) This total includes the staff of 3,112 sub-offices. (12) Not including 650,035 telegrams sent by the railway offices. (13) Not including 27,132 telegrams sent by the railway offices. (14) Not including 41,464 telegrams sent by the railway offices. (15) Not including 16,366 telegrams sent by the railway offices. (16) Telegrams relating to the postal and telegraph services only are considered as service telegrams. In the total there are 270,629 telegraph service messages and 82,102 postal service messages. The total does not include the service telegrams of the railway offices. (17) Including 198,169fr. contributed by the telephone administration. (18) Not including the expenditure which is common to the posts and telegraphs.

LUXEMBURG.—(1) Not including 124 kilometres of lines and 815 kilometres of wire belonging to the railway companies. (2) Not including 81 apparatus belonging to the railway companies. (3) Telephonic apparatus. (4 and 5) Cannot be given, as the staffs of the postal and telegraph services are united. (6) Census of 1895.

NORWAY.—(1) Excepting for the figures as to the number of offices, the data do not include the railway telegraphs. The following figures give the results for the railway telegraphs alone, for the year from July 1, 1895, to June 30, 1896. (2) Length of lines 1,723 kilometres, with 3,156 kilometres of wire. (3) Of which

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COMPARATIVE TELEGRAPHIC

—	British India.			Italy.[1]
	Indian Offices.[1]	Indo-European Offices. Persian Gulf line.	Indo-European Offices. Teheran-Bushire line.	
I. Conductor Network.				
(a) Length of the entire network in kilometres	78,164 [2]	3,372	1,086	39 515 [2]
(b) ,, conductors ,,	237,447	5,463	3,260	122,468
II. Offices.				
(a) Number of offices — Open for interior and international service	1,296	7	7	5,261[3]
,, interior service only	2.956	—	7[4]	—
Total	4,252	7	14	5,261
(b) Number of offices — Belonging to the State	1,553	7	14	3,483
,, ,, railway or private companies	2,689	—	—	1,712
Signalling with telegraphic service	10	—	—	66
Total	4,252	7	14	5,261
(c) Number of offices — With permanent service	47	4	3	176[4]
With complete or prolonged day service	392	2	3	446[5]
With limited day service	3,813[3]	1	1	4,639[6]
Total	4,252	7	7[2]	5,261
(d) Number of receiving offices	4,583	—	—	— [7]
III. Apparatus.				
Number of instruments in use — Morse	7,761	29	37	5,621[8]
Hughes	—	—	—	184[9]
Other systems	12[4]	—	—	143[10]
Total	7,773	29	37	5.948
IV. Staff.				
(a) Superior staff and administrative department	175	12	11	192
(b) Number of employés at offices	4,433	106	34	5,666
(c) Second-grade staff	3,005	248	73	2,767
Total	7,613	366	118	8,625[11]
V. Telegrams.				
(a) Home service — Number dispatched and paid for	4,386,828	920	—	6,564,892[12]
Number of free telegrams dispatched	8,586	—	—	1,051.766[13]
Total	4.395 414	920	—	7,616,658
(b) International service — Number sent abroad	182,512	3,868	1,599	821,165[14]
Number received from abroad	168,745	3,411	2,263	1,116,317[15]
Number transmitted from one frontier to another	339,499	138,327	145,518	126,413
Total	690,756	145,606	149,380	2,063,895
(c) Number of service messages	483,898[5]	8,199	8,135	352,731[16]
Grand total of all telegrams	5 570 068	154,725	157.515	10,033,284
VI. Revenue.	Fr.	Fr.	Fr.	Fr.
(a) Net revenue from home service	7.467,754	2,578,922	377,090	10,515 400
(b) Net revenue from foreign service	3,335 553			2,666 802
(c) Sundry receipts	2,965,698	21 072	1,922	773,310[17]
Total	13,769 005[6]	2.599,994	379,012	13,955,512
VII. Expenditure.				
(a) Working charges — Staff	7,546.912	526,517	314,110	2,248 874
Material and upkeep of lines and offices	1,999 215	258,983	60,505	1,679,112
Total expenditure on ordinary budget	9,546,127[8]	785,500	374,615	3,927,986[18]
(b) First cost of network	2,671,668[6]	—	—	—
VIII. General Details.				
(a) Population of the country from census	287,000,000	—	—	30,347,291
(b) Area of country in square kilometres	3.770,970	—	—	286,589

four offices give a prolonged service when required. (4) That is, 28 duplex, 18 quadruplex, 15 automatic Wheatstones, and 223 telephones. (5) The railway offices' apparatus consist of 189 Morse, 81 Digney dials, 23 Siemens dials for electromagnetic currents, and 106 telephones, or 399 in all. (6) Including 263 males and 151 females, but not including an auxiliary staff of 176 persons. The railway companies employ 173 males and 151 females. (7) Including 48 superintendents of the State lines, but not including the workmen employed temporarily for working on the lines. (8) 76,760 private telegrams are sent on the railway lines. (9) The railway offices have dispatched 185,414 service telegrams. (10) Not including meteorological telegrams. (11) Receipts of the railway company, 78,033fr. (12) Cost of establishing the railway offices, 299,221fr.

Holland.—(1) With the exception of the number of offices, the data refer only to the State telegraph system. (2) Including seven semaphores. (3) Of which two are duplicated. (4) Of which four are duplicated. (5) Including two Baudot apparatus and 447 telephones. (6) Including 44 employés of the joint postal and telegraph service. (7) Including 408 employés of the joint postal and telegraph service. (8) Including 1,083 postmen, 21 line superintendents, and 34 workmen. (9) Telegrams dealing with the telegraphic service only are classed service telegrams; meteorological telegrams also are included.

Roumania.—(1) For the year from April 1, 1896, to March 31, 1897. (2) Not including 2,908 kilometres of railway lines with 8,046 kilometres. (3) Rural offices; also all the rural postmen are obliged to receive telegrams for dispatch. (4) Including the rural postal staff. (5) The united staff of the post, telegraph, and telephone services. (6) This includes 87,400 home service telegrams and 8,670 international service telegrams. (7) The first receipts of the three services amount to 8,461,022fr. (8) The total costs of the three services amount to 7,890,707fr. The telegraph costs cannot be separated. (9) Census of December, 1894.

Russia.—(1) This comprises 130,024 kilometres of line with 262,007 kilometres of wire belonging to the State, and 4,252 kilometres of line with 8,535 kilometres of wire belong to private companies. There are, besides, 8,190 kilometres of railway lines with 87,025 kilometres of wires, and 496 kilometres of lines and wires belong to the police system. (2) Not including the railway offices. (3) Comprising 23 Wheatstones, 25 bells, and 94 telephones. (4) This total only includes instruments belonging to the State. (5) The postal and telegraph staffs are united, so separate figures cannot be given. (6) These totals only include the upkeep of the lines.

Senegal.—(1) The figures cannot be given, as the telegraphic and postal services are merged. (2) This comprises the population of the protected country.

Sweden.—(1) This comprises the two submarine cables, with 392 kilometres of wire owned conjointly by Sweden, Denmark, and

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STATISTICS FOR 1896.

Luxemburg.	Norway.[1]	Holland.[1]	Roumania.	Russia.	Senegal.	Sweden.	Switzerland.	Tunis.	United States. Western Union Company.
590 | 1 1,006 |	8,425 | 2 20,924 |	5,695 20,226	6,874 | 2 16,343 |	134,278 | 1 270,542 |	1,889 2,317	8,694 | 1 24,822 |	7,143 | 1 20,303 |	3 436 6,295	306,632[1] 1,344,811[2]
134	454	881	503	1,376	32	535	1,866	88	21,666
—	—	—	—	3,526	—	882	—	—	—
134	454	881	503	4,902	32	1,417	1,866	88	21,666
86	226	526	237	2 319	31	370[2]	1,790	70	—
48	226	348	266	2,583	—	1,046	76	16	21,666
—	2	7	—	—	1	1[3]	—	2	—
134	454	881	503	4,902	32	1 417	1,866	88	21.666
4	2	10[2]	35	195	—	4	5	—	21,666
21	288[3]	259	39	555	—	369	95	14	
109	164	612	429	1,569	32	1,044	1,766	74	
134	454	881	503	2,319[2]	32	1,417	1,866	88	21,666
—	—	—	2,782[3]	—	8	—	70	—	—
60[2]	310	557[3]	1,063	4,449	44	548	2,070[2]	108	67,012
—	—	77[4]	17	194	—	—	52	5	8
67[3]	284[4]	449[5]	5,992	156[3]	5	158[4]	164[3]	51	2 287
127	594[5]	1,083	7,072	4,799[4]	49	706	2 286	164	69,307
— [4]	34	90[6]	120	— [5]	2	41	66	— [1]	68
	414[6]	1,195[7]	1,248		53	757[5]	2,405		32 912
	235[7]	1,138[8]	4,819[4]		62	349[6]	134		1,970
—	683	2,423	6,187[5]	—	117	1 147	2,605	—	34,950
23,699	1,152,248[8]	2,427,708	1 561,193	12,364,338	38,501	1,095,091[7]	1,741,018	185,704	56,632,731
1,350	—	—	145,342	—	16,495	—	—	44,153	—
25,049	1,152,248	2 427,708	1,706 535	12,364,338	54,996	1,095.091	1,741,018	229,857	56,632 731
47,113	307,906	832,630	263,327	1,012,449	3,695	361,131	717,962	137,052	1,477,129
44,140	355,797	999,059	225,617	1,030,595	4,217	404,924	723,594	117,327	—
—	1,655	324.401	81,572	185,247	—	285 508	527,184	—	—
91,253	665,358	2,156,090	570,516	2 228 291	7,912	1,051,563	1,968,740	254,379	1,477.129
6 315	17,539[9]	38,156[9]	96,070[6]	1,000 129	3,245	129,063[8]	138,731[4]	35,875	—
122,617	1,835.145[10]	4,621.954	2 373 121	15.592,758	66,153	2,275,717	3,848,849	520,111	58,109,860
Fr.	Fr.	Fr.	Fr.	Fr.	Fr.	Fr.	Fr.	Fr.	Fr.
8 109	1,161,397[11]	1,568,438	1,465,397	47,656.924	55.614	898 344	1,145 068	145,870	98,516,215
41,404	708,980	1,303,455	558,934	9 246 300	25,000	1,160,700	1,449,156	196,812	10 382 005
268	71,297	209,604	644.329	—	—	53 766[9]	120,079[5]	968	3 949,675
49 781	1,941,674	3,081,497	2,668.660[7]	56,903,224	80,614	2,112 810	2,714,303	343,650	112,847,895
— [5]	1,517 042	3,477,497	— [8]	— [5]	— [1]	1,435,987	1,905,308	— [1]	43,069,170
	322,783	1,797.575		6 200,000[6]		423,769	908,636[6]		41.854,210
—	1 839 825[12]	5 275,072	—	—	—	1,859,756[10]	2,813,944	—	84,923,380
—	1,030,850	—	— [8]	3,600,000	— [1]	142,444[11]	63,941	— [1]	—
217,583[6]	2,055,000	4,928,656	5,406,249[9]	120,000,000	1,100,000[2]	4 962,568	2,917,819	1,500,000	74,036 761[3]
2,597	322,520	33,075	160,150	22,434,392	155,000	447,862	41 418	130,000	7,752,810[4]

Germany, but does not include 4,642 kilometres of wire and 16,367 kilometres of wire belonging to the railway companies. (2) Of which 203 are telephone offices where telegraphs may be sent. (3) State office. (4) Also there are 1.606 apparatus belonging to the railway companies. (5) Of which 526 are females; about 100 officials are engaged by the railway companies for telegraphic purposes. (6) With counting the superintendents of the lines on the staff of workmen for line repairs. (7) Of which 158,000 are sent exclusively on the lines of the railway companies. (8) These comprise the meteorological telegrams. (9) Also for the private messages of the railway companies, 191,574fr. (10) Also the railway companies have been paid 140,968fr. for the use of their staff, and 123,117fr. for the rent of telegraph lines. (11) Also for the railway companies lines, 125,010fr.

SWITZERLAND.—(1) Not including 1,704 kilometres of private and railway lines having 11,868 kilometres of wire. (2) Of which 245 are relays. (3) Comprising 1 duplex Baudot and 163 telephones which have replaced telegraph instruments. (4) Service telegrams, of which 58 per cent. concern the home postal service. (5) Not including the increase of capital charges of 99,641fr. (6) Including 64,761fr. interest on capital and the first cost of the wires plus 327,796 as sinking fund, of which 201,324 is an extraordinary charge.

TUNIS.—(1) The postal and telegraph services being united these figures cannot be given.

UNITED States (Western Union Company). — (1) Including 292,162 kilometres of aerial lines, 296 kilometres of buried conductors, and 14,174 kilometres of cables. (2) Including 1,317,528 kilometres of aerial wires, 11,417 kilometres buried, and 15,868 kilometres of cables. (3) Estimated to December 31, 1896. (4) Not including the Indian territory and Alaska.

The Number of Telephones in Use.—According to *Electrical Engineering* of Chicago, the total number of telephones in use in various countries has been tabulated as follows: Province of Angola, 200; Austria, 20,000; Australia, 2,000; Bavaria, 15,000; Belgium, 11,000; British India, 2,000; Bulgaria, 300; Cape of Good Hope, 600; Cochin China, 200; Cuba, 2,500; Denmark, 15,000; England, 75,000; Finland, 6,000; France, 35,000; Germany, 140,000; Holland, 12,000; Hungary, 10,000; Italy, 14,000; Japan, 3,500; Luxemburg, 2,000; Norway, 16,000; Portugal, 2,000; Roumania, 400; Russia, 18,000; Senegal, 100; Spain, 12,000; Sweden, 50,000; Switzerland, 30,000; Tunis, 300; United States, 900,000; Wurtemburg, 7,000. These give a total of 1,402,100.

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THE

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TO CORRESPONDENTS.

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BOUND VOLUMES.

Vol. XIX. of new series of "THE ELECTRICAL ENGINEER" can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.

MAKING FRIENDS WITH MAMMON.

The coming session of Parliament will witness the commencement of an attempt on the part of gas companies to consolidate and confirm their monopolies. The idea is not new. It was suggested in the very early days of electric lighting, and has been advocated in various quarters ever since. We refer to the suggestion that gas companies should obtain provisional orders and become undertakers of electric energy generation, and distribution. In our opinion the movement has come too late, and what was just possible sixteen or seventeen years ago will now be found to be impossible. After the 1878 International Exhibition in Paris those who really investigated the subject saw that, at any rate, electric street-lighting and the lighting of large spaces was not only possible, but was within the bounds of commercial practicability. The Electrical Exhibition in 1881, also at Paris, proved further that internal, as well as external, lighting by electrical means was commercially possible. Then came a false electrical boom, which, if it did nothing else, did two things fairly completely—made the fortunes of a lot of company promoters, and thoroughly frightened a number of people interested in gas. A goodly number of these people have not got over their fright yet, as may be proved by the weekly pabulum served up to them in the journals devoted to their interest. We contend that had the gas companies in those early days immediately succeeding these international exhibitions, and during the boom, entered carefully into the question and attempted to meet the promised competition by preparing to undertake the work themselves, they might have obtained control, and that would probably have delayed electric light progress by at least half a century. The time which has elapsed since then has not been lost. It has really opened the eyes of a large number of municipalities to the evils of any "light" monopoly outside the hands of the authorities themselves. They see it is beneficial to the ratepayers to purvey their own light, and they are acting with great success upon the conclusions formed. Gas companies will as a rule be absolutely unable to obtain control of both systems of lighting. There may, of course, be exceptional cases where the authorities may assist them in gaining control, but even when the representatives of the ratepayers and the ratepayers themselves agree to aid the gas companies, we venture to doubt if the Board of Trade or Parliament will be moved by the most specious reasoning to grant orders. The tendency of the day is to restrict, not to extend monopolies, and we shall be somewhat surprised if the Margate Corporation, for example, is permitted to transfer its order to the Thanet Gas Company, or that an order will be granted to the Tottenham and Edmonton Gas Company.

WATER v. ELECTRICAL ENERGY.

If the arguments brought forward at Shoreditch in favour of electrical power and apparatus for the working of lifts, and, indeed, for general purposes,

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are correct, it is to be regretted that any opposition should have been commenced against the extension of the Hydraulic Company's mains. It seems to us that two questions only present themselves to the business men of a district wherein both hydraulic and electric power are available. Assuming, as at Shoreditch, the hydraulic power is in possession, and is installed in various places in the district. The owners of any such installation will have to consider whether changing from hydraulic to electric power will pay, and those who have no installation are quite free to determine between the two without considering any outlay already made. Few people agree to an expenditure of one or more hundreds of pounds without considering alternative proposals, and if it can be shown, as we believe it can, that the use of electrical power is cheaper and better than hydraulic, almost all, if not quite all, of those who intend to instal one or the other, will decide in favour of electricity. The difficulties and losses in changing from one to the other will no doubt prevent many who have hydraulic lifts from immediately altering their plant. It may be taken for granted, then, if these assumptions are correct, that no hydraulic company would be warranted in undertaking a large expenditure on extension of mains in a district well supplied with electrical energy by the local authorities. This is specially the case, because the intending users, considering the merits of the competing systems, would naturally have a bias towards supporting their own power station. On the other hand, there are some operations where great compressive forces are required in which the hydraulic power possesses advantage. The progressive municipal fathers at Shoreditch, in their ungrounded fears for their electric station, are inconveniencing their ratepayers in preventing the use of hydraulic power in such cases.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ELECTRIC WAVES.

SIR,—I trust you will allow me to correct a mistake in your *résumé* of Mr. Campbell's lecture at the Camera Club on the 22nd inst. It is there erroneously stated that I said during the discussion which followed the lecture *that as Hughes did not understand what he saw, etc.* I beg to say that I said nothing of the kind, but I think someone else in the room made remarks to that effect.—Yours, etc.,

98, Haverstock-hill, N.W., A. STROH.
November 29, 1897.

LEGAL.

Messrs. Sugden and Harford write to us on the question of Magnolia metal, referred to in our correspondence columns on November 19 last. A part of their letter we think immaterial, the only material part being the following:

SIR,—Our attention has been called to a letter in your issue of the 19th inst. Such letter would be unimportant save for one statement, which is calculated to create a false impression, and to injure the business of our clients.

. . . . Mr. Stanley, in his letter, seems to us to be endeavouring to secure for the benefit of this American company the impression that they only are entitled to deal in genuine Magnolia metal. This fallacy has been decided by the decision of both Courts of Appeal in this country, and it is now well known that our clients, the Atlas Metal Company, Limited, are and have been doing business in Magnolia metal, and have the right to do so. . . . SUGDEN AND HARFORD.

THE APPLICATION OF THE STORAGE BATTERY TO ELECTRIC TRACTION.

BY CHARLES HEWETT.

The following abstract of a paper read by Mr. C. Hewett before the Niagara Falls Convention of the American Street Railway Association last October, will be of interest to compare with the Epstein recent paper on a similar subject. This is particularly the case, as figures and facts are given by Mr. Hewett.

The author commenced by stating that to give a history of the application of the storage battery to electric traction would only be turning over dry bones. The long series of remarkable failures is no doubt familiar to all. To say that the storage battery has no place in electric traction is an error, and, on the other hand, to say that it will supplant all other means of applying power to the cars is, he held, only the dream of the enthusiast. We are sufficiently acquainted with the possibilities and limitations of the storage battery of to-day to be able to make installations whose success will be certain. Improvements in manufacture have certainly been made during the past few years, but the cause of past failures has been due quite as much to errors in installation and in manipulation as in manufacture. The most important applications of the storage battery to electric traction are: (1) the application of the battery direct to car or locomotive; (2) the application of the battery at points on the line distant from the generating station; (3) the application of the battery in the power-house.

THE APPLICATION OF THE BATTERY DIRECT TO CAR OR LOCOMOTIVE.

One is led to consider this form of application first, not on account of its successes, but rather on account of its conspicuous failures. From our investigation we can see nothing in this form of installation to commend, except for certain local conditions, which are peculiar to the large cities on the continent of Europe.

The first cost is greater than the present overhead form of construction, and the expense of operation is considerably greater; in fact, it is doubtful whether the expense of operation can be brought below that of horses. It is less reliable and more objectionable to passengers on account of the gas given off. But very little reliable data are obtainable from all the various experiments which have been made. Most of such experiments in America have been made by battery manufacturers, and the results obtained have been most carefully guarded.

In a paper read by the author before the Engineers' Club of Philadelphia, December 5, 1896, he gave in detail results of a test made by him of a certain battery car. The main results agreed quite closely with data from European publications, and he felt confident in stating that the battery car requires considerably more power to operate than an ordinary trolley car of the same size and under the same conditions; and, further, the battery car will require a larger investment in generating machinery. The unreliability of the battery car and the disadvantages due to the necessity of constantly changing the batteries are familiar to all, and there were no facts which would give any hope of improvement in this line. In fact, unless some form of battery be discovered with entirely different characteristics from the lead battery, he would advise leaving such experiments to those who enjoy spending money on this kind of a hobby.

The author proceeded to review the reasons leading him to this conclusion—that the inherent characteristics of the lead battery prevent it competing successfully with the trolley system. Experiments were now being made at Chicago from which great results were expected; but great results had been expected from other sources which had not been fulfilled. It was claimed that the batteries in use

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in Chicago will have a much longer life, but the author did not think that fact would reverse his conclusions.

The author then referred to the Hanover system as follows: In some of the larger cities on the Continent there is a prescribed area within which overhead lines are not allowed. To overcome this difficulty, the cars are supplied with batteries sufficiently large to propel them at a low rate of speed for a distance of three or four miles from the point where the overhead line ends, into the city and return. While the cars are completing the trip the batteries are charged from the overhead wire. The author thought that such an arrangement would not commend itself to any practical railroad manager, except as a makeshift in such government-ridden cities as exist in Europe. The advantages of this method are apparent. Aside from the objection to overhead lines in the centre of the city, there is the marked advantage that the batteries are not removed to be recharged. The author then criticises the arrangements somewhat unfavourably, and says that the extra cost of feeder cables due to the current required for the charging of the batteries and to the extra current required to propel the weight of the accumulators will more than offset any saving in the cost of the line work. He regretted that figures were not to hand as to the working of this system.

The author then gives data as to the details and cost of working of accumulator cars at Paris, Berlin, Vienna, The Hague, and Birmingham. These figures have all been published before.

(To be continued.)

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. The answers to any question should be sent within 10 days after the question has appeared, and should be written on one side of the paper only. Questions may be sent at any time.

QUESTIONS.

16. When counter E.M.F. cells are used to reduce the pressure of supply, in what form is the energy lost?—H. M
17. What are the various methods of running arc lamps from an alternating-current station, and which method do you consider best?—A. BROUGHTON.

ANSWERS.

The large number of answers received to the questions Nos. 11 and 12 makes it exceedingly difficult to select the absolute best. We have been obliged in both cases to make a compromise by bracketing the two best answers as equal and dividing the premium.

Question No. 11.—What is the best way of controlling from a central station the pressure of the supply when a number of feeders of various lengths are in use?

Answer to No. 11 (*awarded* 5*s.*).—There is no best way; the length of the feeder does not affect the question of control—it is the feeder resistance and the current which affect the question. I take it, however, that what is meant is, "What is . . . when the feeders are of such a resistance that the drop of volts in them vary." There are several ways of compensating for this defect, which is undoubtedly one of design if it occurs in a single network lighting station. If there are plenty of feeders, and if the distributors are of ample size, the currents will divide themselves between the feeders in such a manner that the drop of volts will be the same in each, whatever the lengths; the feeders can then be paralleled. This is the ideal method of controlling the pressure. It often occurs, however, that there is more than one network, and they are not interconnected, and on which the characters of the loads are different. For instance, one network may supply a business portion of the town and the other a suburb, or there may be a large day load on one portion and not on another. It then becomes necessary to have a means of compensation for the varying drops of pressure, and the feeders cannot be paralleled at the station. This refers more particularly to low-tension stations, as often with high-tension systems the feeder drop is small and often is not taken into account at all, except to run the volts a little higher at time of heavy load. This is done at the House-to-House Company's station, West Brompton. To compensate for the increased pressure at time of heavy load where the feeders are all paralleled, there is no doubt that, as a rule, the dynamos should be run a little faster. This is not always practicable with water power and with gas-engines, but as a rule it can be done. If now one feeder does not require as much pressure as the others, there are several ways of reducing it: (1) by inserting resistance; (2) by connecting it to the battery at a different place from the rest of the feeders; (3) by using a kind of booster, which in this case does not augment but reduces the pressure, and supplies power to the 'bus bars at the normal pressure; (4) by detaching a dynamo from the 'bus bars and connecting it to this feeder, and so giving it the pressure it requires. All these methods are good, and the best one will vary with circumstances.

1. Resistances inserted are very suitable where the differences of pressure are not great, and where the need for a varying pressure does not occur often. A case in point is when one part of the district requires very little power on Sunday night, say. Where, however, this variation occurs often, a resistance is very wasteful.

2 By connecting the feeder to a different point of the battery the direct waste of power is avoided, but the regulation cells are discharged unevenly. It depends upon the relative size of the battery and the feeder current whether it is advisable to do this. If the current is large, some of the regulation cells may be charged or discharged above the safe rate, and in any case there is a waste of energy when the battery is again charged. The writer has a case in mind where this separate regulation was carried out and where several of the cells were ruined, and the efficiency of the battery was often considerably reduced. If, however, the battery is large compared with the currents in the feeder, very little harm will be done, and by the judicious use of "milking" cells the losses may be minimised.

3. A booster is very suitable where the currents are large, and where the difference of pressure is great. The booster would be a motor connected to the 'bus bars driving a dynamo in series with the feeder. Where the feeder pressure is less than that of the 'bus bar, the dynamo part would run as a motor, and the drop in voltage would appear as current feeding the 'bus bars. Such an apparatus can be made automatic in its action. Where the feeder pressure is required to be above that on the 'bus bars, current is taken from the 'bus bars, and the energy appears as raised pressure on the feeders.

4. By detaching a dynamo from the 'bus bars and connecting it to the feeder we increase the expenses on the head of coal, because the engine load factor is made worse—*i.e.*, we cannot keep this engine running at its economical load, as the load is fixed for it by the current in the feeder. This disadvantage is often a great one, and there are few cases where this separation of the plant is justified.

It is thus evident that there is no *one* "best" method of contrast for every case.

If there are a number of feeders requiring varying voltages, no doubt it would be better to keep the 'bus bar volts near an average, and use boosters on each feeder. It must be remembered, however, that the need for such separate adjustment is preventable if the distributing networks can be connected together, and if the characters of the load centres do not vary greatly for the different districts.—W. FENNELL.

Answer to No. 11 (*awarded* 5*s.*).—The best way of regulating the pressure in alternating-current feeders is not necessarily the best for continuous-current feeders, so that each system must be considered separately. There are several ways of regulating or controlling the pressure in continuous-current feeders: (1) By raising the pressure of the 'bus bars to that required for the feeder with the

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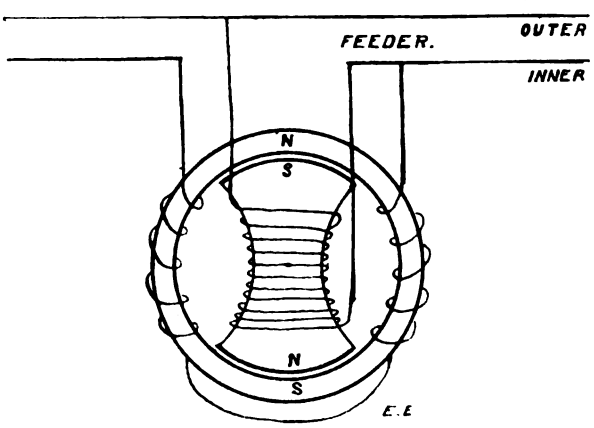
largest drop, and reducing the pressure on the other feeders by putting resistances in series with them. This means a loss of power, for the pressure has to be increased for all in order to decrease it again on some. (2) By using accumulators instead of resistances, in series with each feeder, arranged so that their E.M.F. opposes the E.M.F. of supply. The accumulators may be replaced by cells having simple lead plates immersed in acidulated water. (3) By making the cross-section of each feeder such that the drop of pressure is the same for the same relative loads, whatever the length of the feeder. Then if the loads on the feeders vary equally, altering the 'bus bar pressure will equally affect each. If the loads do not vary equally, then it is possible to cut off the feeder which is at the highest potential at the feeding point, and allow that portion of the network to draw current from the other parts. It is not always advisable to increase the copper of the mains to ensure the same drop in all the feeders, so the following method may be adopted: a reasonable drop may be allowed in the longest feeder, and then permanent resistances or back E.M.F. cells may be put in series with the other feeders to make the drop in them the same. It is best to keep to Kelvin's law as a basis for the calculation of the cross-sections of feeders. (4) By the use of motor-generators or "boosters." The dynamo side of the booster, which is series wound, is connected in series with the feeder, whilst the motor is connected as a shunt to the mains. The 'bus bars may be kept at a constant pressure—viz., that required for the feeder with the lowest drop—and the increase of pressure given by the various boosters arranged to suit the drops in their respective feeders. If they have all the same drop for the same relative loads, they can be connected to the network and thus balance themselves according to their loads. If any regulators are used to independently control any feeder, the network must be separated and each feeder must serve its own network.

In regulating the pressure on alternating-current feeders the following are some of the methods: (1) as in continuous current, by putting in resistances; (2) by using choking coils, which serve a similar purpose to that of the back E.M.F. cells of (2) above; (3) by making the cross-section of the feeders similar to (3) above; (4) this is a "boosting" method. There have been several arrangements tried by various persons by means of modifications of ordinary transformers, but they have not appeared to be satisfactory. The one which answers the best is the "regulating transformer" of the Edison and Swan Company. The main current flows through coils wound on a ring-shaped core, whilst a shuttle-shaped core is magnetised by a coil which is a shunt to the feeders. The shuttle is rotated within the ring through an angle of 90deg., which gives a variation from maximum effect to no effect. Thus a pressure can be added to the feeder pressure, or by rotating in an opposite direction a pressure can be deducted. The same considerations with regard to networking apply in this case as in continuous-current work. The best method seems to be (3) for continuous and (4) for alternating current feeders.—T. A. LOCKE.

Answer to No. 11.—Feeder regulation is one of the vexed questions in current distribution for electric lighting. The Board of Trade allow a variation of pressure at the consumer's terminals of 4 per cent. from the declared pressure of supply, and to keep within this maximum some system of regulation of each feeder is necessary. In designing a system of distribution the feeders are generally arranged to be of the same resistance, although they may vary greatly in length, in order that there will be the same drop of pressure in all of them when each is carrying equal load. But in practice it is very seldom that the load on the distributing mains, whether they are interconnected in one network, or each feeder is arranged to supply a separate network, adjusts itself so that equal current is flowing on each and all of the feeders at the same time. You can regulate the pressure on the distributors by feeder regulators when the network is split up into sections, each fed by a separate feeder direct from the station. But if the distributing mains are all interconnected in one network, and fed by several feeders, it is impossible to so regulate the pressure on the feeders that the voltage all over the network shall be equal. Suppose a heavy demand occurs in the neighbourhood of a feeding point, more current would be drawn from that feeder, with a consequent fall of pressure. You now increase the station pressure on that particular feeder, or reduce it on the other feeders, with the result that more current then passes on that feeder and less on the others. In fact, current is taken from the feeders which are lightly loaded and thrown on to that which is already heavily loaded, and the ultimate result is that the pressure at the feeding points of the lightly-loaded feeders increases nearly in the same proportion as the increase of pressure at the feeding point of the heavily-loaded feeder; and consequently there is very little improvement in the variation of the voltage over the whole network. In continuous low-pressure systems, the switching apparatus is generally arranged that any feeder can be plugged on to any machine and run separately at any desired pressure. Another method of regulation in use is the switching in circuit with the feeder of a number of back E.M.F. cells, the number depending on the amount of reduction of pressure required. No system of feeder regulation is of much use on very large systems, and the regulation of pressure has to be done on the network itself by motor-transformers. On high-pressure alternating-current feeders the percentage drop of voltage is not so large as in low-tension feeders, and therefore feeder regulators are not often used. However, there is sometimes considerable variation of pressure over the distributing network, due to drop in transformers, as well as loss of volts in the feeders, which ought to be adjusted. For this purpose adjustable choking coils have been used, but are not to be recommended on account of their wastefulness. The most efficient feeder regulator is an adjustable transformer placed in circuit with each feeder. The secondary winding of the transformer is in series with the feeder, and the primary winding connected in shunt across the feeder. The primary is wound on a movable shuttle core, and its position relative to the secondary winding determines the E.M.F., which is added to the initial pressure of the feeder. The following sketch



shows the arrangement of a regulator which is due to Mr. John H. Rider. The primary winding is shown in the position of maximum effect, and when in the position of least effect the core is horizontal. If the core is rotated beyond the horizontal with like poles approaching, volts will be subtracted from instead of added to the feeder volts. The regulators should be designed to add about 5 per cent., which is equal to a range of 10 per cent., sufficient for all ordinary purposes.—JOHN PILLING.

Question No. 12.—Detail the various losses of electric energy which occur between the 'bus bars in a central station and the consumer's meter with the various systems of supply. How can these losses be reduced, and how far is one wrong in considering the maximum loss as an indication of the disadvantage of any system?—H. M.

Answer to No. 12 (*awarded* 5*s.*).—This is a very wide question, and open to considerable argument. In the low-tension continuous-current system, the principal loss is due to ohmic resistance in the feeders and distributing mains. The feeders are usually designed for a loss of about 18 per

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cent. at full load, and the distributing network must be arranged for a loss at full load of 5 to 6 per cent. in order to meet the Board of Trade requirements as to variation of pressure. There is also a small loss in the consumer's cut-out meter and demand indicator when used, but this loss is incidental to all systems, so need not be taken into consideration when comparing the losses in various systems.

In the high-tension continuous-current system from the 'bus bars to the consumer's meter there is the ohmic loss of the feeders, which may be designed for any particular loss (say, 4 or 5 per cent.) at full load. The loss in motor-transformers is a serious item, as all the current has to pass through them before being supplied to the private consumers. The current for battery-charging has also to be taken from the transformers, thus necessitating a double loss. The motor-transformer is rather inefficient compared with the alternate transformer, which has made it the greatest drawback to this system of supply. There are also the network distribution losses, as in the low-tension system. This system of distribution as a whole is low in efficiency, as is shown by Prof. Kennedy's 24 hours' test at Oxford in December last, which gave 63·7 per cent. total efficiency, and the unit efficiency of the battery, including booster and resistance losses, was 69·4 per cent. The only course open to reduce the resistance losses of the conductors is to increase their sectional area, but it is not economical to increase the area beyond the point when the cost of the units wasted exactly balance the interest on the additional value of the increase of sectional area, added to the increased expense incidental to laying of the conductors. The heavy losses in the motor-transformers of direct-current high-tension supply can only be minimised by using the most efficient machines in the most economical sizes for the work required to be done, and by switching them in and out of circuit as the load varies in order to secure the very highest load factor. The percentage loss in the batteries depends largely on the treatment they receive.

In the alternating system there is the feeder ohmic resistance loss, which is usually arranged to be about 5 per cent. When a secondary system of mains is used, the same loss practically occurs in them as in a direct-current supply. Transformer losses must also be considered. The light-load loss in well-designed transformers over about 12 kw. should not exceed 1 per cent. of their capacity, and the full-load losses 3 per cent. Induction losses appear with alternating currents, but in a system of well-selected mains this should be absent. There is also a disadvantage in alternate over direct current systems, which results in a loss, though it may not be a direct loss, and that is in the lag of the current behind the E.M.F. It varies with the amount of apparatus on the mains, having self-inductive circuits, such as motors, arc lamps, choking coils, etc. The effect is that often large wattless currents are taken from the mains, thus loading the plant and mains unprofitably. To reduce this wattless current to a minimum, the induction in the mains and apparatus on the circuits must be kept as low as possible. For example, from the station engineer's point of view, it is much better to use non-inductive resistances instead of choking coils for arc lamps. In concentric mains, which are generally used for alternate currents, electric capacity losses appear. But capacity may be looked upon more as an advantage than a disadvantage, as the losses do not cause a drop of pressure, but rather an augmentation of the E.M.F. at the far end of the cables; besides, the use of concentric cables enables the switching gear to be considerably simplified.

The amount of loss in an alternating system depends chiefly on the method of transformation in use. If house transformers are used largely, there will be a considerable all-day loss on account of the low total load factor of the transformers, as well as the lower efficiency of small as compared with large-size transformers. The way to reduce losses to a minimum is to employ wherever there is sufficient demand transformers of not less than 12 kw. capacity, banked in transformer pits or sub-stations, and feeding on to low-pressure distributing mains. It may then be also found practicable to switch transformers out of circuit when not required.

It is impossible to determine the merits of one system over another by their losses, as a particular system may be especially suited to one town or district and quite unfitted for another. You must consider the character of the demand in deciding upon any system. Take a town in which a considerable motor and arc lamp demand is sure to crop up, and it would no doubt be best to adopt one of the continuous systems, in spite of the fact that you may have much greater losses in the one selected. One important feature in alternating systems is that the losses are not so great when the plant and mains are fully loaded as in other systems, but that the light-load losses are considerable. This is an advantage in one sense—viz., that the whole system is working more efficiently at the time of maximum load, whilst there is a disadvantage, more particularly in small stations, in not being able, without the outlay of considerable capital, to supply the light-load demand by means of batteries and motor-alternators. In some alternating stations of comparatively small size a minimum load of, say, 10 amperes at 2,000 volts is usual, at light load, due to losses in transformers, mains, etc., and to deal with this current by means of batteries becomes a rather expensive affair.

The whole question seems to depend on the adaptability of a system to the area it has to supply. If a system is adopted which best meets the demand, and thus gives the greatest satisfaction to the consumers, it is certain to turn out the most successful in the end.—JOHN PILLING.

Answer No. 12 (*awarded* 5*s.*).—The form of this question definitely limits the question to distribution, and therefore excludes the questions involved to the comparison of continuous-current and alternating-current systems, such as loss in batteries at the central station.

There are two systems of supply: (1) the direct; (2) the sub-station system. The losses in the first-mentioned are confined to resistance losses where the current is continuous, as it always is. The loss of energy in such a case is proportional to the current squared and the resistance of the cable. Thus it is obvious that, as the energy is fixed, the only way to reduce the loss is to reduce the resistance or increase the pressure. The amount of resistance allowed in such stations is usually such that the loss of pressure in the feeder does not exceed 20 per cent. When a higher voltage—say 200-volt system—is used, the loss is often reduced to 10 per cent. The amount of loss allowed in the mains depends upon the value of capital sunk on them as compared with the value of the energy lost in them. For instance, a local authority should have larger mains than a company, because it can obtain capital on better terms. With a three-wire system the losses between 'bus bars and the meters follows similar laws, but there are other losses due to balancing transformers and other arrangements which are usually considered outside the distribution question. However, if a balancing transformer is used, there is a constant loss of units in turning it and exciting its fields going on all the time. The units lost in the daytime are not so valuable as those in the evening. In comparing direct systems of supply, the loss at maximum load is, excluding the question of the balancing transformer, a fair method if the load factors in the two cases are similar. The effect of a better load factor is to make the loss of units greater than if it is worse, the maximum being the same. It is therefore important to have a less percentage drop if the load factor is good. In this case, then, we are wrong in comparing two systems by the maximum percentage loss to the same extent as the load factors differ. It must, however, be remembered that a small loss in the mains does not mean a good system, if the value of the units saved does not pay the interest on the extra capital involved.

The sub-station system may be divided into two branches—the low-tension direct and the high tension. In the first case, accumulators are placed in sub-stations, charged at times of light load and discharged at times of heavy load. The losses in such mains and system are the resistance losses, and the waste of energy in the accumulators. The effect of such a system is to render the plant at the central station much smaller; the feeders to these batteries and the low-tension network can be smaller, and the load factor of the engines may be increased. This

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system would increase the total losses in the mains, probably, but would decrease them at full load, as there would not need to be the extra plant provided for the units lost in the mains at full load, as is the case with the simple low-tension direct. The losses in such a system would occur at times when units were not valuable, so the loss at maximum load could not be any guide to the value of such a system. The value of such a system would, as in all others, depend upon interest on capital saved by its adoption and the value of the units wasted in it. The losses can be reduced by keeping the charging current uniform, so improving the load factor and by using efficient accumulators and attending to them carefully. The high-tension sub-station system involves the use of transformers to change the pressure from the high one to that declared for the consumers, or, at least, a low pressure. These transformers involve a continual waste of energy when running. By their adoption, however, the loss of energy can be reduced, and so can also the size of the mains, by the use of high-pressure feeders. The losses consist of those due to resistance in mains and to running losses in transformers. The first-mentioned losses can be reduced in this system, as in all the others, by increasing the pressure, in this case the primary pressure only. The running losses in transformers can be reduced by sub-dividing the transformer units and adopting switches, automatic or otherwise, which will keep the number of transformers running proportional to the load. The idle turning or running of transformers will be reduced. This can, in the case of a continuous-current system, be further reduced by the use of accumulators for the day load placed in sub-stations, thus confining the use of the transformers to times of fairly heavy load. In the case of alternating currents the losses can, in addition to the use of automatic switches, be reduced by lowering the periodicity at times of light load. This system has the great fault that if we are to consider a central station as a serious concern, we must admit that a fixed periodicity is necessary, and almost as necessary as a fixed secondary voltage. However, it is claimed that this reduces the hysteresis losses in the transformer by reducing the cycles per second, and reduces the speed, and consequently the engine losses. However, it is a scheme which is dead. The proper way to reduce the losses is by switching off transformers, and by using large and efficient ones in sub-stations. The losses in the high-tension alternating-current systems are (1) resistance; (2) the effect of self-induction in increasing the loss by introducing "wattless current"; (3) the resistance losses in the primary and secondary of the transformers; and (4) the eddy currents in the iron and copper; (5) the hysteresis loss and no doubt the drop of pressure due to induction of the primary missing the second, which, if not directly a loss of energy, causes a loss indirectly, as the iron has to be made heavier, the primary turns increased, and losses incurred under both these heads. There is then the copper losses in the secondary. Most of the losses are reducible, but at the expenditure of considerable capital.

Speaking generally, the losses at full load give very little idea as to the value of any system. The cost of the units wasted must be balanced against each other in systems to be compared, and due regard taken of the load factors, the capital outlays involved, and the interest on this. For the direct current the cost of mains and plant required extra at full load is only taken, and for the transformed or sub-station system the cost of mains, plant, transformers or accumulators, switches, etc. The sum of cost of units lost plus interest on capital is, for all systems, a fair figure of demerit or merit.—W. FENNELL.

Answer to No. 12.—In a continuous-current system the chief losses are in the distributing mains and feeders, the copper loss to remote districts often amounting to 10 per cent. If all the machines are run in parallel on one set of 'bus bars, and the E.M.F. regulated by back E.M.F. cells or resistances, a large loss will take place in these regulating devices, the voltage on this system being about 120 volts on 'buses for 110-volt supply, and a loss of 10 per cent. will consequently occur on every unit sent out from the station. A more modern practice in large stations is to have several sets of bars with a difference of several volts between each set, and the feeders plugged on to the bars giving the required voltage. In the daytime all bars are paralleled, enabling one or two engines only to supply the load, and simplifying the working of the station. Another loss is the leakage between the mains, this, where bare copper is used, being very large—sometimes several per cent. if the weather be very wet. The practice of supplying 220 volts to consumers enables a very large saving to be effected, and with a three-wire system and 440 volts on outers the losses are in every way greatly reduced. For a given supply of energy and amount of copper in the mains the losses are reduced to one-fourth, as the current is halved, which reduces the volts lost by one-half, and this loss is again halved by the ratio it bears to 440 volts against 220. Rubber cable, armoured or enclosed in pipes, will almost entirely do away with all leakage. In alternating systems supplying direct to transformers on the consumers' premises the chief loss is in the small transformers, which are always in circuit, and give a big all-day load. Most of these stations are now being altered to a sub-station system, where large transformers feed into a low-tension network. By this means only the transformers needed to supply the actual power required are kept in circuit, but the greater saving is in the much larger efficiency of large transformers against small ones. The main points in effecting a saving in the outside circuits, and which affect the station working, are ease of regulation and the number of machines required to supply the power. If separate machines are run on each pair of feeders, the loss due to the machine being under-loaded will more than counterbalance any saving in the mains. It is also most necessary to keep the capital expenditure low; economy can always be effected by a big outlay in copper. The main point is to reduce the all-day loss. A loss occurring during a few hours only of heavy load is of little matter if the regulation of the voltage at distant points is not affected, but the loss due to a large number of transformers in circuit for the whole 24 hours may be, and sometimes is, 15 per cent. of the maximum load; and this, when totalled up, is nearly one-third of the whole output for 24 hours.—ADRIAN JONES.

FORTHCOMING EVENTS.

The following are some of the announcements for the forthcoming week:

TO-DAY (FRIDAY).—Institution of Civil Engineers, students' meeting, 8 p.m. ("Permanent Way: its Construction and Relaying," by Mr. Grote Stirling, Stud.Inst.C.E.).

SATURDAY, DECEMBER 4.—Holloway College (at the House of the Society of Arts), 11.30 a.m., conference.

MONDAY, DECEMBER 6.—Society of Arts, John-street, Adelphi, Cantor Lecture, 8 p.m. ("Guttapercha," by Mr. Eugene F. A. Obach, Ph.D., F.C.S.); second of series of three.—Royal Institution, Albemarle-street, Piccadilly, general monthly meeting, 5 p.m.—Society of Engineers, Royal United Service Institution, Whitehall, 7.30 p.m.—North-East Coast Institution of Engineers and Shipbuilders, at Literary Society's Hall, Sunderland, 7.40 p.m. (general business and paper on "The Theory of the Centrifugal Pump and Fan," by Mr. C. H. Innes, M.A., Cantab).—Imperial Institute ("The Mineral Resources of British Columbia and the Yukon," illustrated, by Mr. A. J. McMillan), 8.30 p.m.

TUESDAY, DECEMBER 7.—Institution of Civil Engineers, Great George-street, Westminster, ordinary meeting, 8 p.m.; paper to be further discussed ("On the Law of Condensation of Steam," by Messrs. Hugh L. Callendar, M.A., F.R.S., and John T. Nicholson, B.Sc.).—Röntgen Society, first ordinary general meeting, 11, Chandos street, at 8.30 p.m. ("Adjustable X-Ray Tubes," by Mr. A. A. Campbell Swinton).

WEDNESDAY, DECEMBER 8.—Society of Arts, John-street, Adelphi ("The Mining Metallurgical Industries of Sweden as shown at the Stockholm Exhibition of 1897," by Bennett H. Brough).—Institution of Electrical Engineers, 28, Victoria-street, S.W., students' meeting, 7.30 p.m. ("Asbestos and the Use of Asbestos in Electrical Engineering").

THURSDAY, DECEMBER 9.—Institution of Electrical Engineers, annual general meeting, at 8 p.m., at Institution of Civil Engineers, Great George street, Westminster (members and associates only).—Finsbury City and Guilds Technical College, Leonard-street, City-road, E.C., 8 p.m. (Mr. Philip Dawson on "Electric Traction").

FRIDAY, DECEMBER 10.—Institution of Junior Engineers, at the Westminster Palace Hotel, 8 p.m. ("Main Engine Auxiliaries in the Mercantile Marine").

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PHYSICAL SOCIETY.

At the ordinary meeting of this society on November 26, Mr. Shelford Bidwell president, in the chair,

Mr. Rollo Appleyard read a paper on "**The Failure of German-Silver and Platinoid Wires.**" The mechanical defectiveness, and the consequent electrical instability of alloys used for electrical wires, may be discussed from two points of view—(1) as to the constitution and metallurgy of the alloy; (2) with regard to the subsequent treatment and environment of the wire. In stating the case, the author gives instances of the failure of German silver and platinoid wire that have occurred among several thousands of resistance coils distributed over widely different latitudes. In periods of time, varying from six weeks to several years after manufacture, the wire on some of the bobbins became brittle, and broke, not only on the outer layers, but also within the coils. The towns where the faults appeared are all within the tropics, and included nearly within the isotherm of 25deg. C. Other coils, of nominally the same material, manufacture, and environment, have retained their original good condition. It follows that metallurgical differences exist between different samples of the same nominal quality of alloy. Examples are given to prove that failure sometimes occurs with platinoid through which no electricity has passed. Provided that the wire is good, the effect of environment is almost insignificant—*i.e.*, the question is one of metallurgy rather than of instrument making. The author introduces a distinction in regard to brittleness. He discriminates between 'primary" and "secondary" brittleness. "Primary" brittleness is characteristic of certain alloys—for instance, of gold-lead or of gold-bismuth—from the moment of their solidification. But the brittleness of German silver and of platinoid is of a different order; it is a subsequent phenomenon. "Primary" brittleness is thus an accident of birth, and 'secondary" brittleness is a disease that develops with age and circumstance. The fracture of bad specimens of German silver and platinoid shows patches of dark metal, crevices, and fissures. It may be supposed that during the process of cooling, "liquation" occurs—the metals that first solidify rejecting yet molten portions, as ice rejects foreign matter. Consequently, the strength of the final alloy varies from point to point of its mass, and in passing afterwards through the die the weaker portions give way, and the general structure is loosened. Moisture can then intrude through the capillary channels. At all fissures and crevices the electric current produces undue heating; this accounts for the failure of resistance coils on arc light and other circuits As regards the protection of coils against moisture, paraffin wax is of no use whatever; it is highly absorbent. Shellac varnish is greatly to be preferred. Ebonite does not seem to have any deteriorating effect, but it may be well to keep the alloys out of actual contact with it. In conclusion, Mr. Appleyard expressed a hope that British metallurgists would give electrical alloys special consideration Already British cable manufacturers are importing thousands of tons annually of sheathing wire from Germany; this is sufficiently to be regretted. He had good reason to know that instrument makers were beginning to get the wire for their resistance coils also from Germany. He had not enough experience of manganin to say whether that material would stand rough service in the tropics.

Prof. Ayrton said the paper had raised the extremely interesting question of the permanency of metals used for resistance coils Some time ago he had immersed bare platinoid wires in running water in metal tanks, and the wires all broke into short pieces. He thought at the time this might be due to electrolysis. On another occasion he had found that by raising the temperature of platinoid to a dull red heat in the air by an electric current, any acquired faults in the wire were corrected, and the original resistance and flexibility were restored. Even when such metals are in good condition the resistance-temperature curve does not return upon itself: it encloses a loop, indicating two distinct values for resistance at each temperature. He had been told by Dr. Muirhead that coils intended for hot climates should be enclosed in airtight metal cases English manufacturers were still dubious in regard to manganin. In 1892 he had 20 coils of this material, each of 1,000 ohms; the wire was silk covered. There were 2,000 volts between the terminals. Their resistance had certainly not changed by 1 in 1,000, although there was some amount of vagueness regarding the fifth figure, which might be due to molecular alteration, for they were heated more than was good for resistance coils. He confessed that this manganin had come from Germany.

Dr. S. P. Thompson mentioned an alloy that was proposed in Germany under the name of "Constantine." He would like to know whether any information could be obtained as to the employment of cast-iron wire. It was a metal that in some respects commended itself. He had observed the failure of some German-silver coils, but he had generally attributed it to rough handling.

Mr. W. Watson referred to the recent work done at the Reichsanstalt with regard to German silver and platinoid. It was there found that all alloys containing zinc were liable to erratic change of resistance, and were unsuitable for standard coils. Moreover, even the slight amount of zinc introduced into manganin during soldering with soft solder robbed that alloy of its constancy. Silver solder containing 75 per cent. of silver should be employed for manganin. If Prof Ayrton's coils were soldered with soft solder, that was sufficient to account for the change in the fifth figure. Shellac varnish was undoubtedly the best protection for coils. Absolute alcohol should be used as the solvent, and the coils should afterwards be heated for some hours at 140deg. C. If a heating current was passed through German-silver or platinoid coils immersed in water, the general result was to produce brittleness. Mr. Watson then described a thermostat which he had contrived for drying the coils after applying the shellac varnish. A hot-air oven contains a thermometer with a platinum contact at the 140deg. mark and an 8-c.p. lamp. The thermometer is in circuit with a relay actuating a mercury key for the 8-c.p. lamp. The key consists of two mercury-cups and a corresponding U-piece of copper, inverted, one limb to each cup. It is important to keep the heating circuit always made; for this purpose a 32 c.p. lamp is permanently connected between the two cups.

THE DISTRIBUTION OF ELECTRICAL ENERGY.*

BY C. H. WORDINGHAM, A.M.I.C.E., M.I.M.E., M.I.E.E., CITY ELECTRICAL ENGINEER, MANCHESTER.

(Concluded from page 694.)

It may not be out of place here to say a few words as to vulcanised indiarubber. There are laid in Manchester some 80 miles of single conductor in which this material is exclusively used, 15 miles of which has been at work for over four years, so that the author has had some experience of it. There have undoubtedly been a fair number of instances in which it has failed, but in all these cases the damage has been local—that is to say, there is no evidence of a general deterioration of the cable; it has merely failed at one particular point, and the failure appeared to be due not to the rubber, but to the way in which it is laid. The author has before expressed himself as averse to drawing-in systems. These cables are drawn into pipes. In many cases they were drawn in one after the other, though for some considerable time the author has made a practice of drawing all five in together. It is impossible to ensure that the interior of a pipe shall be absolutely smooth, and if there be a slight obstruction, the men drawing in cannot feel the extra pull on the cables, and great damage may be unconsciously done. A pipe laid underground cannot be kept perfectly dry, and water will occasionally find its way in, the cables being thus alternately wet and dry, which is very destructive. Mechanical damage may readily arise from the rope used to draw in other cables, and rats may enter the pipe and gnaw the cables. In one instance the author found a considerable quantity of nibbled rubber in a pipe, the rat having apparently gnawed it because it was an obstruction, and not for gastronomic reasons. The most fruitful source of danger, however, has been observed by the author to be caused by cement. Wherever a vulcanised rubber cable is in contact with Portland cement and moisture, it will almost certainly fail. The author has had a good many cases in which a rubber cable passing through a glazed earthenware pipe, fixed into the side of a brick box with cement, has been attacked just at the mouth of the pipe. Large masses of salt have formed, and in several cases a considerable quantity of metallic sodium has been found. The author believes that with the exception of a few cases, not more than half a dozen, all the failures of rubber cable which he has experienced are to be accounted for either by the presence of cement, by a sharp edge or projection in the pipe, or by other mechanical damage. In connection with rubber cables, it is interesting to note that vulcanised joints have been employed in Manchester in all cases, and in no one instance has such a joint failed.

It would be tedious to describe all the kinds of insulated cables made. Whatever may be the insulating material, the author would lay the cable on the solid system so as to preserve it from attack. Whatever the material, the specification should prescribe a definite insulation resistance depending on its nature, and in addition certain mechanical tests. The so-called "bending test," first introduced by the author in a specification of his in July, 1895, is a useful one. It consists in bending a sample piece of cable backwards and forwards several times round a drum of small diameter, then immersing the cable in water, and finally breaking it down under pressure. A certain ultimate dielectric strength should be settled on for each material. Stretching tests should also be included for such materials as rubber. A form of built-in system, which has met with a great deal of favour, consists in enclosing the cable in steel armour, either in the form of stranded wire or of ribbon. This iron is then lightly braided over, and the cable laid directly in the ground. In spite of its having been largely adopted in many towns, the author cannot feel any confidence in the durability of this system. It appears certain that the steel must be attacked in the course of a few years, and the cable is then subject to the action of all kinds of soils. That this disadvantage is being recognised appears certain from the fact that it is becoming the practice to lay such cables in a wooden trough, and to run them round with pitch or some similar material, thus practically coming to the solid system advocated above.

In main-laying, great care should be paid to details. Thus the cables should all be laid on a definite plan, cables of the same polarity should always be to the right when looking down

* Paper read before the Northern Society of Electrical Engineers.

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the main with the back to the station, and when this rule cannot be applied, the same pole should always be next the buildings. If a drawing-in system be employed, the cables should be differently coloured throughout their length, or two may be of one colour, one being braided, the other taped. Again, the ends of all the cables of the same polarity should be painted the same colour, a different colour being selected for each pole. Among other details, one of great importance is the treatment of the ends. The author has found the best way to avoid surface leakage is to pare down the insulation for 3in. or 4in., and the braiding or lead for a couple more; pure rubber strip is then tightly lapped round from the conductor to a point 2in. or 3in. over the braiding—*i.e.*, for a length of 8in. or 9in.—this rubber is then painted over with anti-sulphuric enamel of appropriate colour. Immediately a cable is laid, the the ends should be sealed until it can be treated as above, for if water be admitted to the interior, it may do great damage, even if the dielectric be waterproof. Intimately associated with mains are junction boxes. These should always be well ventilated, and the lids left loose. The former course will tend to prevent an explosion, and the latter to diminish its destructiveness if it occurred. It is very difficult to make a lid watertight, and apart from this, a packed lid takes time to open in case of emergency; in the author's judgment it is best not to attempt the exclusion of water, but to let it get in and drain it away. A ventilated cover, as devised by the author, in use in Manchester, will be found described in the appendix. Junction boxes should always be drained except in very sandy soils, and plenty of room should be allowed in them. It is a great mistake to endeavour to make them small, the extra space costs little either for excavation or building, and the advantage in point of convenience and safety is great. Balancing sub-stations naturally call for attention when speaking of junction-boxes. They are most conveniently constructed under the footpath. They should be well lighted, and means should be provided for readily bringing in plant and removing portions for repair. It is essential that they should be absolutely fireproof, and it is advisable to maintain a slight pressure of air within them in order to obviate any risk of the entrance of coal-gas, or of noxious vapours from the sewers or soil. The construction adopted in Manchester will be found fully described in the appendix.

The following is a summary of the distributing mains laid in Manchester up to the present time. The size of the main is reckoned by one of the outer conductors, hence the lengths given are the actual main and not single conductor, some of the mains being five-wire ones, others three-wire, and a few two-wire, as will be seen from the particulars:

LENGTH OF DISTRIBUTING MAINS LAID IN MANCHESTER.

Five-wire.				Four-wire.			
½ sq. in.	¼ sq. in.	⅛ sq. in.	1/10 sq. in.	½ sq. in.	¼ sq. in.	⅛ sq. in.	1/10 sq. in.
Yards.	Yards.	Yards.	Yards.	Yards.	Yards	Yards.	Yards.
1,7461	16,555	8,103	180	—	128	285	70
Three-wire.				Two-wire			
897	4,314	4,978	820	—	—	2,354	—

Total length of distributors, 31 miles 1,585 yards.

With the exception of those laid at the initial stage of the undertaking, these mains have all been put down by the Corporation's own workmen, under the personal supervision of the author, and in his opinion this is by far the wisest course, as not only is there a better chance of securing good work in this manner, but the men who have subsequently to maintain the mains are familiar with them, and know exactly where to look for weak points should trouble arise. The author has purposely refrained from giving the cost of the various mains, partly because they are nearly all five-wire ones, and the figures are therefore not applicable to other towns, partly because it would involve publishing contract prices, which is contrary to the practice of the Manchester Corporation.

The subject of mains may now be left and attention drawn to service lines. It is necessary to have these very flexible, as they have frequently to be taken round corners, and often some little distance into a building. It is further desirable to be able to draw in additional cables in the event of subsequent extension by the consumer. The author first tried rubber cables in wrought-iron pipes. The objections to this system are (1) its extreme awkwardness if there are many bends; (2) liability to destruction of the pipe in certain soils; (3) dangers of cables being cut by the edge of the pipe; (4) establishment of connection between consumer's premises and main pipe or culvert, allowing bad smells to enter house.

In certain cases where no bends were required, cast-iron pipes were used, thus getting rid of the second objection. In both cases the cables are liable to be attacked by the cement at the end of the pipe.

The next system tried was rubber-covered cables, armoured with two steel ribbons, and drawn into a common earthenware pipe. This was a great improvement, as it allowed a much neater job to be made inside the premises, and obviated the second and third objections to the first method. The armour was also some protection against the action of the cement. Both these systems admit of additional cables being drawn in except when there are many bends.

The third system, and that now exclusively used by the author, is armoured rubber cables laid solid in bitumen in wooden troughs with cast-iron covers. This is described fully in the appendix. This system appears as near perfection as possible, the only drawback being that additional cables cannot be drawn in. This, however, merely necessitates the cutting of an additional hole in the wall, not a serious matter in comparison with the advantage of a system free from all the drawbacks named above. The distributing system ends with the service cut-out and meter. These cannot be too simple, and, above all things, it is desirable to have uniformity.

The cut-outs used in Manchester will be found described in the appendix. They have proved very successful, are cheap, give very high insulation, and all classes of services can be dealt with with only three patterns, all very similar.

With regard to meters, it is well to choose one pattern, and to keep to it. Nothing is so confusing or so wasteful of time as to have a number of different types, especially when an instrument has to be changed. By keeping to few types, it becomes possible to standardise everything, even to the boards for supporting cut-outs and meters. Samples of these are in the room.

In conclusion, the author cannot but feel that he has trespassed greatly on the time and patience of the members of the society. He has endeavoured to express his own individual opinion on several controversial subjects, and he trusts there will result an animated and instructive discussion which will to some extent atone for his tediousness.

HYDRAULIC POWER v. ELECTRIC POWER AT SHOREDITCH.

The Shoreditch Vestry at a recent meeting decided to refuse the London Hydraulic Power Company permission to extend their mains in the parish. The reasons and arguments adduced in the debate are worthy of reproduction, and for them we are indebted to the *Hackney Express*.

The resolution in question was moved by **Mr. H. E. Kershaw**, chairman of the Lighting Committee, who said he felt great pleasure in opening a fair and honest debate on a big question of principle and privilege from a Progressive point of view. His first reason for doing so was the ignorance of the ratepayers and users of power generally as to the relative value of electric energy compared with hydraulic power. While the latter was generally in use and had had a life of 40 years, electrical energy for motive purposes was of comparatively recent birth; only of late years systems had been put down to enable users of power to utilise electric current. His second point was that the growing tendency of progressive municipal opinion was to prevent vested interests controlling the necessities of life. Thousands of pounds were being taken out of the parish every year through a privilege granted by the Vestry in September, 1896, for which they did not receive a penny piece. That was reasonable, because the Vestry were not then in a position to supply power, and consequently ought not to refuse ratepayers a necessity in the working of their businesses. The Vestry were now in a position to supply electric power, and they had their own electrical lifts working, as well as two or three others in the neighbourhood. It had been conclusively proved that electric power was best and cheapest for the purpose. One of the largest power companies in the world, the Otis, had commenced to supply electrical cranes; and from a paper read before the Institute of Electrical Engineers he found that the cost of current at 4½d. per unit to drive an electric lift came to £19 or £20 per annum, while £47 was the cost of a hydraulic lift under similar conditions and doing the same work. The charge at Shoreditch being only 2d. or 2½d. a unit for power, these figures could be reduced by half. The figures of Mr. W. H. Preece, electrical adviser to the G.P.O, gave the cost for hydraulic lifts at £47, as against £7 for electric power under similar conditions. These facts the speaker substantiated with a further letter which he had received from Bradford, the first corporation to establish an electrical installation, and now producing an immense amount of day load for motive purposes. Another advantage of electric power was that it could not freeze. During the last great frost the hydraulic as well as the drinking water mains were frozen, which must have been an immense cost and loss to business houses. Moreover, electricity had the longest life, with the minimum of upkeep, and was equal in every respect to hydraulic as to control, starting, stopping, smoothness of running, and attention, as an electric lift could be worked by an unskilled person. The hydraulic apparatus costing £80 as against £100 for electric, was generally chosen by the ground landlord, as it worked out to his advantage, while the tenant was thus debarred from using the electric power, that was far cheaper.

Mr. Winkler, as a Free Trader, strongly objected to restraining ratepayers from using what power they pleased by forcing this monopoly down their throats. The principle of Free Trade being established in this country, any restriction of trade was a violation of that principle. The resolution meant the protection and benefit

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of the few at the expense of the many. He failed to see how the pre-ent agreement benefited the ground landlord; the fixtures which a tenant or leaseholder put in he was at liberty to take away. It would be better if the Lighting Committee, instead of taking up this matter, had tried to improve the lighting of the parish by going into the nooks and corners With a very heavy expenditure they had only two or three miles lighted.

Mr. Trowbridge, chairman of the Parliamentary Committee, who seconded the motion, urged that it was conceived in the interests of the ratepayers, and of those who might think of going in for hydraulic power in the first instance. He believed he represented eight out of ten Shoreditch working-men in opposing a private monopoly coming into the parish. This talk about Free Trade was arrant nonsense. He and many others wanted this undertaking to relieve the rates a bit, and not for the profit to go into private concerns. He hoped they would oppose every vested interest that wished to come into the parish to the detriment of their undertaking.

Mr. S. G. Porter said, as he was somewhat pleased to be identified with the Progressive party in Haggerston, he thought it well to state that he felt bound to oppose the resolution, although it was quite unnecessary for him to assure the Vestry that he was in no sense interested in company promoting. He felt that Mr. Kershaw's policy would be unwise on the part of the Vestry in the interests of their own undertaking. Mr. Kershaw had proved conclusively that his motion was totally unnecessary, and that taking the two methods on their merits the hydraulic had not a chance against the electric. He accepted as wholly true the many instances from other places, but the capabilities of electric power in Shoreditch had yet to be tried, so far as lifting and economy were concerned. He fully agreed with the broad principle of municipalising all monopolies; but under the present circumstances this motion was a source of danger. He fully admitted the demonstration that electric power was cheapest for lifting; but the danger was that, once this arbitrary resolution was passed, and ratepayers who desired hydraulic power for lifting were denied it, the question would then arise as to the motive of such an arbitrary resolution. The policy of Mr. Kershaw would mean bloated revenue raised at the expense of shutting out another commodity, and all the evils they had complained of in private monopoly taken over by a public monopoly, which he entirely objected to. It was clear, he maintained, that the policy advocated was on all fours with the position of private monopolies. How far was that arbitrary principle going to extend? If they allowed Mr. Kershaw's enthusiasm to extend much farther they would find him prohibiting companies supplying Shoreditch with gas, because the Vestry were able to supply electric light. It would be unwise all round in policy and principle to adopt the resolution.

Mr. Cox also urged that there was good reason for rejecting the motion. He did not understand the Progressive principle to mean that they should take all the advantage themselves, and shut out all possible advantage to everybody else. It was the business of the Vestry to show they could supply better and cheaper power, and if they could do that they would soon shut up their competitors. They were not going to do him out of using a steam or gas engine if they could not supply something better in its place. He hoped the Vestry, with its reputation as a Progressive body, would not pass this most reactionary proposal.

Mr. Cooking declared that the Vestry were almost coerced into allowing hydraulic power in the parish, and the motive of that coercion was to damp out the Shoreditch lighting undertaking. He believed sincerely in Free Trade, but self-preservation was a higher and nobler law. He wanted to see their scheme a success, and to get the greatest possible number of customers, and it was their bounden duty to study ratepayers rathor than a contemptible monopoly.

Mr. Vandy warmly supported the motion, urging that the Vestry should have this matter in their own hands and get all possible benefit out of the working of the system. The small sums charged never paid the Vestry for the disturbance of the roads by these monopolies. He thought the proposal before them would protect the ratepayers.

Mr. Kershaw, in closing the debate, pointed out that he had no power to prevent connections with the present hydraulic mains according to the terms of agreement, but he should see that the latter were adhered to. The official figures were not yet made known, but he assured the Vestry that they were supplying electricity at a magnificent profit, cheaper than it had ever been supplied before in any part of England.

A division was taken on the motion, which was carried by 34 votes to 21, the result being received with applause.

ILFORD ELECTRIC LIGHTING.

The following is a *résumé* of Mr. W. C. C. Hawtayne's report to the Ilford Urban District Council, which was considered and adopted at last week's meeting:

Referring to the progress of municipal electricity supply made, Mr. Hawtayne called attention to the Board of Trade returns, which show that up to the end of last September 283 provisional orders had been granted, of which no fewer than 203 had been to local authorities. Electricity supply undertakings, he said, are now proving successful, and there is no longer any reason to doubt that with careful management they can be made most remunerative. It was an ascertained fact that with one or two exceptions every such undertaking in the kingdom under municipal control that had been at work for more than three years was yielding handsome sums annually towards reduction of town rates, and within the last year or two eight local authorities had purchased, or had agreed to purchase, the works of companies supplying electricity in their districts. He advised that the streets scheduled in the compulsory area be the High-road from River Roding to Oakland's Park-avenue, The Pavement, Ilford-lane, Cranbrook-road from High-street to Northbrook-road, Coventry-road from Cranbrook-road to Granville-road. The large and growing residential districts in the neighbourhood might easily be connected to the supply mains from the extremities to these lines and materially increase the revenue of the undertaking.

Although it would pay the Council to light the whole of their public lamps by electricity, he recommended that they should at present light only all the lamps in the streets before mentioned. The district was everywhere developing so rapidly that it would be a pity to lay a small main only suitable for public lighting where there was likely to be a heavy demand for private supply within a few years. From the bridge over the Roding to the extremity of the lines in High-street he recommended that they erect lamps of 2,000 nominal candle-power; also in Cranbrook-road from the High-street to Balfour-road. Throughout the remainder of the streets he recommended lamps of 32 c.p., to be adapted to the present lamp-posts. He considered that within a few years the equivalent of 10,000 lamps each of 8 c.p. would be in use in Ilford; 5,000 within a comparatively short time.

As to the question of the utilisation of house refuse as a means of generating steam to drive the plant at the electricity supply station, he considered the destructor method of disposing of town refuse was far and away preferable to any other method, and he saw so reason why it should not be put down at Ilford. The principal makers of destructors were now prepared to guarantee 1lb. of steam generated for every 1lb. of refuse destroyed at the average town, and if a similar result were obtained at Ilford, the whole of the coal bill should certainly be saved, but he preferred not to enter into a comparison of working costs until some test had been made with Ilford refuse. The erection of a destructor would add about £1,800 to the cost of the scheme given further on. He believed the cost of destruction would be something like 1s. 6d. per ton.

As to the site, he suggested for various reasons the selection of ground in the neighbourhood of that already owned by the Council in High-street.

He put the cost of the undertaking at £14,240 without a destructor; with a destructor, £16,040. He recommended that the Council should not charge more to the consumer than at the rate of 6d. per Board of Trade unit, which was generally reckoned as the equivalent of gas at 3s. per 1,000 cubic feet, and he estimated the revenue at £2,600 and the working cost of £1,500. After adding to this item the repayment of capital and interest at 5½ per cent. on £14,240—viz., £784—there would therefore be a profit of £316 available for reduction of rates or other purposes.

In conclusion, Mr. Hawtayne said that in framing the report and estimates he had been largely guided by ascertained results of other similar undertakings, and had under-estimated rather than over-estimated the profitable nature of the business, and he strongly advised the Council to retain their powers, when obtained, in their own hands, and to put their provisional order into effect with all reasonable dispatch.

CHELTENHAM ELECTRICITY WORKS.

The members of the Gloucestershire Engineering Society have just recently paid a visit of inspection, by invitation, to the Cheltenham electricity works, when they were received by the Mayor (Colonel Rogers), the Deputy Mayor (Alderman Norman), and others. The Borough Electrical Engineer (Mr. Hamilton Kilgour) said he thought that the visitors, before they inspected the arrangements of that particular station, might be interested in a few figures common to all electric supply works, as showing the loss of energy consequent upon converting the energy of fuel into light. In most cases they started with coal, and the chemical energy of the fuel was converted in the boiler furnace into heat, which, by means of steam, was carried to the engine, and transformed in that to mechanical energy. The mechanical energy of the engine was employed in driving the dynamo, and there converted into electrical energy. Conductors carried the latter to various centres in the town, whence by smaller conductors the current was distributed to the customers' premises, where, by means of lamps, it was finally made to yield light. In 1lb. of average coal—of better quality than that used in the Cheltenham furnaces—there was, roughly, a little more than 11 million foot-pounds of energy. In a good boiler, working under ordinary conditions, 1lb. of this coal would heat up from 60deg. F., and evaporate at 350deg. F. (at the pressure of 120lb. per square inch, at which they worked there) about

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7½lb. of water. The resulting 7½lb. of steam contained about 6,788,000 foot-pounds of energy, so that the efficiency of the first process was about 61 per cent., the other 39 per cent. being lost. Loss by radiation caused about ½lb. of steam to condense, and rendered it useless on its way to the engine. Seven pounds of steam reached the engine, therefore, or an equivalent of 6,334,000 foot-pounds. The efficiency of the steam-pipes thus worked out at 93 per cent. A good compound condensing engine such as those on the premises, driving its own pumps and working at its most economical load, required 18lb. of steam per brake horse-power hour, so that of the 6,334,000 foot-pounds delivered to it, the engine gave out 770,000, its efficiency being only 12 per cent. A good dynamo would convert 693,000 foot-pounds of this into electrical energy, or about 90 per cent. Next came the losses in the mains and transformers, which under most advantageous conditions would at least come to 69,000 foot-pounds, the efficiency of the distributing system thus being 90 per cent. The next step—the conversion of electrical energy into light—caused the most serious loss, for the efficiency of the best incandescent lamp was not more than 9 per cent. at a liberal estimate, and the light energy resulting from the 624,000 electrical was only 52,000 foot-pounds. The net result was that each pound of coal burnt only provided sufficient energy to supply five 16-c.p. lamps at the customer's house for one hour. The total efficiency of the whole series of transformations was therefore only ½ per cent. He wished to call attention to the startling fact that while the efficiency of the steam-engine was only 12 per cent., that of the dynamo was 90 per cent. Much was still heard of the trite dictum that electricity was "in its infancy," but his hearers must see that the dynamo was very nearly perfect, and that any substantial raising of the percentage of light energy obtained from the chemical energy of coal by the processes he had enumerated was much more likely to come about by the improvement of the steam-engine than the further perfecting of the dynamo. They would thus see that the most room for improvement lay not in the electrical part of the process, but in the mechanical conversion—a stage common to all processes of production requiring power. The incandescent lamp certainly left ample room for improvement, but the perfecting of this appliance would make no difference to the supply station. The advantage would be to the consumer, who would receive more value for the money spent on lighting.

The party were able to inspect the present plant and the extensive additions now in course of construction. The machinery at the time supplying current included the three kilowatt sets of Belliss or Willans engines and Siemens alternators, excited by a 22½-kw. direct-current dynamo driven by a Universal engine. The two 35-kw. alternators with Willans engines were not running, the night load being then comparatively light. The three 300-h.p. Galloway boilers were in use, and the two 500-h.p. Babcock boilers were seen in course of erection. In the engine-house the excavations (17ft. deep) for the two new 200-kw. generating sets could be seen, and at the west end of the buildings the commencement of the excavations (22ft. deep and 40ft. square) for the foundations of the new chimney stack, which will be 200ft. high. To the north of the present buildings are the foundations of the accumulator stores and testing-rooms, covering about 75ft. by 40ft. Beyond is the cooling tank, an interesting apparatus in an early stage of construction. This is 100ft. by 60ft., and will be employed in cooling the stream of water by which the exhaust steam from the engines is condensed. After circulating through the condenser the water will be forced through numerous nozzles into the air, and, cooling by contact with the air, will be ready for again performing the duty of condensing the exhaust steam.

LEGAL INTELLIGENCE.

THE UNDERGROUND WIRE DISPUTE.

In the City of London Court on December 1, before Mr. Commissioner Kerr, an action was brought by the Duke of Norfolk, as Postmaster General, against the Commissioners of Sewers of the City of London for the determination of a difference which had arisen between them under the joint operation of the several Telegraph Acts

Sir Robert Hunter, solicitor to the Post Office, stated that on July 28 a notice was served by the Secretary of the Post Office upon the Commissioners calling upon them to give their consent to the placing and maintaining of a line or lines of underground telegraphs in or under Newgate-street, St. Martin's-le-Grand, Cheapside, St. Paul's-churchyard, Cannon-street, Old Change, Knightrider-street, Lambeth-hill, and Queen Victoria-street. The parliamentary authority to the Postmaster-General to place wires under the streets could only be exercised by obtaining the consent of the body which had the control of the streets. The Commissioners had given their consent to the streets being opened for the purpose of laying telegraph wires; but the City authorities had imposed as a condition that the Postmaster-General would not allow the wires to be used by the National Telephone Company. The Postmaster-General's view, as advised, was that the Commissioners had no authority to impose such a condition. Under those circumstances there was no alternative but to come to the court to have the condition removed.

Mr. Lyttleton Chubb (with him Mr. Clappcott), counsel for the Commissioners of Sewers, said that they had made the stipulation now objected to in the interests of the public only. The City body did not object to the Postmaster-General's having permission to lay down wires if the public were to have the exclusive use of them. All they objected to was the National Telephone Company's taking over the lines after their construction, as was intended. At one time the whole telegraphing system throughout the country was in the hands of private companies. Then the Legislature gave the Postmaster-General the monopoly. The Commissioners of Sewers were withholding their consent, except upon the condition mentioned, because they wanted to force the National Telephone Company into providing a better and very much cheaper service of telephonic communication.

Sir Robert Hunter informed the Court that the wires were to be laid to connect the central telegraph office with the sub-exchanges of the National Telephone Company; and so put them into direct communication with the Post Office. The Telephone Company would rent the wires; but that could be stopped at any time.

Mr. Commissioner Kerr said he must decide the difference unfavourably to the Commissioners of Sewers. He could not understand them objecting to the National Telephone Company. What the Postmaster-General wanted to do was for the benefit of the public at large, and at the same time it would bring money to the public purse. The condition imposed by the Commissioners was unreasonable, and, therefore, the consent which had been given would be unfettered by the condition. That was the order which he would make. He was happy in thinking that there was an appeal; so if he was wrong, he could be put right. The point was, no doubt, of great importance.

PROMOTING AN ELECTRIC LIGHTING COMPANY.

In the action of Taylor *v.* Sax, arising out of the Lambeth electric lighting scheme, in which Mr. Justice Channell in the early part of this month found for the defendant, Mr. A. S. McIntyre, for the plaintiff, asked Lords Justices Smith, Rigby, and Collins, sitting in the Court of Appeal on November 29, for leave to set down notice of motion for a new trial, which was resisted, on behalf of the defendant, by Mr. Tindall Atkinson, Q.C. Plaintiff sued as assignee of a commission note to one Gomer, that "in the event of your getting a transfer of the Lambeth lighting order and floating the same successfully into a company I undertake to pay you £500 in shares, in consideration of your doing your best to assist me in forwarding the project." The defendant was an electrical engineer who was in negotiation with the Lambeth Vestry to obtain from them a transfer of the order. The order was eventually obtained by the South London Electrical Supply Company, promoted, it was said, by the defendant and Mr. Jacob Atherton, and the ground for the fresh application was that defendant did not, in his disclosure of documents, reveal an agreement which, it was alleged, would contradict the part of his defence which denied that he had received anything in respect to the matter covered by the commission note, he having for a consideration, by way of loans, assigned it to his father in-law, one Vandenberg, who had received £1,700 out of a total of £6,000 for the purpose of settling claims against the defendant in respect to the promotion and formation of the company. This evidence, it was the case for the applicant, plaintiff, if disclosed on the trial, must have led to a verdict for him, and have shown that defendant was not to be believed in stating that he received nothing out of the promotion. Mr. McIntyre added that he did not suggest the documents were intentionally kept from the Court; but they were not disclosed to the plaintiff, and the fact that they were not, he submitted, entitled him to this application.

As the result of some hour and a half's argument, their **Lordships** gave plaintiff the leave asked for.—*The Financial News.*

COMPANIES' MEETINGS AND REPORTS.

INDIA RUBBER (MEXICO) COMPANY, LIMITED.

An extraordinary general meeting of the Company was held on the 29th ult. at Winchester House, Mr. J. Greenlees presiding. There was a large attendance of shareholders, and the proceedings were frequently of a noisy character.

The **Chairman** said the object of the meeting was to consider certain proposals made by the vendor company (the Mexican Finance Corporation, Limited), which would have the effect of placing the shareholders who subscribed at the time of the issue of the prospectus in a much improved position. Briefly, the offer was that out of the Company's revenue available for dividend 10 per cent. should be annually hypothecated to the payment of a preferred dividend on 100,000 shares, to include all those subscribed and paid for by the public; that, subject thereto, the 300,000 remaining shares should then be entitled to a dividend up to 10 per cent. in each year; and that the surplus available for dividend should next be shared proportionately between both classes of shares. In addition, the Mexican Finance Corporation had agreed, subject to the completion of the contracts between

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the two companies being forthwith effected, to take up £15,000 of 7 per cent. debentures in the India Rubber (Mexico) Company, and then deposit such debentures with this Company for two years as security for the payment of the debenture interest which would accrue during that period. The vendor company had further consented to reimburse them for the interest paid to September 30 last, and had given them a debenture as security for that amount. He was pleased to say the difficulties in connection with the legal transfer of the properties had now been adjusted, and they were informed that complete titles were awaiting their approval. Rumours, as they were aware, reached the directors with regard to the properties to be acquired which, he must admit, were of a disturbing nature. Therefore, in order to satisfy themselves, the Board engaged Mr. Yorba, an expert in Mexico City, on the recommendation of the British Legation there, to report on the estates, and the latter reported that there was not likely to be any difficulty in obtaining labour, and that on the Llano de Juarez estate there were, besides other things, 300,000 rubber trees and valuable timber to the extent of 50,000 tons. On the other estate he estimated there were 50,000 rubber trees and 8,000 tons of timber. Mr. Yorba added, with regard to the Esmeralda estate, that he thought there were few plantations to equal it in every respect, and that a company possessing it, with ample means to maintain it in good condition, combined with proper management, could render it one of the most important of its kind in the Republic

A lengthy discussion followed, after which the **Chairman** moved a resolution to the effect that the offer of the Mexican Finance Corporation should be accepted, and that the Board be authorised to carry out the purchase of the properties comprised in the agreement of March 17 without incurring the delay and expense of obtaining any further report.

Sir Thomas Richardson seconded.

Dr. Marshall moved as an amendment that the consideration of the offer of the Mexican Finance Corporation be postponed, with the object of obtaining further information respecting the properties. This was seconded by **Mr. Robertson**, but on a show of hands, it was negatived by a large majority. The resolution was then carried.

Resolutions for rearranging the capital in a manner occasioned by the acceptance of the offer of the Mexican Finance Corporation were afterwards agreed to, and it was decided, on the motion of **Mr. Leuty, M.P.**, to remit forthwith to the Company's acting agents in Mexico a sum of £10,000 for general management of the estates, to be accounted for by the vendor company on completion of purchase.

LONDON ELECTRIC OMNIBUS COMPANY, LIMITED.

A meeting of the shareholders, convened by Mr. W. Marshall (formerly deputy chairman of the Company), was held on the 26th ult., at Cannon-street Hotel, to consider the position of the Company's affairs.

Mr. E. Kimber, who was voted to the chair, remarked that one electric omnibus was constructed by Mr. Marshall, and handed over to the Company, but even that had not been put on the streets except for trial trips. He thought the shareholders were entitled to information as to what had been done with the thousands of pounds they had subscribed, and he suggested that a committee should be formed to make the necessary investigations.

Mr. Marshall, who then addressed the meeting, explained that he took part in the promotion of the Company, and was, until some time ago, the deputy chairman. On going to allotment, the directors had, according to contract, to pay him £20,000 in cash, and they handed over to him a portion of that sum—between £5,000 and £6,000. He saw at once that the Company had gone to allotment with too small a capital, and he returned the cheque to the Company and took up 28,000 shares, for which he gave a cheque for £13,000. According to the prospectus the Company was to have placed 125 omnibuses on the streets, and he believed that altogether they received ample capital for doing so. He then criticised the management, spoke of the acquisition of the "Sola" accumulator as useless expenditure, etc. He admitted that they had not the same chance as when the Company was started, because then they had the field to themselves. Now the London General Omnibus Company were negotiating for the placing of 400 electric omnibuses on the streets. A resolution for appointing a committee of investigation for the purpose of reporting to the shareholders, at an early date, on the position and prospects of the Company, and for making such recommendations as they might deem fit, with power to call in expert assistance and advice, if necessary, on the subject of the patents, construction of the omnibuses, and the running of them, and also on the different negotiations entered into by the directors, and any other matters connected therewith, was discussed and carried. Mr. Ware, Mr. Flaxman Haydon (trustee in bankruptcy of Mr. Marshall), Mr. Condict, Colonel Turnbull, and the chairman were elected to serve on the committee of investigation.

PROVINCIAL TRAMWAYS COMPANY, LIMITED.

The fortieth ordinary general meeting was held on the 26th ult at the office, Poultry, Mr. George Richardson presiding.

The **Chairman**, in moving the adoption of the report, stated that the net revenue from the local tramways for the 12 months to September 30 amounted to £31,123, as compared with £30,284 in the previous year; £19,306 remained at the credit of the net revenue account. From this amount they recommended that the sum brought forward from last year, £1,101, should be written off capital expenditure for general depreciation; that the following sums should be set aside towards the cost of reconstructing the permanent way—namely, Plymouth, £2,500; Cardiff, £3,500; Portsmouth, £2,000; and Grimsby, £2,000; and that a dividend should be paid on the ordinary shares of 5s. 6d., making with the interim dividend 8s. per share for the year. These payments would leave £1,354 to be carried forward. Their negotiations with the Town Council of Cardiff had come to an end, and, owing to the opposition of that body, the provisional order for extensions which the Company had promoted was withdrawn. The provisional order for extending the lines from Grimsby to Cleethorpes was passed, and it contained powers to enable the lines to be worked by electricity if it were deemed desirable to do so, and they intended to seek similar powers in any other schemes they might promote. The Corporation of Portsmouth intended to promote a Bill to seek powers to acquire the lines of the Landport and Southsea Tramways Act of 1863, and to make arrangements with this Company for purchasing the whole of the lines. The directors could not say what action they would take until they were in possession of the proposed Bill. The Cardiff Corporation had also given notice of powers for tramways apparently all over the borough.

The report was adopted.

CROMPTON AND CO., LIMITED.

An extraordinary general meeting was held on the 29th ult. at the Cannon-street Hotel, Mr. John Trotter in the chair, for considering the following resolutions: (1) to reduce the capital of the Company from £280,000 to £168,000, the reduction to be effected by cancelling capital to the extent of £2 per share upon all the existing 34,108 shares which have been issued, and by reducing the nominal amount of the shares in the Company's capital from £5 to £3 per share; (2) to further reduce the capital from £168,000 to £162,000 by cancelling 2,000 ordinary shares of the Company, numbered 1,393 to 2,784, and 6,785 to 7,592, both inclusive, issued as fully paid up; and (3) to agree, in case of the reduction of capital mentioned in the last resolution, that the holders of the 28,180 preference shares should cease to be entitled to any preference or priority, either in respect of past or future dividends or capital, over the holders of the ordinary shares. After some discussion these three resolutions were carried.

A separate meeting of the preference shareholders was afterwards held, when a resolution was carried approving an agreement under which the rights of the holders of the preference shares of the Company were modified in accordance with the resolutions passed at the previous meeting. At a subsequent meeting of the ordinary shareholders a similar resolution was passed.

ALLGEMEINE ELECTRICITAETS GESELLSCHAFT.

The report for the fifteenth year ending June 30, 1897, has just been published, and contains a statement by the chairman of directors referring to the trust society recently started by this Company, from which we translate the following: "We have founded, on the methods established by the Local Street Railways Company, a current-supply company, under the title of Electricitäts Lieferung Gesellschaft. Just as the former unites a number of electrical railways and successfully manages same upon a uniform principle, so will the latter undertake the management of such electricity works which cannot support or afford the expensive apparatus of an independent establishment, or which require a certain length of time before paying appreciable dividends. We incorporated the total capital of £250,000 permanently into our assets, and so secured the controlling influence of that company. Certain (named) light works have been given to the Company, estimated at the value in which they figure in our books. Prices and conditions for the building of further central stations are fixed by agreement at a low figure, in consideration of the intimate connection of the companies. In consequence, we are already building three small works on account of the former company. We also have transferred to them our shares and interest in the (named) works"

The *Frankfurt Zeitung* says upon the subject: "The project of the trust company of the Allgemeine Electricitäts-Gesellschaft appears to include a direct junction with the Bank for Electric Enterprises (Unternehmungen) at Zurich. Two of the former for one share of the latter are to be changed."

Electricity works in Germany have increased lately to such an extent that foreign capital has become necessary for the further development of the industry, and a similar trust company is being formed by Messrs Siemens and Halske, the German Bank and the Banque de Paris co-operating in the scheme.

During the year 1896-1897, 5,189 machines were manufactured of an average of 20 h.p. each and a total of 76,300,000 watts, or 103,000 h.p. (one horse-power taken at 736 watts); this shows an increase of 52 per cent. as compared with the preceding year. The two factories of the Company are worked for one central station with two steam dynamos of 1,000 h.p. and 500 h.p. each. The weekly output of the metal foundry is about 25,000lb. The total number of men employed is 9,817, of whom 6,000 are in the machine and armature factory. Fourteen engineers' offices and 65 agencies are established in 16 cities to manage the various light and power works of the Company, besides 11 European and 18 foreign agencies. A limited number of Röntgen tubes have been turned out, but the demand is on the increase. During the year 49 electric lines have either been built or were in course of construction. The length of line increased from 320 miles to 475 miles, and the number of motorcars from 918 to 1,273. A central

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station with 5,000 h.p. was erected at Genoa. The raw material is estimated at £485,450, and the profit (without considering works in course of completion) is estimated at £358,950, added to this £6,300 balance for the previous year makes £365,250, which leaves, after deduction of all expenses, depreciation, etc., £291,050. Out of this, £50,000 is put to reserve fund and a 15 per cent. dividend is distributed, leaving various sums for directors' fees, etc., and about £8,500 balance to carry over.—The Electrical Company, Limited, London, are the sole representatives of this Company for Great Britain and the British Colonies.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

St. Pancras.—The Vestry of St. Pancras invite tenders for the supplying and erecting of arc lamps, posts, and circuits complete, also feeding and distributing mains. For particulars refer to our advertising columns. Tenders by December 28

Catanzaro (Italy).—Tenders are invited for electric tramway or other light railway between the town and the railway station. The deposit required is £400. Specifications are to be obtained from, and tenders addressed to, the Municipal Authorities by December 30.

Londonderry.—The Corporation invite tenders for the supply of carbons for one year from January 1, 1898. Schedules of quantities and further particulars may be obtained on application to Mr. John Christie, city electrical engineer, Guildhall, Londonderry. Tenders, accompanied by samples, marked "Tender for Carbons," to be lodged with him by December 9.

Hackney.—The Joint Public Health and Electric Lighting Committee of the Vestry are considering the question of lighting Hackney by electricity, either combined with a dust destructor or without, and are prepared to consider any scheme for this purpose from parties in a position to carry it out. Particulars may be had of the Vestry Clerk, Town Hall, Hackney. All schemes and particulars are to be sent to the Town Hall, Hackney, by 6 p.m. on December 14.

Edinburgh.—Tenders are invited by the Edinburgh and District Tramways Company, Limited, for 250 grippers for the new cable cars being built for the company. Specifications may be obtained on payment of £1. 1s., from the engineer, Mr. W. N. Colam, 57, Henderson-row, Edinburgh, where also plans and drawings may be inspected. Tenders to be lodged with Mr. John E. Pitcairn, general manager and secretary, 1, South Charlotte-street, Edinburgh, by December 6.

Glasgow.—The Corporation invite tenders for the supply of 2,000 tons of steel straight track rails, 200 tons of steel curve rails, and about 120 tons of steel fishplates. Specification, with form of tender and section, can be obtained on application to Mr. John Young, general manager, 88, Renfield-street, Glasgow. Tenders, sealed and marked on cover "Tender for Tramway Rails," to be lodged with Mr. J. D. Marwick, town clerk, City Chambers, Glasgow, by 10 a.m. on December 28.

Newport.—Tenders are invited by the Corporation for an electric lighting plant for temporary lighting at Wentwood waterworks. The plant will be required to light about 350 16 c.p. lamps, or their equivalent. Oil or steam driven machines may be tendered for. Second-hand plant preferred. Further particulars may be had upon application to the Borough Engineer, Newport. Tenders, marked "Electric Light Plant," must be delivered at the office of Mr. Albert A. Newman, town clerk, Town Hall, Newport, before 10 a.m. on 15th inst.

London, N.W.—Tenders are invited by the Vestry of St. Pancras for the supplying and erecting of arc lamps, posts, and circuits, complete; also feeding and distributing mains. Copies of specification, conditions of contract, and forms of tender to be obtained upon application to the Chief Clerk, Electricity Department (offices, 57, Pratt-street, N.W.), on payment of a deposit of £1, which will be returnable on receipt of a bona fide tender, accompanied by the specification. Tenders to be sent to Mr. C. H. F. Barrett, vestry clerk, Vestry Hall, Pancras-road, London, N.W., endorsed "Tender for Arc Lighting Extensions," by 12 noon on 28th inst.

Leicester.—The Sanitary Committee invite designs and tenders for motor vehicles for the collection of house refuse. The motive power, capacity, and all other particulars are to be described in a full specification, accompanied by drawings and delivered at the office of Mr. E George Mawbey, C.E., borough engineer and surveyor, Town Hall, Leicester, addressed to the Chairman of the Sanitary Committee, by January 31. The loaded wagons would have to ascend an incline of 1 in 20, turn in a limited space, back and tip over a beam about 14in. high by 12in. in width, and when empty descend a road having a gradient of 1 in 15. The Committee do not bind themselves to accept any proposal, and firms tendering must do so at their own cost, no fees being allowed for the preparation of drawings, etc.

Barrow-in-Furness.—Tenders are invited by the Corporation for erection of electric lighting station near the top of Buccleuch-street, and on the north-east side of the Board schools. Plans and specifications may be seen and bills of quantities and forms of tender obtained at the office of the Borough Engineer, Town Hall, Barrow-in-Furness, on payment of £1. 1s, which will be returned on receipt of a bona fide tender. The contractor will be required to pay the rate of wages and observe the hours of labour recognised and agreed upon between the trades unions and the employers respectively in the locality in which the work for carrying out the contract is to be performed, or such rate of wages and hours as are equivalent or approximate thereto. The contractor whose tender is accepted shall enter into a formal agreement under seal with sufficient sureties for the fulfilment of contract. Tenders, which must be on the form provided by the borough engineer, are to be sent in, addressed to the Chairman of the Electric Lighting Committee, and endorsed "Tender for Electric Lighting Station," by 12 noon on 15th inst.

Canterbury.—The Electric Lighting Committee of the Corporation are prepared to receive tenders for the supply and erection of plant as follows: (Section A) boiler-house plant—Lancashire boilers and accessories, mechanical stokers, feed-pump, injector, economiser, electric motor: (B) engine-house plant—steam dynamos and accessories, condensers, oil-filter, steam, exhaust, feed, blow-off, and sundry pipes, valves, feed-water and storage tanks, &c.; (C) overhead travelling crane; (D) switchboard and instruments; (E) accumulators; (F) mains—insulated cables and trenching; (G) public lamps—arc and incandescent street lamps, lamp-posts, and brackets; (H) meters. The whole bound up in one specification, price £2. 2s., returnable on receipt of bona fide tender. Further copies £1. 1s., not returnable. Tenderers are at liberty to tender for any section, but not for part of a section. Specifications, with terms and conditions of tender and contract, may be obtained at the offices of Mr. Robert Hammond, consulting engineer to the Corporation, Ormonde House, Great Trinity-lane, London, E.C., on payment of £2. 2s., which sum will be refunded on the return of the specification, filled up, with a bona fide tender. Tenders, sealed, and marked "Tender for Electricity Works," must be addressed to Mr. Henry Fielding, town clerk, 15, Burgate-street, Canterbury, and delivered by December 20.

Barrow-in-Furness.—Tenders are invited by the Corporation for the supply and erection of (Section A) boilers, pumps, steam and water pipes, tank, crane, economiser, ironwork; (B) engines, generators, switchboards, instruments, accumulators, motor-transformers, sub-station equipments; (C) high and low tension feeder and distributor cables, house connection boxes; (D) conduits, drawing in boxes. Specifications and forms of tender can be obtained at the Town Hall, Barrow-in Furness, or at the offices of the engineers, Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, on payment of a fee of £3. 3s., which sum will be returned on receipt of a bona fide tender. The contractor will be required to pay the rate of wages and observe the hours of labour recognised and agreed upon between the trades unions and the employers respectively in the locality in which the work for carrying out the contract is to be performed, or such rate of wages and hours as are equivalent or approximate thereto. Contractors may tender for any one of the sections or the four sections complete, and the contractor whose tender is accepted shall enter into a formal agreement under seal, with sufficient sureties for the fulfilment of contract. Sealed tenders, endorsed "Electricity Supply, Contract No. 2," must be sent to Mr. C. F. Preston, town clerk, Town Hall, Barrow-in-Furness, at or before 12 noon on December 15.

Madras.—Tenders are invited for the utilisation of water flowing from the Periyár Lake for purposes other than irrigation and not incompatible with the use of the water for drinking. The irrigating season extends over nine to ten months, during which time the discharge is likely to be from 1,100 to about 500 cubic feet a second, according to the demands for irrigation and the available quantity in the lake. Subject to the risk of interruption by accident or drought, supply can be given throughout the irrigation season. No supply can be guaranteed at other times, but, so long as water is available, the Government will be prepared to issue it in such daily quantities as may seem to it advisable with reference to the time which is likely to elapse before the supply is replenished by the setting in of the rains. The fall from the tunnel to the foot of the hills is approximately 900ft., and the distance measured along the course of the stream about 6,800ft. One cubic foot per second falling 900ft. is estimated to produce over 60 effective horse-power. Intending lessees should state the quantity of water required in cubic feet per second and the annual rent offered for each cubic foot per second. No rent will be charged for the first year from the date of the concession; for the second year the charge will be one-fifth, and an additional charge of one-fifth will be made every year until the full rent is reached. The whole or part of the concession may be surrendered on a year's notice being given. Lessees will construct at their own expense, on plans to be approved by Government, all the weirs and other works required to divert the water from the river below the tunnel. For further information, application may be made to the Chief Engineer for Irrigation, Madras, by whom tenders will be received up to July 1, 1898.

RESULTS OF TENDERS.

Edinburgh.—The following tenders have been received by the Council: Siemens Bros. and Co., Limited, for two low-tension engines and dynamos, £8,480; Electric Construction Company, Limited, for alternators, £6,550; George Sinclair, for four boilers, £4,904.

Salisbury.—The following tenders have been received by the Salisbury Electric Light and Supply Company, Limited, for erection of offices and works:

E. Hale, 73, Castle-street, Salisbury (accepted)	£1,295
P. Tryhorn, Fisherton, Salisbury	825
C. Trask and Sons, Norton, Stoke-under-Ham	1,399
Webb and Co., Endless-street, Salisbury	1,777

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Derby.—The Corporation have accepted the tender of Messrs. Ferranti, Limited (£7,132. 10s.), for dynamo and engine. This amount is included in the sum of £20,000 granted by the Council in April last.

London.—The following tenders have been received for electric wiring, Guildhall School of Music extension :

Vaughan and Brown	£750	0	0
Drake and Gorham	738	18	0
Wenham and Waters	579	0	0
Roger Dawson	507	12	0
Lund Bros.	495	0	0
Rashleigh Phipps and Co.	464	0	0
C. A. Hemingway	405	7	6
Gulich and Macintyre	392	4	6
Johnson and Phillips	357	0	0
Bergtheil and Young (accepted)	342	15	0

Loughborough.—The following tenders have been received by the Brush Electrical Engineering Company, Limited, for extension works :

Gilbert and Gabbitass	£12,499
F. Fish and Sons	12,066
E. Orton	11,858
Main, Kendall, and Main	11,850
A. G. Bell	11,261
T. Barker	10,776
A. Moss and Sons	10,448
A. Faulks, Loughborough (accepted)	10,350

BUSINESS NOTES.

Bedford.—The Local Government Board have sanctioned the Town Council borrowing £19,650 for electric lighting purposes.

Sunderland.—A commencement has been made with the lighting of the streets by electricity, the first standard having been fixed on the 1st inst.

Edinburgh.—The Council have decided to lease three acres of ground at M'Donald-road from the Heriot Trust as a site for a new lighting station.

Edmonton.—The engineer to the Urban Council has been instructed to obtain all the necessary information with respect to the lighting of the parish.

Brighouse.—The Town Council have appointed a sub-committee to consider the question of taking over the electric lighting plant belonging to Mr. A. B. Brook.

Montrose.—The statutory notices appear in the local Press referring to the application (previously noted by us) of the Corporation to apply in the next session of Parliament for a provisional electric lighting order.

Coast Telegraph.—The Post Office Telegraphs have obtained the necessary consent to erect a line of telegraph from Prussia Cove to Gunwalloe, alongside the road from Dodson's Gap to Gunwalloe coastguard station.

Leeds.—At the last meeting of the City Council the tramway management came in for some severe criticism. It was resolved to instruct the Parliamentary Committee to oppose the intended Bradford and Leeds light railway.

Brussels.—The feasibility of constructing an immense bridge to connect the upper and lower town is being discussed. The bridge is to be rendered accessible to foot-passengers by lifts, and furnished with a double line for electric trams.

Queensbury.—Several members of the special committee of the Bradford City Council appointed to deal with the proposal for the extension of the tramways to Queensbury, paid a visit to Queensbury on the 23rd ult. to inspect the route suggested.

Royal Electric Company of Montreal.—Messrs. Coates, Son, and Co. have been advised that the usual quarterly dividend of 2 per cent., being at the rate of 8 per cent. per annum, has been declared by the Royal Electric Company of Montreal.

Stonehouse.—At the last monthly meeting of the Parish Council a circular was read from an engineer offering his services to the Council as consulting engineer if the Council intended to adopt the electric light at Stonehouse. The circular was allowed to lie on the table.

Beckenham.—A letter from Messrs. Waterer and Dickins asking the Council to treat for the transfer of their electric lighting powers to supply Shortlands and South Hill to the Bromley (Kent) Electric Light and Power Company, Limited, has been referred to the Electric Lighting Committee.

Worksop.—At the last meeting of the Council reference was made to a scheme from Warsop for lighting the entire district by means of the electric light, and a motion was carried that the Lighting and Paving Committee enquire and report as to the best means to adopt to safeguard the Council's interests.

Ilford.—At a special meeting of the Urban District Council it was decided to apply to the Board of Trade for a provisional order for supplying electric light in the district. This means that the District Councils of Ilford, East Ham, and Barking, which are contiguous, have each given notice of applying for an order.

Electric and General Investment Company.—The directors of the Electric and General Investment Company, Limited, have declared an interim dividend of 10 per cent. on the capital paid up on the ordinary shares, payable on and after 15th inst., to those shareholders registered in the books of the Company on November 30, 1897.

Broadstairs.—Mr. Warden-Stevens, who some time since applied to the Council to be engaged to give preliminary advice in electrical matters, again wrote stating that he was prepared to give the necessary technical assistance in obtaining a provisional order.

The Great City Fire.—We understand that one of the sufferers by the recent fire in Cripplegate (the firm of Messrs. Holyman and Co., of Jewin street) found on opening their safes that the contents were in a perfect state of preservation. The safes were supplied by the Ratner Safe Company, Limited, of 51, Moorgate-street, E.C.

Shrewsbury.—The notice of application for a provisional lighting order by the Corporation (referred to in our last) mentions, besides the supply of electricity, also the purchase of the undertaking and works of the Shropshire Electric Light and Power Company, Limited, and the revocation of the Shropshire Electric Lighting Order, 1894.

Blackpool.—Major Cardew, R.E., held a Local Government Board enquiry on Tuesday last with reference to the proposed adoption of the overhead system of electrical working on the tramways. The Corporation are asking the sanction of the Board of Trade to the borrowing of £9,400 for the purpose. There was considerable opposition to the scheme.

Hammersmith.—The Vestry have adopted the following report of the Electric Lighting Committee : "It having had before them applications for electric motive power, they recommended that the Vestry supply current for such purpose at the reduced rate of 2½d. per unit upon the understanding that the current so supplied was used for a minimum of 48 hours per week."

Dingwall and Strathpeffer.—A meeting of the Provisional Committee of Dingwall and Strathpeffer Electric Lighting Company was held on Monday, when a number of preliminary details connected with the joint schemes was considered. The electrical engineer is Mr. Yorke, Glasgow, and the agent for the proposed company is Mr. E. J. Gunn, solicitor, Dingwall.

Lancaster.—Mr. Councillor Hall has been appointed chairman of the Electricity Committee. The Ripley Hospital Trustees have applied to the Council for a supply of electric current to the Ripley Hospital. The engineer estimated the cost of extension of main required at £200, and it has been resolved that the supply asked for be granted, and that the engineer lay the necessary mains.

Folkestone.—The *Daily Mail* says the inhabitants of the fashionable quarters of Folkestone are up in arms against the proposal of two distinct companies to run electric trams along the main thoroughfares of the town and district. The adjoining towns of Sandgate, Hythe, and Cheriton are all in favour of the scheme, which also finds support from the middle classes in Folkestone.

Newcastle.—At a special meeting of the Newcastle City Council the report of the Lunatic Asylum Visiting Committee, recommending further expenditure in connection with the extension of the lunatic asylum, principally for the installation of the electric light, was adopted. It was stated that half the contract with Mr. Walter Scott had been completed, and the extras thus far did not amount to £250.

St. Pancras.—At the last meeting of the Vestry a report with regard to the extension of current for public and private lighting to the Prince of Wales-road, Malden-road, Queen's-crescent, and Ferdinand-street was carried. This scheme provides for 30 arc lamps for public lighting, and for 750 16 c.p. lamps in Malden-road and Queen's-crescent for the purpose of private lighting, at an estimated cost of £5,422.

Carlisle.—The Provisional Committee having in hand the promotion of the Mid-Cumberland light railway, find that none of the companies will give the undertaking support. The committee are determined to persevere, and have decided to recommend the route from Wigton, on the Maryport and Carlisle Railway, through Caldbeck, and Hesket-New-Market to Troutbeck, on the Cockermouth, Keswick, and Penrith Railway.

St. Mary Abbotts, Kensington.—At a meeting of the Vestry held on the 1st inst. a report of the Works and Sanitary Committee, stating that notices and plans have been received from the House-to-House Electric Light Supply Company relative to extensions of their mains in Wright's-lane, Marloes-road, Hollywood-road, Earl's Court-road, and Old Brompton-road, was adopted, and permission was given for the works being proceeded with subject to the usual conditions.

Appointments Vacant.—In another column appear advertisements of several vacancies, amongst which we note that the city of Sheffield require a resident electrical engineer in connection with the reconstruction of certain of the existing tramways into the electric overhead system, and the construction of extensions of tramways on the same system; an engine driver is required at the electric lighting works of the St. Mary, Islington, Vestry, and several other vacancies occur.

The Projected Lochfyne Railway.—The North British Railway Company's surveyors and engineers intend to make a final survey of the proposed line from Arrochar to St. Catherine's before the plans are submitted to contractors for offers for the construction of the line. The North British are prepared to proceed with the work immediately after the Light Railway Commission submit their report. A very substantial pier is to be erected at the terminus near St. Catherine's, Lochfyne.

Gloucester.—At a meeting of the City Council on the 30th ult. at the Guildhall, Gloucester, under the presidency of the Mayor (Alderman Estcourt), it was decided to instruct the engineer to advertise for the materials for the electric light installation, and to apply to the Local Government Board for sanction to borrow

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£50,000 for carrying out the work and erecting a dust destructor. The meeting was at times somewhat noisy, but all the minutes of the various committees, with one minor exception, were agreed to by large majorities.

Kenmare.—The Rural Sanitary Authorities have passed the following resolution: "That we request the Local Government Board to confer upon us, the Rural Sanitary Authority of Kenmare Union, the powers of an urban sanitary authority in order to enable us to make arrangements for the lighting of the streets of Kenmare town with a local electric company, who are at present supplying the domestic lighting of a number of houses in the town, the area of charge for the cost of same having this day been fixed as the townland of Kenmare."

Derby.—The salary of Mr. J. E. Stewart, engineer and manager of the electric lighting works, has been increased from £312 to £362 per annum by the Council.—A slight fire has occurred at the office at the electric light station, and a claim of £7 has been made upon the Fine Art Insurance Company, Limited. Two superheaters have been ordered from Messrs. Macphail and Simpson, at a cost of £316 each. Additional steel steam-piping for the feed-water softener has also been ordered, at a cost of £62. 10s. These amounts are included in the sum granted by the Council in April last.

Weston-super-Mare.—Notices appear in the local Press referring to an application to the Board of Trade under the Electric Lighting Acts, 1882 and 1888, for a provisional order enabling the Weston-super-Mare Electric Light and Power Syndicate to produce and supply electric light for public and private purposes within the whole of the urban sanitary district of Weston-super-Mare as the same is constituted at the commencement of the order, etc.; and to manufacture, hire, sell, and let electric apparatus, etc.; and to obtain the annulment of the Weston-super-Mare Electric Lighting Order, 1891.

Middlesbrough.—At a special meeting of the Middlesbrough Corporation on 29th ult., the Streets Committee recommended that the tramways company be allowed to place a double line from the tramways buildings in Newport-road to the end of Glebe-road, and to extend the Newport-road crossing from Calthorpe-street to Hartington-road, upon certain conditions. It was also proposed that plenary power should be given to the Streets Committee in the matter of tramways. Several amendments were proposed, and ultimately the minutes were not confirmed, and the Council declined to give plenary powers to the committee.

Newport.—A special meeting of the Newport County Council was held last week. The Electricity Committee recommended, in connection with the extension of the electric lighting of the town, that the consulting engineer be instructed to arrange for one of each of the following lamps being fixed and tested, and to report upon them—viz., the Davey Electric, the Electric Construction Company, the General Electric, the Brockie-Pell, the Crompton-Pochin, and the Brush Company. The Town Clerk reported that he had obtained the sanction of the Local Government Board to the raising of £35,665 for new plant and extensions.

Manchester.—An elaborate report was presented to the City Council at its meeting on the 1st inst. by a special committee appointed to consider the question of the Corporation taking over and working the whole system of tramways. The committee strongly recommended the Council to undertake the working, and to adopt electricity with overhead wires as the motive power. The report was adopted.—The resolution of the Electricity Committee to purchase, for the purpose of cable stores, etc., 4,700 square yards of land in the Polygon, Ardwick, at 1s. per square yard, 20 years' purchase, or a total of £4,700, was confirmed.

Ipswich.—In consequence of the possibility of the introduction of the electric light into the town, a renewed application of the National Telephone Company to place underground wires has been deferred. At the meeting of the committee in charge of the matter it was said that they did not like the wood pavement to be disturbed, and that before very long there would be the electric light, and they did not want to open the streets twice. The Surveyor said the electric light wires would go under one path and the telephone wires under the other. It was decided to adjourn the consideration of the matter till the electric light question came up.

Colchester.—The Electric Light Committee have reported that the Electric Construction Company had written stating that the lighting of the town having been placed in other hands, they could not continue the installation at the military hospital, but offered their portion of the plant at £119 6s. The town clerk had been directed to forward a copy of the communication to the consulting engineers, and obtain their views on the matter. It had been resolved that in the event of Messrs. Siemens expressing willingness to undertake the temporary lighting on similar terms to those existing with the Construction Company, their offer be accepted. The report has been adopted.

Proposed New Light Railways.—The Light Railway Commission closed the books for receiving specifications for new light railways to be considered within the next three months on November 30. The list of those who have conformed to the rules and have lodged their proposals in detail contains 30 new projects: 20 for England, six for Wales, and only two for Scotland. Electricity is coming more to the front as a propelling power, there being no less than 16 railways to be supplied in this way; all the rest are steam, with the exception of one hydraulic. The total length of the combined projects is 289¾ miles, of which distance the electrical railways take 125¾ miles, and steam 164 miles.

Hull.—We are glad to see that the authorities recognise the services of the electrical staff, and have shown such recognition in the most practical way—namely, the increase of salaries. Mr. Barnard is to have another £100 a year, and we heartily congratulate him on this, and we trust that it may not be long ere further similar recognition is given, for it cannot for a moment be said that the present salary is adequate for services rendered. Messrs. Bastow, Gray, Coverdale, Young, and Bradshaw have each received an increase of salary. Progress is being made in applications for supply; and we understand that, amongst others, is one from the North-Eastern Railway Company for 263 lights for their goods offices.

St. Helens.—The St. Helens Parliamentary Committee have resolved that the powers for the construction of tramways to be applied for be amended and various extensions inserted. At a meeting of the Tramways Sub-Committee, Dr. Hopkinson submitted a report as to the introduction of electric traction. It was resolved that for the purpose of the generating station the Boundary-road site be adopted, and the generating plant erected there, the steam to be supplied from the refuse destructor, also proposed to be erected on the said site; that on this assumption Dr. Hopkinson be requested to prepare a specification for the erection of the station and for the system of overhead conductors. The Local Government Board have sanctioned the borrowing by the Corporation of £16,500 for electric light extension in the borough.

St. Mary, Islington.—An ordinary meeting of the Vestry will be held to-day, at which the Electric Lighting Committee will present a report stating that pursuant to Vestry reference of November 5, 1897, it has considered an application from the engine-drivers in the department for an increase in pay equal to that received by the drivers of road-rollers; that it finds that the men are being paid the highest rate for this class of work fixed by the Vestry's schedule of wages adopted on January 29, 1897, and that their responsibilities are much less and their duties much lighter than those of the road-roller drivers; and that consequently it is unable to recommend the Vestry to accede to the application.

W. H. Willcox and Co., Limited.—This old and well-established firm has joined the ranks of the limited liability companies. The change has been made for family reasons, and there seems every probability that the change will increase the usefulness of the firm. No shares have gone to the public, but the old employés of the firm have now become shareholders. The increased interest of these gentlemen in the welfare of the concern will enable the rapid growth in business to be coped with. In consequence of this increase of business, the firm have been compelled to take additional offices, situated at 23, Southwark-street, to which all communications should be sent. The removal of the offices has thus enabled the warehouses at 34 and 36, Southwark-street, to be used entirely as showrooms, stores, etc.

Greenock.—A deputation of the directors of the proposed electric lighting company for Greenock have had an interview with the Town Council sitting in committee asking that the Council would give their support to the provisional order which the company were about to apply for to the Board of Trade to introduce electric lighting and electric motor power in Greenock. After being asked whether they were aware that the Corporation had an electric installation at the Water Trust's works at Prospect-hill, which could be put in use at any time for lighting the streets, several of the deputation said that they did not know this. The Provost stated that some time ago the Council had resolved to oppose any application by a private company to introduce electric power or light into the town. The deputation thanked the Council for granting the interview and withdrew.

Dewsbury.—At a meeting of tradesmen of Wellington-road and Nelson-street, Dewsbury, held to protest against the recommendation of the sub-committee of the Gas, Electricity, and Water Committee in respect of the lighting of streets, which entirely ignores the streets named above, the following resolution was carried: "This meeting having seen the recommendation of the sub-committee of the Gas Committee with regard to the placing of arc lamps in various parts of the town, strongly protests against such recommendation as most unjust and unfair, and considers that such recommendation has not been arrived at in an impartial manner." Resolutions were also adopted in favour of a petition urging the better lighting of the places named, and the permanent lighting of the lamps in front of the free library; asking the Tradesmen's Association to assist them, and a committee was appointed to wait upon the Gas Committee.

Woolwich.—The statutory notices of the following appear in the local papers: Bermondsey, Rotherhithe, Greenwich, and Lewisham electric lighting: Power to the County of London and Brush Provincial Electric Lighting Company, Limited, to produce, store, and supply electricity, electrical energy, and power within the parishes of Bermondsey and Rotherhithe, and the districts of Greenwich and Lewisham, all in the county of London, to construct works, etc.; transfer of the Blackheath and Greenwich District Electric Lighting Order, 1897.—Lewisham electric lighting: Application to the Board of Trade under the Electric Lighting Acts, 1882 and 1888, for a provisional order to authorise the Great Western Electric Light and Power Company, Limited, to supply electricity for public and private purposes within the parish of Lewisham.—The Lewisham district electric lighting: The production, storage, and supply of electricity by the Board of Works for the Lewisham district within their district; for the laying down and erection of electric lines.

Leith.—At a meeting of the special committee of Leith Town Council on the tramways on the 1st inst. it was proposed that a committee be appointed to offer the sum of £75,000 to the Edinburgh Street Tramways Company, after first securing a

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satisfactory fixed bargain with the Edinburgh lessees, for which purpose a further conference be instructed with said lessees; and that a new sub-committee be appointed. As opposed to this motion, an amendment on the lines of the sub-committee's recommendation was moved as a recommendation to the Town Council asking the tramway company to implement their statutory obligation as to cabling to the foot of Leith-walk, with a request for an amicable arrangement as to carrying the cable to Bernard-street. This amendment was carried by a majority of one, and on a subsequent division it was resolved by a majority of one also that the town clerk do not communicate with the Edinburgh Street Tramways Company until after the Council meeting next week.

Aberdeen.—At the last meeting of the Aberdeen Gas and Electric Lighting Committee a letter was read from the Secretary for Scotland sanctioning additional borrowing powers to the electric lighting department to the extent of £10,000. The actual expenditure in this department since the commencement of the works has been £52,000, including the £10 000 now sanctioned. Accounts in the gas lighting and electric departments to the extent of £12,000 were passed. It was agreed to sanction the purchase of a new screw-making machine at a cost of £35, capable of making screws on pipes of from 3in. to 4in. diameter. The question of ordering another 600-h.p. engine was also under consideration in view of the rapid extension of electric lighting in the city. It was resolved to instruct Mr. Blackman, the engineer, to prepare a report prior to next meeting in reference to the provision of the engine. The order, it is stated, would require to be in the hands of the contractors immediately, as it takes about nine months to complete an engine of the size required

Stoke-on-Trent.—At the last meeting of the Town Council a letter was read from the British Electric Traction Company respecting the complaint of the Corporation as to the non-commencement of the extension of the tramways to Hanford Bridge, stating that the company were advised that in commencing the works at various points along the line authorised they had fully complied with the order. The town clerk was instructed to reply to the effect that the Corporation were advised that each separate tramway must be commenced within the time specified, and that unless the work was commenced at once the Corporation would exercise their powers under the provisional order. The town clerk was also instructed to enquire why the British Electric Traction Company had not been able to make arrangements with the North Staffordshire Tramways Company to running powers, as when the Corporation consented to the provisional order it was understood that this section would be worked by the North Staffordshire Tramway Company.

Cardiff.—A deputation of owners and occupiers of property in Working-street attended upon the Public Works Committee of the Cardiff Corporation recently in order to protest against the doubling of the tramway line in that street. The Borough Engineer stated that, with the exception of one point, the distance between the kerbstone and the nearest rail would be greater when the line was doubled than it was at present. After the deputation had withdrawn the question was discussed and it was resolved that a plan be prepared showing a pavement only 6ft. 6in. wide on the free library side, so as to allow the greatest possible width for the roadway and the pavement on the eastern side. The Town Clerk reported that he had prepared the agreement with the tramway company, but the committee decided to postpone its consideration. The town clerk was instructed to introduce into the agreement a clause calling upon the company to discontinue the terminus at St. John's-square when the Custom House-street route was opened.

Poplar.—At the meeting of the District Board, on a motion to sign a cheque for £800 for Messrs. Goddard, Massey, and Warner, on account of the dust destructor, Mr. Stephens asked whether the contractors for the dust destructor were keeping their work "up to time." The Surveyor (Mr. Oxtoby) said the work was well in hand, and he was quite satisfied with the progress made. If the contractor did not complete the building by the time specified, he was liable to a fine of £1 a day. The cheque was then signed. At the same meeting a letter was read from Mr. Sydney Morse, on behalf of the County of London and Brush Provincial Electric Lighting Company, stating that the company proposed to apply to the Board of Trade for a provisional order to supply electricity within the Poplar district, and also to cancel the order already granted to the Board. The letter was referred to the Electric Lighting Committee, as also was one from Mr. F. F. Bennett, of 13, Victoria-buildings, Manchester, applying for the post of consulting electrical engineer in connection with the electric lighting scheme.

Ealing.—At a recent meeting of the Council, the Electric Lighting Committee reported that 12,652 8-c.p. lamps had been connected; the total applied for to that day was 14,065. The Council had under consideration a letter from the solicitor for the United Tramways Company stating that it was proposed to fix on the street lamps notices of the intention of the company to apply to Parliament for powers to construct additional tramways, some of which would be in Ealing. The Surveyor said the notices had been fixed upon the lamps in the Uxbridge-road. The Clerk stated that he had given notice of the intention of the Council to oppose the "light railway" scheme. A similar application elsewhere had been refused by the Light Railway Commissioners, and he hoped to be able to find out the exact grounds of the refusal. The Vice-Chairman said the Middlesex County Council had decided to oppose the "light railway" scheme; the other had not yet come before it. He moved that the Ealing Council oppose the London United Tramways Company's scheme. This motion was carried.

Carnew.—A meeting of ratepayers was held last week for the purpose of considering a scheme to light the town by electricity. Mr. W. Speares (surveyor on the Fitzwilliam estate) said he had carefully examined into the details connected with such an undertaking, and he was of opinion that the scheme would be entirely successful. He said that by erecting a turbine on the stream at the lower end of the village, and laying a cable from that through the grounds by Carnew Castle, thence into the street and along the main thoroughfare, it could be easily accomplished. The cost of laying such cable as would be sufficient for lighting all the houses and shops, in addition to the lamps in the street, would be between £1,000 and £1,100. Such an expenditure could be levied upon the rates, and the capital could be borrowed from the Board of Works by the Board of Guardians, who would have power to levy a rate under the Public Health Act. The matter having been thoroughly discussed, a resolution was passed requesting the local Guardians to bring the matter before the Board at their next meeting.

Camberwell.—At a meeting of the Vestry held on the 1st inst. the General Purposes Committee reported as follows: "Your committee has received a letter from the Board of Trade on the subject of the London Electric Supply Corporation order, stating that the Board does not appear to have any power to revoke the order as to part of the area of supply without the consent of the undertakers, or to prevent the undertakers exercising their powers under the order while it still remains in force. Mr. Stewart Bain, the receiver and manager of the London Electric Supply Corporation, attended the committee and offered on behalf of his Board to supply electric light to any municipal buildings in the line of route, if required by the Vestry, at a sum not exceeding 5d. per unit, and to light the roadways at a sum not exceeding 3d. per unit, and to undertake to complete the work in not more than six months from date of order by the Vestry." It was agreed that, subject to terms to the above effect being properly placed before the Vestry, an agreement be entered into between parties.

Catalogues.—We have received an illustrated catalogue of the "Trusty" Engine Works, Cheltenham. We are informed that the firm's engines secured the highest award and gold medal at the Queensland International Exhibition held at Brisbane this year. The catalogue contains a report from Mr. W. Worby Beaumont, M.I.C.E., on trials made with these engines in May 1893, and also a report by Mr. Hamilton Kilgour, M.I.E.E., on trials made January, 1896.—We have received from Messrs. Callender and Montgomery an illustrated catalogue of pure bitumen sheeting, which is used for dampcourse and damp-resisting purposes in the building of factories, asylums, churches, etc., illustrations of some of which are given in the catalogue.—The Reliance Lubricating Oil Company have issued an illustrated catalogue, in which they state that their non-corrosive lubricating oils, having no property of absorbing oxygen and combining with it, cannot cause spontaneous combustion; and that they are strongly recommended by insurance companies for use in textile mills, sawmills, etc., as being free from the risk of spontaneous combustion, from which there is no doubt many fires originate. We notice in the list particulars of patent ornamental oil-cabinets holding from 10 to 50 gallons, adapted for storing oil in engine-rooms, stores, and mills; they are suitable for heavy or light oil, and render waste impossible.

Croydon.—At the enquiry held here last week Mr. Mawdesley stated that the present population of the borough was 120,000, and the ratable value £622,887. Referring to the application for the extension of the electric light, the Town Clerk said this was for the enlargement of the electric lighting station and extension of plant to meet the requirements of the borough. With regard to the electric supply, they had had innumerable applications for additional connections of the light, and in order to enable them to meet these demands, it was necessary to at once make these additions at the works. They were in a little different position now to when the report was made out, and the chairman of the Lighting Committee would give an explanation as to how their expectations had been exceeded. They required £5,550 for these extensions. Prof. Kennedy said they had now some six or seven miles of mains, but no provision for extension of these was made in the estimate. Before they laid more mains they would require extra power. Mr. Mawdesley said there would be another application before the Local Government Board shortly. Alderman Miller said the installation was commenced in September, 1896, and they now proposed to expend £700 for the extension of the building. Their expectations had been entirely exceeded, for the lights absolutely connected were 14,000, whereas they estimated for 11,000 lights. They had applications for 3,000 additional lights. There was no opposition to this application, and the Inspector stated that he would report upon this matter in due course.

Liverpool.—At a meeting of the Corporation Lighting Committee on the 26th ult., the engineer presented his periodical report. The equivalent number of the 8-c.p. lamps connected to the supply mains was for private lighting 55,895, and Corporation lighting 6,139, making a total of 62,034, being an increase of 1,584 for the month. The number of units supplied during the month of October to private consumers was 175,054, and to the Corporation 46,127, making a total of 231,181, as against 147,924 in the corresponding period of 1896. Authority was given for the extension of the mains in Whitechapel, Scotland-road, Everton-road, Aighburth-road, and Brownlow-hill.—At the meeting of the City Council on the 1st inst., Sir Arthur Forwood, M.P., moved as an amendment, upon the motion for the adoption of the general proceedings of the Health Committee, "That so much of the proceedings of the Health Committee as relates to the appointment of the city engineer be not approved; that there be

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added to the special sub-committee appointed by the Health Committee (namely, Messrs. Cookson, Menlove, Purcell, Roberts, and Meade-King) Sir Arthur Forwood, Messrs. T. Hughes, Banner, Paull, Garnett, Bowring, and Oulton, and that they be deputed to consider and report their recommendations as to such appointment and the duties of the office to the Council; and that the maximum salary be £1,500 per annum." Upon a division the amendment was defeated by 58 votes to 7. A further amendment that the maximum salary be £1,200 a year instead of £1,000 was lost by 30 to 29. The Council at this point adjourned until Wednesday, the 15th inst.

Dublin.—A letter has been addressed to the town clerk by the secretary and manager of the Dublin United Tramways Company, in which it is stated that the company are considering the desirability of erecting a great central generating station for the purpose of supplying electric current to both the Dublin United and the Dublin Southern District Tramways Companies, in which they are largely interested. The letter continues to say that the proposal for lighting would be possible only in connection with an electric station with very large engines and dynamos which will be running at least 16 hours out of the 24. The following terms are proposed: (1) that the Corporation should transfer their lighting order to the company; (2) that the Corporation should assign the company all the buildings, plant, stores, etc., used in lighting the city; (3) the company will accept the transfer with all its rights and obligations, and will take over the obligation for the balance of the debt incurred by the Corporation for the lighting installation, and will undertake to pay the annual instalments of interest and sinking fund, or to pay off the debt at the company's option; (4) the company will undertake to provide necessary cables and plant with all possible speed to supply the existing demands for public or private lighting; (5) the company will undertake to reduce the price from the present price of 7d. per Board of Trade unit to 6d. and 4d. respectively for private and public lighting six months after the transfer of the order, and when their new power station is in working order, or, say, within two years, to further reduce the price to 5d. and 3d. respectively; (6) the company is further prepared to largely extend the lighting area beyond the compulsory area mentioned in the order; (7) the company would take over any of the staff or employés in the Corporation lighting station who desired to enter the company's employment.

Llandudno.—A syndicate has been formed to promote the construction of an electric railway to the highest level of the Great Orme, and recently Mr. Enfield Taylor, engineer, Chester, attended a special meeting of the Llandudno District Council to submit plans of the proposed scheme. The Council approved the scheme. The syndicate intends to apply to Parliament next session for the necessary powers, and if they are obtained the company will be formed at once. The District Council are applying for powers to construct electric tramways in the town, and it is expected that the electric lighting scheme will be carried out before next season. Mr. Frederick H. Tulloch, M.I.C.E., held an unopposed enquiry on the 30th ult., on behalf of the Local Government Board, into an application by the Llandudno Urban District Council for powers to borrow a sum of £25 000 for the erection of electric lighting works and the provision of an electric refuse destructor. Mr. A. H. Preece, the engineer, explained the details of the electric lighting works, which it was intended to erect near the present gasworks. The system to be adopted was that known as the three-wire system, and the scheme had been approved of by the Board of Trade. It was proposed to place 30 arc lights on the promenade, extending as far as Penrhyn Crossing, and 20 other arc lights in Mostyn street and the streets crossing thence to the promenade, making 50 in all, each of 1,200 c.p. The electric lighting portion of the scheme would cost £15,300, and £1 000 had been allowed for contingencies. Mr. Stephenson, the Council's engineer, explained the plans of the electric destructor, which would consume about 15 tons of refuse in 24 hours, the present average being about 30 tons per day. The estimate for the erection of this portion of the works was £8 591.

TRAFFIC RECEIPTS.

Bristol Tramways.—The traffic returns for the week ending November 26 were £2,339. 13s. 10d., compared with £1,917. 4s. 7d for the corresponding period of last year, being an increase of £422. 9s. 3d.

Dover Tramways.—The traffic receipts for the week ending November 27 were £85. 3s. 1d. The total receipts up to the same date were £1,423. 18s. 4d. The mileage open at present is only two miles.

Birmingham Tramways.—The traffic receipts for the week ending November 27 were £3,164. 10s. 7d., as compared with £3,031. 7s. 8d. in the corresponding week in 1896, being an increase of £133. 2s. 11d.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended November 28 amounted to £1,257, as compared with £1,148 in the corresponding week of the previous year, being an increase of £109.

City and South London Railway.—The returns for the week ended November 28 were £1,060, compared with £1,054 for the corresponding period of last year, being an increase of £6. The total receipts for the half-year 1897 amounted to £20,783, compared with £20,895 for the corresponding period last year, being a decrease of £112.

South Staffordshire Tramways.—The traffic returns for the week ending November 26 were £544. 5s. 5d., as compared with £557. 13s. 2d. in the corresponding week of the previous year. The aggregate receipts so far this year were £29,862 11s. 4d., as compared with £28 942. 7s. 6d in the corresponding period in 1896.

S.D. Tramways, Dublin.—The traffic receipts for the week ending November 19 were £380. 12s. 8d., as compared with £411. 16s. 10d. in the corresponding week in the previous year, being a decrease of £31. 4s 2d. The number of passengers carried was 65,213 in 1897 and 62,750 in 1896. The aggregate returns up to date are £13,549. 12s. 1d., as compared with £14,135. 18s. 11d. last year, being a decrease of £586. 6s. 10d. The mileage open is the same as last year—viz., eight miles.

PROVISIONAL PATENTS, 1897.

NOVEMBER 22.

27303. Improvements in prepayment electricity meters. Charles Ashmore Baker, 27, Burnaby-gardens, Chiswick, London.

27345. Improvements in sockets for incandescent lamps. Georg Jaeger and Hermann Bender, 10, Friedrichstrasse, Berlin. (Complete specification.)

27346. Improvements in sockets for incandescent lamps. Georg Jaeger and Hermann Bender, 10, Friedrichstrasse, Berlin. (Complete specification.)

27357. Means to be employed for charging a small number of accumulator elements from high-voltage electric currents. Camille Brault, 47, Lincoln's inn-fields, London.

27366. Improvements in electrical switches. Jacob Gutmann, 6, Bream's-buildings, Chancery-lane, London.

27372. Improvements in the construction of the glass bulbs of electric incandescent and other lamps. Charles Edward Muller and Rowland Frederick Hurran, 165, Boleyn-road, Forest Gate, London.

27374. Improvements in the construction of transformers, choking coils, and similar electric appliances. Walter Langdon-Davies, 24, Southampton-buildings, Chancery-lane, London.

27380. Improvements in and relating to electrical cut-outs and fittings. George Montague Sellick, 70, Chancery-lane, London.

27385. Improvements in the manufacture of incandescent lamps. Adolphe Wierre, 53, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, September 25, 1897, being date of application in France.)

27405. Improvements in or relating to incandescent lighting. Robert Farrington, Malcolm Horseley Hawes, and William Hudson Hand, 111, Hatton-garden, London.

NOVEMBER 23.

27428. Improvements in and connected with electric furnaces for the production of calcium carbide and other substances. Herbert Sydney Riant, 11, Furnival-street, Holborn, London.

27430. Improvements in fixed and portable electrically-driven circular sawing, moulding, rebating, planing, and surfacing machinery. George Cameron, 13, Hayburn-street, Partick, Glasgow.

27433. Improvements in electric cables. George Hinde Nisbett and Darwin Bates, 15, Water-street, Liverpool.

27451. Improvements in fastenings for boxes for electric accumulators and the like. Edward Robert Dale, Crane Villa, Salisbury.

27483. Improvements in connection with electric arc lamps. Peter Spies, William Henry Newall, and Alfred William Shout, 25, Brampton-road, South Hackney, London.

27494. Improvements in the method of and means for regulation of alternating-current systems. The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. (Charles P. Steinmetz, United States.) (Complete specification.)

27495. Improvement in starting devices for alternating-current motors. The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. (William J. Foster, United States.) (Complete specification.)

27496. Improvements in dynamo-electric machines of the inductor type. The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. (Charles P. Steinmetz, United States.) Complete specification.)

27508. Improvements in and connected with the extraction of gold by electrolysis. Octavius March, 40, Chancery-lane, London.

27509. A new or improved meter for electric current. Joseph Möhrle, 18, Buckingham-street, Strand, London.

27543. Improvements in electric cables. John Duncklee Gould, 53, Chancery-lane, London. (Complete specification.)

27544. Improvements in automatic electro-mechanical circuit closers. Charles Wesley Price and John Duncklee Gould, 53, Chancery-lane, London. (Complete specification.)

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27551. Improvements in means to be employed in the electrolysis of salts. Joseph Wilson Swan and Augustus Charles Hyde, 47, Lincoln's-inn-fields, London.

NOVEMBER 24.

27598. Improvements in electrical fusible cut-outs. Gustav Byng, 73, St. Stephen's-road, Upton Park, London.

27619. Improvements in incandescent electric lamps. Robert Nordmann, 8, Rue des Princes, Brussels.

NOVEMBER 25.

27672. An improvement in the application of heat (by gas, electricity, or any other source of heat controllable by a tap or switch) to the sterilisation of water whereby the process is rendered noiseless and automatic. Charles Astley Owen, 16, Molesworth-street, Dublin.

27683. Improvements in and connected with electrical storage batteries. William Henry Lane, Perugia, Sidney-road, Staines.

27695. An improved switch for the making and breaking of high-voltage electric currents. Samuel Edward Foster, 21, Bull-street, Harborne, Birmingham.

27706. Improvements in barrelling electro-metallic depositing apparatus. John Eborall Hartley and Herbert Edward Hartley, 12, Cherry-street, Birmingham.

27707. Improvements in rotative electro-metallic depositing apparatus. John Eborall Hartley and Herbert Edward Hartley, 12, Cherry street, Birmingham.

27712. Improvements in electrodes for use in connection with apparatus for welding and soldering by means of electricity. Albert Hirsch, 18, Southampton-buildings, Chancery-lane, London.

27714. Improvements on those systems of electric tramways and railways in which current is collected from two insulated conductors (positive and negative)—such improvements being in connection with crossings and turn-outs. John Johnston, 22, Ironmonger-lane, Cheapside, London.

27715. Improvements in incandescent electric lamp globes and in the manufacture of the same. George Silas Hingley, 77, Colmore-row, Birmingham.

27725. Improvements in the construction of accumulators. Henry Leitner, 37, Chancery-lane, London.

27749. Improvements in arc lamps. William James Davy and George Thomas-Davies, 40, Chancery-lane, London.

27765. Improvements in electric arc lamps. Thomas Spencer, 111, Hatton-garden, London. (Complete specification.)

NOVEMBER 26.

27805. Improvements in electric lampholders. Alfred Watson, 24, Temple-row, Birmingham.

27806. Improvements in electrical switches. Alfred Watson, 24, Temple-row, Birmingham.

27807. Improvements in and in the manufacture of switches for electrical purposes. Alfred Watson, 24, Temple-row, Birmingham.

27812. Improvements in electrically-propelled vehicles. Robert McLaughlan McDonald, 121, West George-street, Glasgow.

27837. Improvements in electrical indicators for use on public and other vehicles. Hugh White and Reginald Charles Graham, Hogarth House, Clapham, London.

27844. An apparatus for gripping and removing or placing in their holders electric incandescent lamps, globes, and other articles. Frederick Nairn Haward and Herbert Henry Cass, 55, Chancery-lane, London.

27845. Improvements in arc lamps and in magnet winding for same and other purposes. Joseph Devonport Finney Andrews, 45, Fulham Park-gardens, London.

27861. Improvements in electric cables. Henry Edmunds, 47, Lincoln's-inn-fields, London.

27875. Improvements in electric lifts. Alfred Soames, 24, Southampton-buildings, Chancery-lane, London.

27888. Electric furnaces. Charles S. Bradley, 111, Hatton-garden, London. (Complete specification.)

NOVEMBER 27.

27926. Improvements in cable or conductor ways and connections therefor for underground electric traction. James Carr, 2, Market-street, Bradford.

27940. Improvements in electric batteries. Maurice Orban, 8, Rue des Princes, Brussels.

27970. Improvements in dynamos and motors. Albert W. Smith, 58, Grafton-street, Fitzroy-square, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, May 3, 1897, being date of application in United States.)

27973. Improvements in charging secondary batteries or accumulators. Cecil Clark, 2, Lancaster-place, Strand, London.

27980. An alternate-current electric motor. Charles Tuson, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

27982. Improvements in primary batteries. Walter Rowbotham, 18, Southampton-buildings, Chancery-lane, London.

27995. Improvements in or connected with devices for protecting electric circuits and apparatus from injury by excessive electrical potential due to lightning or other cause. Valere Alfred Fynn, 47, Lincoln's-inn fields, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1895.

22661.* Indicating and recording electric supply. Baron Kelvin. (Amended.)

1896.

19757.* Electric lamp circuits. Lake. (Black.) (Amended.)

25170. Loud-speaking long-distance telephone. De Kilduchevsky.

27053. Insulator device for carrying vertical or other similarly suspended electric cables. Holiday.

27167. Electrical batteries. O'Keenan.

27588. Insulating material for electric conductors. Hawkins.

27695 Insulation of electric conductors. Hawkins.

28062. Device for regulating the distance apart of freshly-inserted carbons in arc lamps. Holsten.

28443. High-tension electric fusible cut-outs. Still and Cowan.

28884. System of electric distribution for combined lighting and traction plants. Blackburn and Spence.

29120. Conduits for electrical traction. Waller.

29121 Electrical fittings for conduits adapted to electrical traction. Waller.

29472. Electric switches. Jackson and Co., Limited, and Lewis.

1897.

488. Dynamo-electric machines and electromotors. Marshall.

18430. Manufacture of electric accumulators. Pescetto.

20493. Transmission of energy by alternating currents. Bradley.

20913. Machine for painting electric casing and the like. Cutting and Cutting

21054. Surface-contact electric railway systems, electric cars and their equipment, and automatic switches for use therewith. The British Thomson-Houston Company, Limited. (Hewlett.)

22023. Electric arc lamps. Imray. (Bergmann.)

22032. Detachable securing mechanism for electric incandescent lamp shades. Adolph.

22521. Electric furnaces. Horry.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	11½
Brush Company, Ordinary	3	1¾-2
—— Non. Cum., 6 per cent. Pref.	2	2¼-2⅜
—— 4½ per cent. Debenture Stock	100	107-111
—— 4½ per cent. 2nd Debenture Stock	100	98-102
Callender's Cable Company, Debentures	100	108-113
—— Ordinary	5	7-8
Central London Railway, Ordinary	10	9¾-10½
——	6	5¾-6
Charing Cross and Strand	5	12-13
Chelsea Electricity Company	5	10½-11
—— 4½ per cent. Debentures	100	113-116
City of London, Ordinary	10	26½-27½
—— 6 per cent. Cumulative Pref.	10	17-18
—— 5 per cent. Debenture Stock	100	131-136
City and South London Railway, Consolidated Ordinary	100	68-70
—— 4 per cent. Debenture Stock	100	138 140
—— 5 per cent. Pref. Shares	10	15½ 16
County of London and Brush Provincial Co., Ordinary	10	14½-15
—— 6 per cent. Cum. Pref.	10	15½-15¾
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1¾ 2¼
—— 5 per cent. Debentures	—	89 94
Edison and Swan United Ordinary	3	2¼-3
—— 5 per cent. Debentures	5	4-5
Electric Construction, Limited	2	2¼-2⅝
—— 7 per cent. Cumulative Pref.	2	3¼-3⅝
Elmore's Copper Depositing	1	⅛-¼
Elmore's Wire Company	2	¼-½
W. T. Henley's Telegraph Works Ordinary	10	20-21
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	9½-9¾
—— 7 per cent. Preference	5	11-11½
India Rubber and Gutta Percha Works	10	22-23
—— 4½ per cent. Debentures	100	108-107
Kensington and Knightsbridge Ordinary	5	14½-15½
—— 6 per cent. Pref.	5	8-8½
London Electric Supply, Ordinary	5	2¼-2⅝
Metropolitan Electric Supply	10	18½-19½
—— 4½ per cent. First Mortgage Debenture Stock	100	119-123
National Telephone, Ordinary	5	6¼-6½
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	14-16
—— 5 per cent. Non. Cum. Third Pref.	5	6-6½
—— 3½ per cent. Deb. Stock	100	104-109
Notting Hill Company	10	16½-17½
Oriental, Limited, £1 shares	1	1½-2 xd
—— £5 Shares	5	8-8½ xd
—— £4½ shares	4½	7-7½ xd
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	104-106
South London Electric Supply, Ordinary	2	2¼-3
St. James's and Pall Mall, Ordinary	5	16½-17½
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	36-39
—— 5 per cent. Bonds	100	103-105
Waterloo and City Railway, Ordinary	3	12¾-13
Westminster Electric Supply, Ordinary	5	15-16
Yorkshire House-to-House	5	8-8½

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NOTES.

Acetylene.—The *London Gazette* last week contained an Order in Council declaring acetylene to be an explosive, and prohibiting it from being manufactured, imported, kept, conveyed, or sold.

Electrical Fashions.—A glance at the interior of Covent Garden Theatre on the occasion of a fancy dress ball reveals the fact that electricity is gradually beginning to play a more prominent part in the decoration and illumination of ladies' costumes.

Nickel Manufacture.—The *Elektrotechnischer Anzeiger* says that Prof. Foerster, of Dresden, has found that by using a nickel bath of 50deg. to 90deg. C., instead of the usual one of 18deg. to 20deg., one can make layers of bright nickel of high density which will polish well.

The British Association. — The Corporation of Glasgow have expressed their approval of a letter from the British Association for the Advancement of Science stating that the general committee of the association had unanimously resolved to hold the annual meeting of 1901 in Glasgow.

Horse-Power in Prussia.—At October 1 last there were 2,186 steam-engines, with a total horse-power of 149,096, employed in Prussia, solely in connection with electricity plants; and there were 651 engines, with a total horse-power of 42,839, which were not solely devoted to electricity.

The Electric Lighting of Lyons.—We learn that the Société de Jonage have informed the Administration that they will supply electric light for public services, both in the department and the town of Lyons, at the reduced price of five centimes per hectowatt-hour. This is about 4¾d. per kilowatt-hour.

Mr. Preece's Health.—We are sorry to hear that Mr. W. H. Preece, the engineer-in-chief of the General Post Office, has been on the sick list for several weeks past. He left in the P. and O. ss. "Britannia" last Friday for the Mediterranean, and we hope that he will be quite restored to health by the change of air.

A New Honour.—A Royal warrant has been granted to the Electrical Power Storage Company, Limited, appointing them makers of electrical secondary batteries to her Majesty. We believe that this is the first Royal warrant granted to any electrical firm, although electric lighting has been in use at several of the Royal palaces since 1882.

Exhibition of Acetylene.—A general and international exhibition of carbide of calcium and acetylene and all that relates to them is being organised at Cannstatt (Wurtemberg). It will be held in February, and will be the first public exhibition of the kind. All enquiries should be addressed to Messrs. Herm. Weissenburger and Co., Cannstatt.

Departing Trade.—The New York correspondent of the *Morning Post* states that another large English order for iron goods and machinery has just been booked by American manufacturers, a commission having been received from Coventry for the supply of 1,500 tons of tramway rails and 900 tons of electrical machinery. And yet our workmen still remain idle.

A Tramway Across the Ice.—*L'Electricien*, in its issue of November 27, published a rumour that for the next winter season Cronstadt would be joined to Oranienbaum by a line of electric tramways laid across the surface of the ice in the Gulf of Finland. It would doubtless be all right, provided that a sudden thaw did not surprise the passengers in the middle of their journey.

The Hartlepool Accident.—The accident in connection with the breaking of a wire on the electric trams, which we recorded last week, seems to have spread a considerable amount of consternation among the laics, judging by the different accounts in the local newspapers. In some quarters the impression seems to prevail that the horse which was killed was engulfed in a sort of burning, fiery furnace of biblical dimensions.

Telephone Municipalisation.—The General Purposes Committee of the Huddersfield Corporation have adopted a recommendation from the Electric Lighting Committee to apply to the Postmaster-General for a license to supply telephonic communication within the borough. The National Telephone Company, which at present serves the district, applied to the Corporation some time ago for sanction to lay wires underground.

Institution of Civil Engineers.—At the ordinary meeting on Tuesday, December 7, Sir John Wolfe Barry, K.C.B., F.R.S. (president), in the chair, it was announced that 27 associate members had been transferred to the class of members, and that 101 candidates had been admitted as students. The first ballot of the session 1897-1898 resulted in the election of 19 members, 32 associate members, and five associates.

Chamber of Commerce.—The Lord Mayor will preside at the distribution of certificates and prizes gained by candidates at the fourth senior and eighth junior examinations under the commercial education scheme of the London Chamber of Commerce. The distribution will be made by the Right Hon. G. N. Curzon, M.P. (Under-Secretary of State for Foreign Affairs), at the Mansion House, E.C., on Friday, December 10, at 3 p.m.

Canadian Electric Trust.—A Canadian correspondent states that active negotiations are proceeding between a group of capitalists at Toronto and a large number of electrical and gas-lighting undertakings throughout the Dominion of Canada, but especially in the province of Ontario. The idea is to amalgamate all these different enterprises under one management, and thereby to effect considerable economies in the cost of administration.

Bequest to the Royal Society.—The late Sir W. A. Mackinnon (honorary surgeon to the Queen, and formerly Director-General of the Army Medical Department) bequeathed the residue of his estate, estimated, after payment of the duties, at over £16,000, to the Royal Society for the furtherance of natural and physical science, and for the furtherance of original research and investigation in pathology by prizes and scholarships.

Colour Photography.—Prof. Gabriel Lippmann, who was recently awarded the progress medal of the Royal Photographic Society for "photography in colours by the interference method," will read a paper on the subject before that body at the theatre of the Society of Arts, John-street, Adelphi, at 8 p.m. on Tuesday, the 14th inst. Admission for non-members can be obtained by ticket, which may be had on application to the secretary at 12, Hanover-square.

Lecture on Trams.—The value of electric trams has taken a strong hold on the Irish mind. A short time ago a lecture was given by Prof. Barrett, in Kingstown, on electric tramways and railways, and it was so well received that Prof. Barrett has repeated it, in response to a representative request of the inhabitants. It is always encouraging to observe a genuine desire for knowledge, and an interesting demonstration with working models is a very useful way of enlisting public sympathy.

Royal Institution.—A general monthly meeting of the members of the Royal Institution was held on Monday

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afternoon, Sir James Crichton-Browne, treasurer and vice-president, presiding. The following were elected members: the Hon. H. M. Birdwood, C.S.I., Major John Leslie, Captain H. G. Lyons, R.E., and Mr. Cecil Powney. The special thanks of the members were returned to Prof. Dewar for his present of a portrait of Mr. Benjamin Vincent, hon. librarian of the Royal Institution.

Electric Omnibuses.—A rumour was current last week that the London General Omnibus Company had entered into a contract to put 400 electric omnibuses on the streets. This rumour has been denied, though, of course, not officially, but we may rest assured that if a powerful company like the London General Omnibus Company, with its intimate knowledge of the requirements of the traffic, were to come across a satisfactory type of electric 'bus, they would not hesitate to adopt it.

Cheshire Chemical Trade.—The state of the trade is getting worse and worse, and the outlook for the winter is very gloomy. Last Friday a large number of fitters, joiners, pansmiths, labourers, etc., employed at the chemical works of Brunner, Mond, and Co., Northwich, received notice that their services will be dispensed with. Following upon the closing of the old bleach plant at these works a few days previously, and the depression which has existed for some time past, the news has created consternation.

The Telegraph to Terra del Fuego.—It is stated that work is shortly to be commenced on the military telegraph line from the Rio Negro, in Argentina, to Terra del Fuego. The line is in two sections—the first, from Rio Negro to Puerto Deseado, which is the longest and the worst, is under the supervision of Captain Leroux; and the second, which terminates at Terra del Fuego, is in charge of Frigate Captain Funes. The prospecting is not quite finished, but the poles have arrived, and are reported to be of a quality which will not last more than a year.

Yet Another Society.—Mr. Herbert Coward, C.E., in his presidential address before the members of the Civil and Mechanical Engineers' Society at the inaugural meeting of the session 1897-98 at the Hotel Victoria, Northumberland-avenue, last week, suggested that engineers' draughtsmen should improve their position by combining in an intelligent and moderate manner to form a union or society for themselves—a society that should define the positions or grades of draughtsmen, and fix a minimum rate of wage for each grade.

Naval Engineers.—The ninth annual conversazione of the Institute of Naval Engineers was given at Stratford Town Hall on Friday evening. In the course of the evening, the President (Mr. J. Flannery, M.P.) gave an address, in which he referred to the early history of the generation of steam, and the marvellous evolution of its uses which had taken place during a single century. With reference to the question of the exhaustion of the coal supply, he spoke of other sources of the production of power, such as water, liquid fuel, and electricity.

The American System of Naval Communication.—The Navy Department of the United States Government is perfecting a system of communication along the Atlantic coast, by means of which naval vessels lying off shore may communicate with the land. The system includes semaphore signals and telegraph and telephone lines. The existing telegraph and telephone system of the life saving service will be utilised in the new scheme. A feature is the establishment of a Government line to Washington, which will be connected with the coast system.

The Camera Club.—An exhibition has been opened at this club of photographs executed for the purpose of making an archæological survey of the British Islands. The exhibition has been organised by the Camera Club with a view to promoting the same objects as those pursued by the National Photographic Record Association. Amongst the contributions is a scale for measuring the objects photographed, sent by Mr. St. John Hope, F.S.A. It consists of a paper scale mounted on wood, and marked on one-half in English feet and on the other according to the metric system.

Association of Mechanical Engineers.—The annual meeting of this association was held on Saturday evening at Birmingham. There was a large attendance of members. Mr. Cox was re-elected president; Mr. J. J. Inniss was re-elected vice-president; and Messrs. W. F. Clark, G. Conaty, W. J. Talbot, and E. Binns were again appointed to serve on the committee. Mr. J. Mills was asked to continue the office of auditor; Mr. J. F. Crockatt that of treasurer; and Mr. L. O'Brien still retains the secretaryship. Votes of thanks were passed to the officers for their past services.

Electric Enterprise in Smyrna.—It is reported from Constantinople that a syndicate of financiers are applying for the concession to supply Smyrna with electric light, and have already handed in their project to the Ottoman Government. According to their proposals, the town is to receive 10 per cent. of the income and the free lighting of all public buildings, and they are willing to increase the number of street lanterns, and to reduce the cost of lighting to half the present expenditure with gas. Smyrna, in spite of its important position in the Levant trade, has not yet been properly lighted.

The First French Electric Railway.—The *Revue de l'Electricité* states that the construction of the first electric railway in France is to be commenced immediately by the Paris, Lyons, and Mediterranean Company. The line will connect Fayet and Chamounix. The carriages will be automotor, and the current will be taken from a lateral rail by means of metallic brushes. The same system has been adopted on the Salève railway. The motive force will be derived from two stations which elevate the waters of the Arve to a height of 240ft. The line will have a length of over 11 miles, and will cross the River Arve five times.

Dijon Exhibition, 1898.—The Department of Science and Art has received, through the Foreign Office, a copy of a dispatch from her Majesty's Ambassador in Paris, relating to an intermediate international exhibition, to be held at Dijon, from June 1 to October 31, 1898. The exhibition will be of a general character, and the committee and the city of Dijon will be glad to welcome a large number of British exhibitors. Further particulars can be obtained on application to the organising committee of the exhibition, 38, Rue Monge, Dijon. As a prelude to this exhibition, an exhibition will be held at Lyons during February, March, and April. Communications should be addressed to 32, Rue des Remperts-d'Ainay, Lyons.

Electric Light in India.—The capital town of Darjeeling, in the province of Madras, has just been installed with the electric light, and the installation was formally opened on the 10th of last month by the Lieutenant-Governor of Bengal in the presence of a large gathering of native and European residents. The capital cost of the scheme, including the expenditure likely to be incurred in supplying electricity to private houses on the terms of the agreement, and on constructing a house for the officer in charge of the machinery, will be about £12,000, and the cost of maintaining the installation will be about £900 a year. The Commissioners propose to meet this charge, together with the payments on account of

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interest and sinking fund, by imposing an annual rate under the Bengal Municipal Act. There is a population of about 25,000.

The Institution of Junior Engineers.—In connection with a paper on "Main Engine Auxiliaries in the Mercantile Marine," to be read before this institution this evening (December 10), a visit was paid on Saturday, December 4, to Messrs. Shaw, Savill, and Albion Company's ss. "Aotea," lying in the Royal Albert Docks. The chief engineer, Mr. McCulloch, received the members, and, in showing them round, indicated the features of special interest in the main engines and their auxiliaries. Two sets of Haslam's refrigerating machines are installed for the frozen meat freight, a heavy cargo of which was being unshipped at the time of the visit. Before the party dispersed, Mr. H. B. Vorley, the chairman of the institution, expressed the members' acknowledgments for all that had been arranged for their reception.

The London Juggernaut.—A correspondent writes to the *Times* pleading for an alteration in the construction of the body of the electric cabs. He says they are too low, and anyone falling under them would have no chance of escape, and if he were going to be knocked down at all he would sooner take the chance of going down under an omnibus, horses and all, "than under one of those Juggernaut cars." He relates a pretty little "fact" which occurred to a friend of his, a cyclist. This man cycled into an omnibus, which, with the horses, completely passed over him, and he came out at the other end (*sic*) unhurt, though his machine was smashed to pieces. After this wonderful experience, which we can only look upon as a miracle considering the average weight of horses and omnibuses, we wonder that "M. G. A." has any fear of traffic at all, even of electric cabs.

Agents in France.—The Secretary to the British Chamber of Commerce in Paris writes from 25, Boulevard des Italiens, to call attention to the November number of the monthly circular issued by this Chamber, and to the list which it contains of agents and travellers in various branches of trade who are open for the representation of British houses. "It is a common complaint," he says, "that firms desirous to do business with France cannot get introductions to parties likely to represent them as agents. This Chamber receives a large number of applications for agencies and representations from French and English firms and individuals in Paris and the provinces, and is always glad to place them in communication with English firms intending to do business with this country. The introductions are, of course, made without any guarantee or liability of any sort on the part of the Chamber, but facilities are afforded for making enquiries."

Royal Institution.—The following are the lecture arrangements before Easter: Prof. Oliver Lodge, six Christmas lectures (specially adapted for young people) on "The Principles of the Electric Telegraph"; Prof. E. Ray Lankester, 11 lectures on "The Simplest Living Things"; Prof. Dewar, three lectures on "The Halogen Group of Elements"; Dr. J. Paul Richter, three lectures on "Some Italian Pictures at the National Gallery"; Prof. J. A. Fleming, five lectures on "Recent Researches in Magnetism and Diamagnetism"; Prof. Patrick Geddes, three lectures on "Cyprus"; Mr. William H. Hadow, three lectures on "The Structure of Instrumental Music"; Mr. Lionel Cust, two lectures on "Portraits as Historical Documents, Portraits as Monuments." The Friday evening meetings will begin on January 21, when a discourse will be given by the Right Hon. Sir John Lubbock, Bart., M.P., on "Buds and Stipules." Succeeding discourses will probably be given by Prof. C. Lloyd Morgan, Mr. A. A. Campbell Swinton, Dr. J. Hall Gladstone, Prof. L. C. Miall, Captain Abney, Prof. J. E. Thorpe, Mr. James Mansergh, the Dean of Canterbury, Prof. Dewar, and other gentlemen.

The Railway Agitation.—For some time past there have been ominous rumours of war among the railway workers of the kingdom. Communications were sent to every railway company in reference to wages and the hours of labour, with a request that the companies would submit the matter to arbitration. This was very premature, because, as several of the companies pointed out, there was no disagreement between them and their men, and therefore there was nothing to arbitrate. The companies refused altogether to admit the demands of the Amalgamated Society of Railway Servants, and therefore this body wanted to go in a deputation to submit their grievance to Mr. Ritchie and ask for his intervention. That astute gentleman, however, administered them such a severe rebuke that it has effectually quenched the ardour of the agitators. The editor of the official organ of the Amalgamated Society also discouraged the idea of striking on the ground that the men were not sufficiently strong to do it. For thus expressing his opinion, and perhaps saving the society a useless defeat, Mr. Maddison, M.P., has been called to account, so he has naturally sent in his resignation, which has been accepted. The Amalgamated Society are still considering as to the best course to adopt to obtain redress for their alleged grievances.

Rapid Railroad Construction.—A short time ago the New York and Philadelphia Traction Company were under the necessity of putting in 2½ miles of single electric railroad track within the 24 hours, and in spite of the stupendous nature of the task it was accomplished two hours under the time. The work had to be done to prevent an injunction. Five hundred and fifty men were transported to the locality with as much secrecy as possible, together with car-loads of tools and provisions. The hauling included 250 tons of rails, and large quantities of ties, poles, etc. As the work was done partly in the night-time a large quantity of lighting apparatus had also to be provided, consisting of thousands of Wells's flares and gasoline flares. In nine hours all the grading was completed, and close on the heels of the ploughing teams came the track-layers, the bonders, the linemen, and the pole-setting gangs. The power was derived from an isolated plant in a hotel, and this necessitated 2,000ft. of feeder line being constructed. In 22 hours from the commencement of the work the current was turned on and the car taken over the track. There is a very graphic description of this feat in the *Electrical Engineer* of New York which reads like an exciting up-to-date novel in a nutshell, with attempted arrests, guns, pistols, desperate conflicts, storms of wind and rain, and other stirring incidents thrown in.

Burglar Alarms.—An Italian named Corradino Parodi, of Genes, has taken out a patent for all the towns of Europe of an apparatus which he has invented to protect houses against burglary. The system is this: Supposing a burglar comes to a house at night; directly he opens the door or window, a light flashes out from a lamp hidden in the room. This will so surprise the gentleman that he will pause a moment in astonishment, which gives time for his photograph to be taken by an instantaneous and automatic machine. When this is done the lamp does not go out, and the burglar will find it useful as a dark lantern to reassure his shaken confidence, and to help him in his work. But it is a false friend, for all the while a contact is established with a bell which awakens the porter, and another contact sets the telephone in motion at the central exchange and summonses the police. On the face of it, the poor

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burglar doesn't stand a chance, but if he is cautious many things may happen. In the first place, it is not likely that he will be within distinguishable focus of the automatic photographer, and in the second place it is very easy to put the whole system out of order. Burglars usually carefully inspect a place before they attempt to enter it, and they will easily find some way of evading the trap which is set for them. All these patent schemes seem to have serious drawbacks, and, after all, as a French critic observes, the best way to prevent burglaries is to have a good watchdog and a good revolver!

Electrical Progress in South Africa.—The success of Durban's electric light installation is such that the borough engineer has announced his anticipation at being able at no distant date to very much extend the system, and also to effect a considerable reduction on the high price charged the consumer for current for lighting and cooking purposes. The *British and South African Export Gazette* says that the Town Council have also been recently deliberating on a proposition to acquire the existing tramway company's interest, and to inaugurate a public electric tram service. This proposition is an alternative to that of a powerful syndicate which proposed to acquire and convert the existing tramways into an electric undertaking. No decision on this subject has, however, yet transpired. The electric lighting scheme for Port Elizabeth, which the Town Council are undertaking themselves, is not being delayed. The services of an expert are to be secured to proceed to South Africa to report on the most suitable installation for the circumstances of the town. According to the terms of the contract with Messrs. Siemens and Halske, the lighting of the suburbs of Johannesburg with the electric light should now be complete, and the whole of the area of the Golden City will probably be well lit by the end of this year. It has been decided to take current from the Rand central electric lighting works through a transformer located at the City and Suburban. The construction of the Pretoria tramway is making good progress, the length of the line when completed being 3½ miles. It is being laid so as to be available for electric traction so soon as the Raad's permission is obtained.

The Constituents of the Atmosphere.—The first ordinary meeting of the Royal Society of Edinburgh for the present session was held on Monday evening. Lord Kelvin presided, and gave an address on "The Food, Fuel, and Air of the World." He said that what he meant by food or fuel was anything combustible, and the proposition he laid down was that the total quantity of fuel on the earth had a definite relation to the total quantity of oxygen. Reducing it to a standard, every kind of fuel required three times its weight of oxygen to burn it. In other words, the present quantity of oxygen in the air was equal to three times the weight of all the fuel plus an unknown quantity, which might be zero. It was conceivable that the primitive atmosphere had no oxygen at all, and that the primitive vegetation began to introduce oxygen. It was not only conceivable, but there was a *primâ facie* case for its probability. Oxygen was the most abundant of all the chemical elements, and it was quite possible that there might have been a slight redundancy of oxygen in the atmosphere ready for plant and animal life. A million or two of years did not count very much in the history of the world, but when he considered the question whether there was or had been sufficient vegetation on the earth to account for our present atmosphere, he was driven to the conclusion that there probably was a great amount of oxygen in the primitive atmosphere. In conclusion, his Lordship pointed out the small amount of carbonic acid gas there was in the atmosphere, and suggested, as an interesting question, whether a plant could live healthily in an atmosphere from which the carbonic acid had been carefully taken out.

Signalling Across Space. — Prof. Silvanus P. Thompson gave a lecture last week at the London Institution on signalling across space without the use of intermediate wires. The first part of the lecture was devoted to an account of the references found in mediæval writers to sympathetic telegraphy by means of the magnetic needle, and then Prof. Thompson described several methods of sending signals by electricity between distant places without intervening wires. The first was by conduction. If, for instance, two pairs of metal plates were placed in the water of a river, one pair being on each side, with its two plates connected by a wire along the bank, then the water could be used to complete the circuit, provided the plates were at a proper distance from each other. The second method was by induction, and had been used on a practical scale by Mr. Preece. The third was by means of Hertzian waves. Hertz proved experimentally that when electric sparks were made, electric waves were given off in every direction, and he showed how these might be detected. Lodge in his coherer found a simpler and more satisfactory way of detecting them, but the idea of using them for telegraphing to long distances was not apparently contemplated by him. Tesla, in 1893, was the first to appreciate this possibility, but press of other work prevented him from carrying it into practice. More recently the British Post Office had taken the matter up at the instigation of a young Italian—Mr. Marconi. The lecturer said he had not been able to find out what was new in the apparatus of Marconi, who had simply improved the coherer. However, he had been able to signal for a distance of three miles on Salisbury Plain and about nine near Cardiff, while in Germany recently, by using a sufficiently high base line, it had been found possible to detect the waves with a coherer like Lodge's at a distance of 13 miles.

The Racing of Engines.—A lengthy description is published in the *Electrical Review* of New York of an automatic device for limiting the speed of engines so as to prevent accidents by engines "running away." This machine, or engine-stop, consists of a cylindrical iron case through which runs a 1¼in. horizontal shaft. Attached to one end of this shaft outside the casement is a combination drum and sprocket wheel. At the other end and inside the case is located an air dash-pot, 9½in. in diameter by 3in. in depth. To the shaft at this end is attached a dash or plunger which is operated by a coarse thread cut on the shaft at this point, running through a corresponding thread in the hub of the dash. Attached to the shaft on the inside of the case, and near the combination drum and sprocket wheel, is a steel ratchet wheel 4½in. in diameter. Running across the machine near the ratchet wheel is an iron bridge, to which are attached three binding posts, which pass through insulated bushings in the bridge, the lower ends of which are connected by wires with the magnets, which are placed in a vertical position under the bridge. To the armature on the top of these magnets is attached a horizontal lever which locks or unlocks at will the perpendicular lever to which is attached a vertical steel pawl, which is held in engagement with the ratchet wheel by a brass spiral spring. Running from the sprocket wheel is a sprocket chain connected with a similar sprocket wheel attached to the throttle-valve stem just behind the handwheel, which makes a positive connection between the machine and the throttle valve. This device acts exclusively on the throttle valve. To the binding posts are connected electric wires running to various portions of the plant, to which may be

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attached as many push-buttons as desired. A description is also given of an automatic speed limit, which is attached directly to the main or flywheel shaft of the engine. It is a device which can be used in connection with the engine-stop to cut off the supply of steam at the throttle valve when an accident happens, or a change of load occurs which causes the engine to race. It is arranged so that the speed of the engine can be regulated to any desired excess above normal, and in case of racing it has been found by actual experiments to close the throttle in less than a quarter of the time the engineer could do it were he at his post.

The Water Power of the Rhine.—An electrical power plant of considerable magnitude is in course of erection, and almost completed, on the Rhine at Rheinfelden. The company formed for the purpose of constructing and working the plant has acquired tracts of land on the Baden and Swiss sides of the river, which, it is expected, will be utilised for the erection of manufactories. In planning the works, account has been taken of the favourable conditions for erecting electrical power works, which prevail on that part of the river extending from Reichenau to Basel, a distance of 154 miles, in which there is a total fall of no less than 1,120ft., and it is hoped that the construction of a power plant at Rheinfelden will transform this district of the Upper Rhine into a manufacturing centre of considerable note. A description of the new works has been published in the *Morning Post*, from which we abstract some interesting particulars. Below the confluence of the Aar and the Rhine there is a constant flow of 77,000 gallons per second, and this circumstance, connected with the fact that the topography of the country is favourable to the establishment of factories, and that in a stretch of the Rhine only 1½ mile long there are three rapids with a mean fall of 23½ft., determined the company to place its works at the spot chosen. It was originally proposed to utilise the whole low-water head of 25ft., and in the first plans it was estimated that 11,000 h.p could be obtained at an expenditure of £500,000. These plans were finally modified by Prof. Intze, of Aachen, and it was decided to use a head of water of only 16ft., thereby confining the construction to about 1,100 yards of the river. It was estimated that to secure 15,000 h p., the cost of turbines and buildings alone, exclusive of the electrical equipment, would be £223,000. The contract was given to Messrs. Escher, Wyss, and Co., of Zurich, and Messrs. Zschokke and Co., of Aarau ; Prof. A. Zschokke taking charge of the works under Prof. Intze. The electrical plant was built by the Allgemeine Electricitäts-Gesellschaft and the Oerlikon Works. A plan of the works shows that a dam has been built right across the river, which contains a sluiceway 65ft. in width, a head-race leading the water to the turbines and the power-house. The crown of the dam is 6ft. 6in. broad, and while its back has a steep angle, the face slopes gently to the river bed. The head-race is 170ft. wide, the wall on the river side being 23ft. high, 5ft. broad at the top, and 13ft. at the base. The entrance to the head-race is protected by screens to keep out rocks, boulders, and rubbish. Here also are placed the gates regulating the flow of water. The sides of the head-race are lined with brick set in cement. At the right hand of the turbines a sluiceway is provided for letting out the ice from the front of the screens in winter time. The power-house has 20 chambers, though only 10 of the 840-h.p. turbines have as yet been placed. The chambers measure 18ft. by 33ft. by 49ft. high, and the partition walls are 4ft. in thickness. Gates shutting off the water from the chambers are provided which will resist a pressure of 70 tons. For the electrical plant the three-phase alternating-current system of transmission has been adopted. The generators rest on a floor of concrete immediately above the water-tanks of the turbines. The normal output of each dynamo is about 720 kw., and the efficiency is calculated at 92 per cent. The machines are excited by three 150-h.p. rotary transformers. Transformers are also used for lighting the power-house and the surrounding grounds. Five of the generators will be set aside for lighting, and the other 15 are intended for power and for electro-chemical works.

The Engineering Dispute.—Since writing last week a most important development has taken place in the dispute between the employers and the men, of which, no doubt, all our readers are by this time fully cognisant. At the conference last Friday, the Employers' Federation rejected practically the whole of the proposals of the men's representatives. In the first place, the employers refused to give way on their proposals that every workman should undertake to work peaceably and harmoniously with all fellow-employés whether they belonged to a trade union or not; that every workman should be free to belong to a trade union or not, as he might think fit; and that every employer should be free to employ any man whether he belonged to a trade union or not. The men agreed to the major portion of this, but wanted to bind the employers to make no distinction between or give preference to non-unionist as against unionist workmen. The conference then passed on to the consideration of the best means of avoiding, as far as possible, future disputes, and of the question of hours of labour. In reference to the first of these, the employers proposed that deputations of workmen should be received by employers or their representatives for the discussion of any question that might arise, but only the local associations of employers would negotiate with trade union officials. Failing a local settlement of any question, it should be referred to the executive board of the Employers' Federation and the central authority of the trade union, and pending its being dealt with there should be no stoppage of work, either of a partial or general character. The men's counter-proposal was in the same terms, except that they propcsed to insert the words "or their representatives" after "workmen" in the first sentence. The employers decided to adhere to their proposal. In reference to the hours of labour, the men, in view of the increasing efficiency of labour due to improved machinery, claimed the introduction of an eight hours' day or 48 hours' week. The employers replied that they could not consent to any reduction of the hours of labour, chiefly on the ground that, in view of keen and increasing foreign competition, the trade of this country will not bear any increase in the cost of production. After this reply, the men's representatives stated that they desired to submit the conclusions of the conference to a vote of the men, and the conference was adjourned to allow this to be done. The result of the ballot is not yet made known, but whether it is for or against submission, it can only be postponing the evil day. The men cannot stand the enormous drain on their finances very much longer, and they will be wise if they submit now. The employers have stated that they have had no intention of interfering with what they regard as the proper functions of trade unionists, and that they will continue to receive deputations from workmen, including trade union officials. Every day makes their position stronger, because the men they have employed to take the place of the strikers are rapidly becoming efficient, and if the strike goes on much longer, it will end in there being no room for the majority of the unionists.

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NOTES ON ACCUMULATOR CONSTRUCTION.

BY DESMOND G. FITZ-GERALD.

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XXXVI.

On October 8, 1881, M. Ernest Volckmar took out a patent in France, and on the 10th of the same month one in Belgium, for an invention which was probably quite original on his part, and the nature of which may be gathered from the following claims: (1) The establishment of numerous and closely approximated cells or cavities which allow of the peroxidised or reduced lead being held and maintained without the aid of any porous vessel; the peroxidised and reduced lead being brought into this condition by the formation resulting from an electric current. (2) The use of lead, mechanically or chemically subdivided (preferably pure lead), to fill the interior portion only of these cells.

Ernest Volckmar—whose life, partly a romance, ended in tragedy—was a young man in the service of the Société Force et Lumière, presided over by M. Philippart, sen. This company—from which the Faure Electric Accumulator Company subsequently purchased the Faure patents for the United Kingdom—was, to use the inventor's own words, "entrusted with the industrial working out of his patents, under his (M. Faure's) technical superintendence." The managing director was M. Simon Philippart, one of the sons of the above; and another son, young M. Gustave Philippart, was also employed in the office. Between the latter and young Volckmar a great friendship sprung up; and when, during the absence of M. Simon, the former was left in charge of the workshops, the question of improving the accumulator was frequently discussed. Although M. Gustave was under age, the two friends became closely associated; and ultimately they agreed to take out the above patents and to leave the service of the company. On April 5, 1882, we find Volckmar at the dinner given at the Crystal Palace by the newly-constituted Electrical Power Storage Company, formed to acquire and work the patents of Messrs. Sellon and Volckmar. Sir Daniel Cooper, chairman of the company, presided; and young Volckmar was "made much of;" the toast of "The Electrical Power Storage Company," coupled with the names of Sir D. Cooper, Mr. Sellon, and Mr. Volckmar, being proposed by a director of the Crystal Palace Company, and enthusiastically received. Mr. Sellon afterwards made a lengthy speech, in the course of which he said: "In September last I took out certain patents relating chiefly to the form of plates for secondary batteries, intending to take them out for abroad in an amalgamated form when the time arrived to file my English finals. In the course of events, some three or four months later, I came into contact with Mr. Volckmar, who, in October, had taken out patents in the same direction. In him I recognised a gentleman of great power of work and of perfection in detail; and I may here explain that the finishing touch of success as to the increased efficiency of these batteries is in great part due to him. We ultimately, as you are aware, joined forces; but meanwhile I found that Mr. Joseph Swan, of well-merited fame in the electrical world, had anticipated so far back as May last one of the forms of plates covered both by Mr. Volckmar and myself. I speak of 'form of plates' in contradistinction to 'formed plates'; and Mr. Swan will, I know, allow me to say that he had not, at any rate at that time, worked out to a successful issue the principle of his patent. I immediately communicated with him, gave him my provisional patents to read, and ultimately purchased from him his patent rights over the whole world, so that no question or dispute could arise in the adoption of any forms of plates so covered by patent rights. The Electrical Power Storage Company possess, therefore, the patents of Mr. Volckmar, Mr. Swan, and myself."

On the 19th of the same month Mr. Sellon intimated that certain points of difference between the Electrical Power Storage and the English Faure Companies would be "determined scientifically and legally," and that in the meantime the new batteries would be offered to the public under guarantee of indemnity.

In May of the same year the directors of the Faure Company instructed their solicitors to commence legal proceedings against the Electrical Power Storage Company. At a meeting of the former company on May 23, 1882, Sir J. Otway, Bart., M P., the chairman, said: "No sooner was this new accumulator launched than we took steps that are necessary to protect the rights of the Faure Company in the High Court of Chancery, and it is our intention to pursue these steps with all the energy that is necessary, unless we should be delivered from the necessity of war by that which is always better than war—namely, a satisfactory peace."

But signs of such a peace were already in the air, and shortly afterwards the following letter was addressed to Mr. Volckmar:

446, Strand, W.C., June 7, 1882.

Dear Sir,—I acknowledge, before we enter into our conventions, that you have given me full explanations upon the circumstances which have been on my part the object of personal attacks affecting your honour. I therefore retract every expression and every accusation which, publicly or otherwise, have been used by myself or on my behalf which could reflect in any way upon your honour.

From to-day we, on both sides, loyally put an end to any dispute or lawsuit between us.—Yours faithfully,

(Signed) S. PHILIPPART.

Mons. E. Volckmar, 74, Hatton-garden.

It is not within my present province to enter upon the arrangements ultimately concluded between the three companies.

XXXVII.

And so, amidst pushing, striving, dining, scheming, litigating, and trumpeting, the lead reversible battery became a commercial fact. But how slow does progress sometimes appears in the retrospect! The substitution, for a porous vessel to retain the active material, of cells or cavities in the electrode itself. That is all, or very nearly all! Before this substitution took place, Planté's couple was 23 years old. And, some 20 years before it happened, I myself had described the porous pot arrangement, and adverted to the fact that the great power of certain secondary combinations is due to the presence of peroxide of lead in contact with what was then (at least) called the negative element—*i.e.*, that corresponding to the copper in a Daniell couple.* But it must be admitted, I think, by those versed in the "ways of the world," that any simple-minded, unsophisticated, and, perhaps, impecunious inventor coming forward—say, in 1871—with the Faure improvement, or even with the Faure-Volckmar improvements combined, would have been "before his time," and probably have been utterly ignored. There would have been no mention in the *Times* of his "marvellous box of electricity." He would have been told (XXX.) that his invention had long since been anticipated—that, in fact, so obvious a modification was no invention at all. History repeats itself, and at the present moment there are improvements, worked out on the scale possible to the ordinary inventor, quite equal in importance to those of Faure, Swan, and Volckmar, which at the present time excite no interest, and must await *le moment psychologique*, which may not occur for 10 years to come.

XXXVIII.

Mr. J. W. Swan is a thorough inventor; and each of his specifications—whether it be, like the following, of undoubted practical importance, or, like the next in order, of doubtful utility—bears at least the stamp of original thought. Both are for improvements in elements of the Planté type. In patent No. 4,455, October 13, 1881, the inventor points out that these, when constructed of simple plates of lead, require a very considerable period of time in order to undergo the change necessary to render them capable of storing a large amount of energy. The object of the present invention is to avoid this disadvantage by so preparing the lead plates that they are capable of rapid transformation into the condition necessary for large storage. "I accomplish the object stated," says the inventor, "by cutting or scraping or equivalently acting upon the surface of the lead plates in such a manner as to

* The *Electrician* (old series), March 20, 1863. Also Messrs. Biggs and Beaumont on "Electric Light Engineering." The *Electrician* (new series), March 11, 1882.

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expose a greatly enlarged surface to the action of electrolytic gases produced in the act of charging; whilst at the same time, if necessary for strengthening the plates, I leave sufficient solid metal or unacted-upon portions to give the plate the requisite stability, and hold the oxidised or disintegrated portions adherent to the body of the plate. I produce the said extension of surface either by scraping or by cutting the surfaces or one of the surfaces, or a portion of the surface or surfaces of the plates." By the scraping or abrading process, a comparatively thick nap or fur may be raised. In the cutting process, cuts or "incissions" may be produced by means of a machine with cutting blades similar to a slotting machine; but so constructed that, by a combination of a reciprocating action on the part of the blades and a progressive step-by-step action on the part of the lead plate, or *vice versâ*, a succession of cuts very close together may be obtained. The inventor also uses plates (of hard metal) engraved or otherwise roughened, so as to communicate to (lead) plates pressed between them the punctured, incised, or roughened character required. The claims are in accordance with the above description.

According to patent No. 5,494, December 15, 1881, granted to the same inventor, lead plates intended for Planté cells are exposed to the combined action of acetic acid, carbonic acid, and atmospheric air, as in the well-known process for making white-lead, which action results in the formation of carbonate of lead on the lead plate. The layer of carbonate, of any required thickness, is to be electrolytically reduced to spongy lead, after which operation the plates are to be used in the construction of accumulators. I have found spongy-lead elements made by this process to be fairly good; but the peroxide elements obtained by making the spongy-lead plates the anodes in an electrolyte of dilute sulphuric acid are not comparable with those obtained according to Planté's original process. A better result is obtained by peroxidising the plates, without reduction, in an electrolyte of magnesic or sodic sulphate. But perhaps the main objection to the process is the uncertainty of its operation in producing the layer of carbonate to be converted into active material.

XXXIX.

One more patent taken out in 1881 may be noted—viz., No. 5,631, December 23, granted to J. S. Sellon for "improvements in the construction of secondary batteries." This "relates to the construction of the terminal plates, supports, retainers, or frames, upon and in which the active material or agent is deposited, placed, or fixed." In carrying out the invention, the supports or frames are constructed "of a material or materials not readily subjected (? subject or liable) to the destructive influence of oxidation or other destructive action, such, for example, as carbon, either in a solid form or compressed or mixed or amalgamated with other substances, or as asbestos, wood, papier-mâché, cellulose, either alone or in combination with metals not easily oxidised, such, for example, as platinum." In regard to form, the plates, supports, etc., may, "for example, be made of a cellular, perforated, corrugated, grooved, fluted, roughened, indented, tubular or woven shape, or any combination of these forms, or of any other shape capable of retaining the active material," etc.

The claim is for "the construction of terminal plates, supports, retainers, or frames employed in secondary batteries of a material or materials not readily subjected to the destructive influence of oxidation in the manner and for the purposes described."

Without setting myself up as an authority on patent law, I may express a doubt as to the validity of the above claim in regard to any material that is not particularly specified and ascertained. Of those which are specified, wood, papier-mâché, and cellulose ($C_{18}H_{30}O_{15}$) cannot be regarded as substances not readily liable to oxidation or other destructive action. Neither is carbon such a substance when in direct or indirect contact with peroxide of lead in an electrolyte of dilute sulphuric acid. This, which implies that carbon is electro-positive to peroxide of lead in the given electrolyte, may be a fact not generally known; but it is one which has been verified to their cost by more than one inventor and patentee. In this connection it may be interesting, briefly, to refer to some experiments I made in June, 1888, which were published somewhere at the time. In one of these experiments I took a plate of lead peroxide, in the form of lithanode, and a plate of carbon of French manufacture. These I immersed in dilute sulphuric acid (specific gravity about 1·2) and tested for E.M.F. against a standard cell. The initial E.M.F. was ·96 volt; nor was this the highest value obtained during the experiments. Although the initial E.M.F. was not maintained when the circuit was closed, these elements constituted a permanent couple. To illustrate the difference between various forms of amorphous carbon, a carbon incandescence-lamp filament was substituted for the above-mentioned sample; and in this case the E.M.F. was ·17 volt, falling to half and ultimately to one-fourth of that value after the circuit was completed. In my recent experiments, with special carbons supplied by the "Le Carbone" Company, the plates coated with peroxide of lead were all rapidly destroyed by corrosion, whilst those coated with a layer of spongy lead remained perfectly intact.

ON THE MANAGEMENT OF STEAM-BOILERS.

BY F. G. ANSELL, F.C.S.

In an electric light works, just as in many other factories, the steam-boiler plays a most important part, yet it often happens that hardly any part of the plant receives so little attention. The boiler is expected to do its work regularly and well, no matter what happens; even a small leak must often remain until the proper day comes round to blow off and make a thorough inspection of the inside. However, I do not propose to say much about the defects of the few, but rather to point out the common considerations in the proper management of the steam-boiler to ensure its full efficiency and to avoid as far as possible all risk of danger. My own observations lead me to suppose that most large boilers are reasonably well cared for, and that most people in charge of them understand the terrible consequences of an explosion, and know how to avoid gross faults, such as allowing the water to get too low, but I do not consider this sufficient knowledge to enable a man to manage steam-boilers properly. Firstly, I will speak of the firing, and secondly, of the feed water.

In good stoking, a nice bright fire should be evenly and not too thickly spread over the firebars to their full extent. When necessary, fresh coal or coke should be put on the front of the fire, so that any smoke or gas it gives off at first may be burnt by the back part of the fire, and so a large body of flame pass over the bridge. Whilst this is going on, air should be judiciously admitted, according to the quality of the fuel, so that the gases generated by the heat may be completely burnt, or at least as far as possible, but at the same time too much air should not be allowed to enter, because it would have a tendency to cool the boiler, and so would, to a certain extent, neutralise the effect of the fire. Also, the stoker should be careful that he does not push the fire too far away from the door, because it is possible that damage may result to the boiler where it forms the arch of the furnace, and just inside the door, through too much cooling during stoking. I once knew damage done to a large Lancashire boiler in this way. The reason is not far to seek. Any difference in the heat means, of course, unequal expansion, and if this is repeated as often as stoking is necessary, damage may not unreasonably be expected. The boiler I speak of developed a crack about 8in. long in the "skin" of the inside of the furnace. This was discovered and duly mended. Clinkers must never be allowed to remain on the firebars, because they are capable of dissolving the iron of which the bars are composed, and so they rapidly do considerable damage. They would also spoil the draught if allowed to accumulate. When the fresh fuel has been put on and burnt up nice and bright, so that it gives off no more smoke and gas, then the draught-holes in the firedoor should be closed so that all draught must pass through the fire, and whilst the fire remains in this state the dampers may generally be lowered a little in order to regulate the draught and keep the fire from getting too fierce. It is well to remember that the

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hotter the fire the greater the draught, as if this were unobserved it might easily lead to waste both of fuel and steam; therefore this excessive draught should be checked by lowering the dampers, which, however, should be raised again to their full extent when fresh fuel is put on to avoid the accumulation of any combustible gases; for although this may appear impossible to some of my readers, many will know well that it is easily possible. I was once called in to explain how the fire in a certain new furnace could have blown flame out into the stokehole and burnt the stoker's arms. I found that the poor fellow did not understand the use of the dampers, and having had them shut down had stopped all draught whilst putting on fresh coal, consequently gases had got into the space between the fire and the damper, and a mild explosion had occurred. After my explanation no further trouble happened. It has often appeared to me that it would be advisable to control the draught of some large Lancashire and Cornish boiler furnaces from the firedoors in the front instead of by dampers at the back of the boilers. The usual way of setting these boilers gives a great length of flue in which gases may accumulate, and if an explosive mixture should happen to rest there the consequences might be very serious, whereas if the draught were controlled from the front, the back of the furnace would always be in full communication with the chimney, and by opening the doors to stoke or to inspect the mixture would soon be carried up the chimney, and so be easily and safely disposed of. However, it appears to me that in no case should the dampers ever be entirely shut. I have sometimes noticed that stokers will allow a fire to roar, and even to allow the draught to set up a vibration in the chimney, although by a very little regulation of the dampers this vibration might be entirely stopped, as it should always be immediately in the case of large boilers set in brickwork, or else the setting will suffer.

In this article I am dealing more particularly with large stationary boilers of the Lancashire type suitable for electric light works, etc., and therefore I have assumed a good chimney provided and forced draught unnecessary. Forced draught is undoubtedly a good thing in some cases—*e.g.*, where there is a deficient chimney—but we must not forget that it means a constant demand for steam, and so for fuel to maintain the draught alone.

I now pass to the consideration of the water supply, and in my opinion all water for steam-boiler use should be carefully and fully analysed, especially where the supply is derived from isolated wells, surface drainage, etc., which are always liable to variation in the amount of mineral matter they contain. In fact, most waters vary more or less in this respect with the time of year, all being subject to influence by flood and drought. I believe there are some marine boilers which are lucky enough to be supplied with distilled water only, but for our present purpose I shall not refer to these. Most boilers have to use what they can get irrespective of its mineral contents, and my present object is to show how this mineral matter may be reduced to a minimum and rendered harmless to the boiler. It is, of course, obvious to all that if water contains any mineral matter in solution, although it is quite invisible, still, if I evaporate all the water away in the form of steam, I shall have the mineral matter left behind; and experience shows that some of this will adhere to the containing vessel, although if the boiling is very rapid, some of it will fall in powder to the bottom. This, then, is the origin of the scale, or fur, as some people call the incrustation known to us all in the inside of the tea-kettle. Its most usual constituents are carbonate of lime, carbonate of magnesia, and sulphate of lime. Mere ebulition is sufficient to deposit the two first, because they are only soluble in water as bicarbonates, which are decomposed by heat into free carbonic acid gas, which escapes with the steam, and carbonate of lime or magnesia, which are deposited. The sulphate of lime is thrown down by excessive evaporation, it being only sparingly soluble in water, and, in fact, becomes less and less soluble after the temperature of the water rises above 95deg. F. These deposits stick remarkably tight to the inside of the boiler, and are usually removed by chipping with sharp-edged hammers, but this is a process I strongly disapprove of, because it takes a long time to do, and is apt to lead to a certain amount of injury to the inside of the boiler. I have seen the scale in boilers ½in. thick, and as it is a non-conductor of heat, this means excessive firing and excessive heating of the furnaces to get sufficient steam, and, of course, if the furnace plates are heated too much they become burnt, and so deteriorated more than they should do. Therefore it is most important to remove this deposit at all cost if only out of consideration for the well-being of the boiler, but there is also another consideration—viz., the amount of fuel wasted. I remember the case of an engineer who cleaned his boilers out thoroughly well and noted the amount of coal used daily, and invariably found that after the first few days the amount of coal used increased 10 per cent., and before long 40 per cent. Either of these figures is sufficiently serious as regards the coal bill. Fortunately, chemistry has supplied us with remedies. I will now suggest three separate modes of treatment, each good under given conditions; the simplest I will put first—viz.:

1. Provide a tank (an old boiler with the end out and stood up will do nicely); inside this put a steam-coil for the exhaust steam from the engines to pass through. The pipes of the coil must be fairly large so as not to put a back pressure on the pistons, and the steam should enter at the top of the coil; the steam will then pass through cooler and cooler water as it descends, and will finally fall out as water or as hot vapour into the drain. This condensed steam would be excellent water to put into the boiler again if quite free from oil, but freedom from oil is most important, as I will show later on. Oil separators can be bought, but they require very careful attention. The feed water might also be heated by the gases from the furnace before they pass up the chimney, but in this case care must be taken not to cool the heated gases too much, or the draught will inevitably suffer. Water treated in this way must be kept very hot for not less than 20 minutes, and at the best it is only a partial remedy, as it would not act upon the sulphate of lime. The cold water should be put in at the bottom of the heating tank.

2. To the above method may be added a proper quantity of ordinary washing soda—*i.e.*, crystals of carbonate of soda. It is preferable to dissolve them in some hot water, and then throw the solution in and thoroughly mix it, after which a white powder will fall to the bottom. The analyst will tell the proper amount of soda to add per gallon. The chief objection to this method is that the soda remains in solution, probably as sulphate of soda mostly, but other salts will also generally be present.

These two methods require frequent blowing off from the bottom of the boiler, or else the water will become too thick, or might even become quite solid in time, especially when the fires are put out for cleaning; but I suppose, however, that this is most improbable, as no stoker with any experience would allow the water to get cold before opening the bottom valve to blow out all the sediment and water.

3. The Porter-Clarke process, which is by far the best for an ordinary calcareous water, and which I will briefly describe. The process is continuous, cheap, and efficient. I had a small plant put in for my present boilers about 10 years ago by Messrs. Porter and Sons, of London, capable of softening 2,000 gallons an hour; it can be started and stopped instantaneously, is very little trouble, and gives most excellent results. In fact, it has saved fuel enough to pay for itself many times over, and by using it I can be quite sure of keeping the inside of the boilers free from "scale." The apparatus is very simple. I have part of an old boiler, with the furnaces removed, stood on end. It is 18ft. high and 8ft. diameter. In the middle of it is a vertical tube, about 10in. diameter, going to within about 15in. of the bottom. The hard water is led by a pipe to the top of this 10in. tube, and so is a smaller pipe conveying lime-water, and the two streams mix as they fall to the bottom of the 10in. tube, and when at the bottom the water spreads out across the 8ft. cylindrical tank, and so rises gradually to the exit tubes, whence it flows into the heating tank, where it is heated, as above described, by exhaust steam from the engines. The lime-water is made by putting quick-lime

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into some water and stirring, by which it is made to appear somewhat like milk, and the quantity required is regulated according to the natural hardness of the water to be softened. This is, of course, determined by the analyst. I have many times analysed the water before and after softening by this process, and find that the total amount of lime is reduced from 10 grains per gallon to 1·4, the carbonate of lime from 15 grains per gallon to nothing, the total quantity of magnesia from 2·5 grains to ·5 grain per gallon, and the total solids from 30 to 10 grains per gallon before it reaches the heating apparatus. This result I consider very satisfactory, and I find that the boilers can be kept quite clean if the stoker will blow off frequently enough to prevent the water in the boiler from becoming too concentrated. Of course, if this is neglected, any sulphate of lime naturally in the water will be deposited on the inside of the boiler, and so will a small percentage of magnesia. The boilers I now speak of are of the Lancashire type, 30ft. long, 8ft. diameter, and run for three months at a time, when they are cleaned out and examined. If the above-mentioned details are properly attended to, then there is absolutely no chipping off of scale to do, but a slight difficulty may arise with regard to the frequency of blowing off in the case of waters containing sulphate of lime. However, there are two ways of obviating this—viz., put a little carbonate of soda into the heating apparatus, or (in fact, I might say in some cases, and also put) the day before it is proposed to draw the fires and stop the boiler about 1cwt. of the soda crystals to dissolve in some of the feed water, and pump it into the boiler a little at a time. The solution should be allowed to stop in the boiling water of the boiler up to its working level for about 24 hours, where it will attack any scale it may find there, and make its removal quite easy. It is advisable to add this solution of soda a little at a time, in case the stoker should not be quite certain as to the state of the water in the boiler, because if it should be loaded with mineral matter, then the addition of soda in any but small quantity would most likely cause "priming." The great advantage of Porter-Clarke's process is that it adds nothing to the mineral matter dissolved in the water, but, on the contrary, actually removes a good amount, as all those who use the process know. The removal is effected by opening a valve in the bottom of the 18ft. by 8ft. cylindrical tank mentioned above, which is made of such a size that the mixture of water to be softened and lime-water when spread over its bottom shall rise more slowly than the sediment falls, and so the feed water for the boiler is run off the top quite clear. The sediment should be run out about once a week, and does not take many minutes. I much prefer not to add soda if it can be avoided, because it is impossible to remove it from the water when it is once put in, and of course it is also a little extra expense.

All feed water should be let into the boiler close to the level of the surface, and it is a good plan to make a series of small jets, so that the surface may be well disturbed, and so break up any scum which may have accumulated upon it; but I do not think there is any fear of scum if the water is properly softened and clean before it enters the boiler. Hot feed water may easily be pumped into a boiler just as cold may, provided the hot water is delivered to the pump a foot or two above the receiving valves, but of course, owing to the extreme tension of the vapour of hot water, no suction is possible. If the feed water can be heated by any waste heat as suggested above, so much the better, as, of course, it means a saving of fuel. A second means should always be provided for getting the feed water in—*e.g.*, two donkey pumps, or a donkey pump and also an injector. Injectors can be had to work with the feed water up to a considerable heat, and donkey pumps will throw water very nearly or quite boiling.

No oil or grease of any sort should be allowed to get into the boilers under any circumstances whatever, because it is apt to form a protecting surface over the water and so to make it possible for the temperature of the water to rise above its proper steam-giving value; and this is very likely to occur while the boiler is at comparative rest, such as dinner-time. If the water should happen to get into this quiescent state, the least motion may upset the equilibrium, a vast quantity of steam would be suddenly formed and the boiler burst. The opening of the steam-valve might even do this. If my memory is not treacherous, this danger was pointed out many years ago by the great Faraday, whose name is as much honoured by chemists as it is by electricians.

All the valves and taps about the boiler should be frequently examined, to make certain that they really are in good working order. The safety valve must never be tampered with, and certainly should never have fireirons or bricks hung on it, or even wet coats to dry. The low-water safety valve must never be neglected. The importance of this valve is quite equal to that of the safety valve itself. It should be frequently tested from the outside to see that it has not got stuck, and whenever steam blows out there in ordinary working, fresh feed water must be injected immediately, or else the fire must be taken out of the furnace immediately. The pressure gauge must be watched constantly and carefully. The water-level gauge glasses must be constantly watched, and the level of the water should be kept at its proper height. For further information on these glasses I beg to refer the reader to p. 595 in the issue of the *Electrical Engineer* for November 5, 1897, where he will find all that can be said upon the reading of these glasses, and the faults to which they are subject, thanks to the most useful and instructive system of questions and answers by which our editor has enhanced the value of his already good and entertaining journal. I will take this opportunity to thank him for introducing these highly practical questions which tend to make us all think and so to improve us all for our respective spheres. One other point and I have done. Gauge-glasses are apt to become corroded at the top of the underside. This is because they are attacked by the lime salts contained in the water, and therefore whenever it occurs it is an increasing weakness, and should therefore be carefully watched, or a fracture is certain to occur.

In conclusion, I must specially urge the importance of ensuring any and every steam-boiler, because I consider that the greatest advantage to be derived from this course is the regular periodical inspection by the Boiler Insurance Company's agent, who is necessarily a man with great opportunities for gaining experience. His report is valuable in itself, and has the additional advantage of making those in charge of the boiler take special interest in it, and so give it special care and attention which otherwise it might not get.

THE APPLICATION OF THE STORAGE BATTERY TO ELECTRIC TRACTION.

BY CHARLES HEWETT.

(Concluded from page 722.)

The Application of Storage Batteries on the Ends of Long Lines.

In such applications the conditions are entirely different. The battery in this case acts essentially as a pressure regulator. The conditions do not restrict the size of the plates, so that the plates can admit of such a size that the current density on discharge can be kept well within the limits of normal discharge; and in consequence of this the battery is not subject to the great loss of efficiency due to the fall of E.M.F. on discharge. Only a few such installations have been made, two of which are on the Isle of Man; one has been installed by the Anaconda Mining Company at Butte, Mont.; there is also a small plant at Merrill, Wis. The first installation, however, that has been made from any large city road for its suburban service is the one installed by the Union Traction Company, of Philadelphia, Pa. The road was originally a horse-car line, running some 7½ miles from the present power-house. An electrical equipment was installed which was supposed to be amply sufficient at the time. The success of this line led to extensions, and then trouble arose from drop of voltage in the cables. There were three feeder cables used, the longest being five miles long. All these cables were 1,000,000 circular mils in area, rubber covered and

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lead sheathed, and laid in terra-cotta ducts. These feeders had cost without the ducts about £20,000. To have increased the cable system so as to have supplied the extended sections properly, would have taken about 336,000ft. of the same section cable. At 4s. 2½d. per foot laid, this would have cost £70,560. Deducting the value of the cable already laid, it is estimated that the extra cost of cables without conduits would be £54,760, which figure is prohibitive. The author showed a chart of the voltages at Chestnut Hill before the introduction of the accumulators, which indicate that the pressure often fell to 350 volts. The average pressure with 530 volts at the 'bus bars was 400 volts.

It was necessary, therefore, to furnish some means of keeping up the pressure. If a station had been built at that point, it would of necessity have been small and inefficient. From records taken at the main power-house, it was found that it would be necessary to provide a station of about 750 kw. capacity; such a station would have cost about £17 per horse-power, or a total of £17,000. A battery station, on the other hand, required but little real estate, and would be inexpensive to operate; its cost would be considerably less than a power station. In the Chestnut Hill plant the entire cost of real estate, battery, and building, was approximately £5,000; to this must be added the cost of a booster in the main power-house. This required a 200-kw. generator, which with its engines would cost about £1,600. The total cost of battery and booster would, therefore, have been £6,600. In this installation, however, they simply adapted a 300-kw. generator at their power-house to this service, so that they were put to but little extra expense in the power-house for adapting it to booster purposes. We find, therefore, that deducting £6,600, the cost of the battery and booster, from £17,000, the cost of a station, that the difference in first cost is £10,400 in favour of the battery. In addition to this, they were put to an expense of a little over £2,600 for changes in the cable. In the estimates that follow, the author does not include any cost or interest on the cable, as the investment would have been about the same whether they had built a station or installed a battery. It is very apparent, therefore, from the facts given, that on the score of first cost the battery was by far the cheapest instalment which they could make.

In ordinary operation the current on the cable passes through the booster at the power-house, by which the initial pressure is raised 150 volts more or less above the ordinary 'bus bar pressure of 550 volts. By this means the drop in the cable is overcome, so that the pressure at the battery-house can be adjusted to a point where the battery varies but little to either side of the zero point, or, in other words, it charges and discharges continually, maintaining the load on cable No. 3 nearly constant, and consequently maintaining a constant E.M.F. where the current passes out from the battery-house through cable No. 4. This cable (No. 4) is therefore fed from two points—namely, from the power-house end at 550 volts, and from the Chestnut Hill end at about 515 volts. As a consequence, the distribution along the line from Wayne Junction to the end at Chestnut Hill is comparatively uniform, and is now very satisfactory. At first the battery was allowed to discharge during the day about three times as much as it charged, making up the charge at night between the hours of 1 a.m. to 5 a.m. Later, the amount of day discharge was decreased until the charge and discharge were about equal. The first gave a very even voltage of a little over 500. With the present method the voltage is somewhat more irregular, but the average is somewhat higher. By keeping the battery continually up to full charge, the night man has been dispensed with. When the load in the line is low, the current going over the cable No. 3 to the battery-house divides at the 'bus bar, one part supplying the necessities of the line, the other part charging the battery. When the demand on the line is heavy, the pressure drops a little at the battery-house. All the current going over cable No. 3 will pass out over cable No. 4, and, in addition, the battery will discharge sufficiently to make up for the extra demand for current. This has the effect of keeping an almost constant load on cable No. 3.

Cost of Operating.

For volt and ampere meter readings taken from the power-house in October, 1890, we find that 136,576,919 watt-hours were delivered to the line at the battery-house. These figures, I may explain, do not include the watt-hours generated by the booster, since we have assumed that this entire amount is lost in transmission. As a matter of fact, this is not strictly correct: but if a station were operated at Chestnut Hill, it would be run at a 'bus bar pressure a little above the battery pressure, and therefore for our present purposes the assumption is correct. From our experience in operating power-houses of various capacities, we find that a power-house operated at Chestnut Hill under conditions which I have described would cost about ¾d. per kilowatt-hour. We therefore got the following as the cost of generating the number of units required by the Chestnut Hill branch if furnished by a station there. Allowing for 5 per cent. interest and 5 per cent. depreciation, the total cost on the above basis would be £586. The total cost in the main power-house worked out at ⅜d. per unit for the same month, so that the actual cost with the battery system came out as follows:

Power (170,811 units)	£239
Labour, etc., and battery-house	36
Total	275
Battery depreciation at 5 per cent.	17
Interest at 5 per cent.	27
Rates and taxes, etc.	6
	£325

The results are favourable to the use of accumulators, but the depreciation of batteries and labour in maintaining are placed very low by the author. Further results are also given.

Application of Battery to Power-House.

This form of installation has not become very generally appreciated in this country, and but few installations have been made. As its advantages become better known, the author feels confident the practice will become more general.

The wide fluctuations in load in railway power-houses are now well known. The average daily load varies from 50 per cent. of the maximum in small stations to 70 per cent. of maximum in the largest stations. In the majority of stations the average load is very close to two-thirds of the maximum load. Now, it is also a well-known fact that the maximum economy of the steam-engine exists for a very small range of load, and that on each side of the point of maximum economy the efficiency falls off; rapidly on the overload, somewhat less rapidly on the underload. The result is apparent. In most stations the engines at the best have an average load of only two-thirds their most efficient load, and as a consequence consume over 4·5lb. of coal per kilowatt-hour.

With badly-regulated engines, and especially with water-power plants, the changes in load are accompanied by variations in speed and consequently in voltage. These troubles may be entirely corrected by installing a battery.

The battery in this case becomes distinctly a load regulator. Figs. 1 and 2 show results obtained at Woonsocket, which is a water-power plant. In Fig. 1 the load is carried entirely by the generators, and as is to be expected the potential curve is very irregular, varying almost 100 volts, while the current varies from 0 to 250 amperes. The action of the battery is shown in Fig. 2, where the generator load varies about 50 amperes and the potential curve is most regular. Fig. 3 shows the results obtained at Easton, Pa. In this case the battery is quite small, and the advantage is not quite so marked as it would be if a larger battery were used. Instead of using four generators, however, they are able now to operate the same number of cars with three engines. No cost figures for these plants are made public, but the increased efficiency is made apparent.

It is necessary that the capacity of the battery should bear a larger ratio to the output of the station than is necessary for potential regulation as described in the previous section of this paper. In potential regulation a comparatively small battery is necessary, since by changing

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the potential of booster from time to time during the day the charge and discharge can be kept very low. In the case described, a battery rated at 120 amperes has successfully regulated for a total output of 1,400 amperes. For load regulation, however, the battery should have a capacity

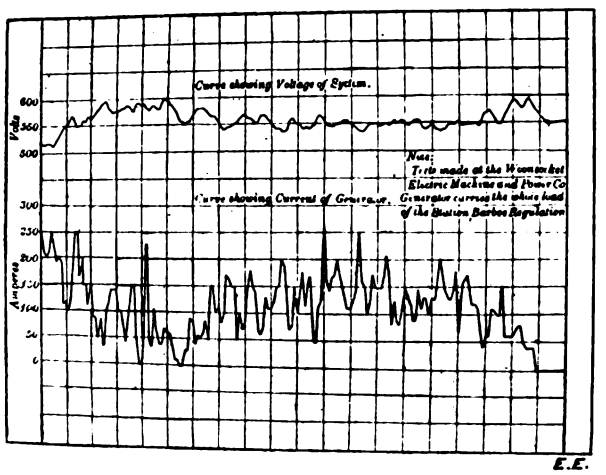

FIG 1.—Current and Pressure Curves at Woonsocket before the Battery was Installed.

equal to one-third the maximum output of the station. The average load of the station may then be made the maximum load of the engines, the battery taking care of the fluctuations. As in the previous case, there are no

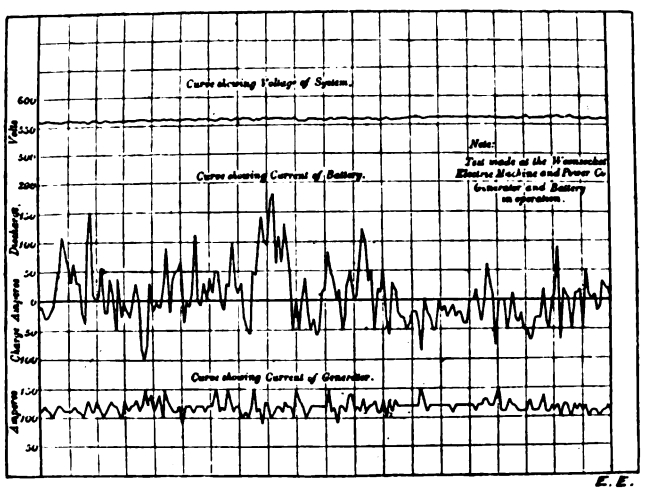

FIG. 2.—Current and Pressure Curves at Woonsocket after the Battery was Installed.

physical limitations to be placed on the size of the plates to be used, and the charge and discharge may be kept well within the normal rate. Under such conditions the efficiency of the battery is high—85 to 90 per cent.—and

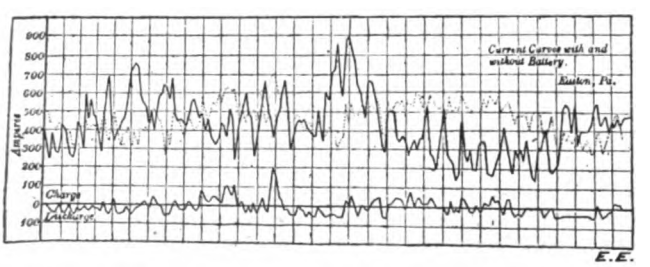

FIG. 3.—The Heavy Line shows Output of Four Generators without Battery. The Dotted Line shows Output of these Generators with Battery at Easton, Pa.

the deterioration very low. In most cases no additional labour will be required.

Calvert's Mechanics' Almanac, 1898.—The twenty fifth issue of this "workshop companion" has just appeared. It is compiled and edited by Mr. Joseph Nasmith, M.I.Mech.E., the editor of the *Textile Recorder*, and teems with useful tables and practical, technical, and industrial information for artisans and handicraftsmen, and those generally employed in the engineering and kindred trades.

GAS-PRODUCING PLANT AND GAS-ENGINES FOR ELECTRICITY WORKS.

The following is a report by Prof. Henry Robinson, M.I.C.E., M.I.E.E., on the Leyton Urban District Council's electricity station. The report is dated November, 1897, and runs as follows:

When, in 1895, I advised the Leyton Urban District Council to adopt gas-producing plant and gas-engines at a proposed electricity installation, which I subsequently carried out for them, I was of opinion that the somewhat unsuccessful results that had hitherto attended the exclusive employment of gas-engines for driving dynamos in electric lighting central stations was due to causes which could be avoided. The successful working of the Leyton station since its opening in September, 1896, has proved that my anticipations were correct, as will be seen by the results of tests that I made last month (October) of the plant after a year's working. It may be mentioned that the supply of electricity to the Leyton district is on the continuous-current three-wire system, with 300 volts across the outer conductors, or 150 volts on each side of the middle conductor. The plant at the central station consists of the following:

No. 3.—Dowson gas generators, made by the Dowson Economic Gas and Power Company, Limited, of 39, Old Queen-street, Westminster, two of which are intended to serve 110 b.h.p. each, and the third is lined with thicker walls to reduce the furnace to serve about 85 b.h.p The lining can, however, be altered at any future time to make all three generators alike.

No. 3.—Sets of gas coolers, scrubbers, etc.

No. 1.—Gasholder, 20ft. in diameter and 10ft. high.

No. 4.—"Premier" gas-engines, made by Wells Bros., of Sandiacre, near Nottingham, each driving by belting a 35-kw. dynamo, made by the Electric Construction Company, Limited.

No. 2.—Batteries of 85 storage cells, arranged on the three-wire system. The cells are of the "Tudor" type, made by Mr. A. B. Pescatore, of Manchester, and have a capacity of 880 ampere-hours.

No. 3.—Motor-transformers for balancing the pressure on the two sides of the three-wire system.

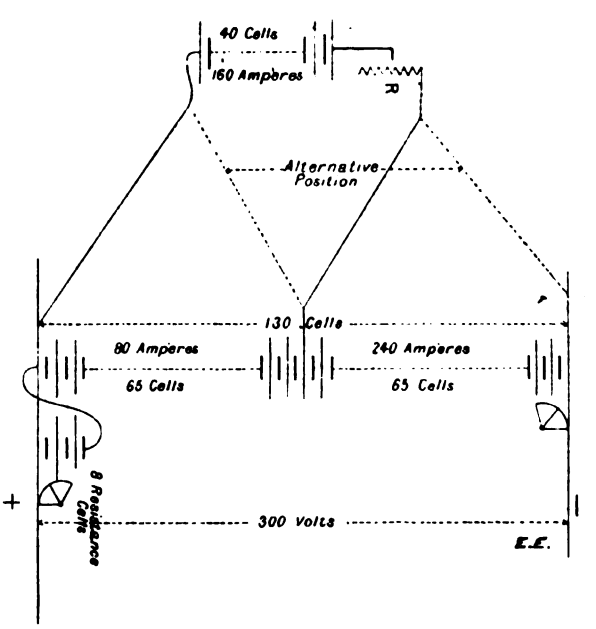

FIG. 1.—Battery Charging Arrangements.

The battery-charging arrangements are designed with a view to charging off the 300-volt mains, so that the dynamos may be used for direct supply simultaneously with charging, and also to enable the pressure-steadying influence of the batteries to be felt at all times on the mains (although it is not always needed). This is effected by cutting out 40 cells from the 170, thus leaving 130 to be charged across the 300-volt mains, including a number of regulating cells, which may be cut out towards the end of the charge. A cable connection divides

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the 130 cells into two sets of 65, and the group of 40 cells, together with a resistance, is placed in parallel with either of the sets of 65 cells, and is shifted from one set to the other at regular intervals during the charge, and the resistance is so regulated as to ensure a uniform charge to all the 170 cells. A diagram of this system is given in Fig. 1. It will be noticed that the introduction of the resistance in series with the group of 40 cells involves some loss in charging, which is approximately equivalent to charging (65 – 40) 25 extra cells, or 195 cells instead of 170. Taking into account the effect of cutting out the regulating cells towards the end of the charge, it represents more like 190 cells in place of 170, or, say, 12 per cent. excess charge. If, therefore, the efficiency of the batteries is, say, 70 per cent. in ordinary work, this special system of charging would reduce it to about 63 per cent. The advantages resulting from this arrangement, however, far outweigh the loss incurred by the small extra coal consumption, but inasmuch as a large part of the output at Leyton takes place at present from the batteries, it might be thought without this explanation, that the figures which are hereafter given show an excessive difference between the current generated and the current sold. As the demand increases the proportion drawn from the batteries will decrease, and therefore the fuel consumption per unit sold will approximate more nearly to the consumption per unit generated, without regard to any improved efficiency which would naturally follow on an increased load.

In October, 1896, some tests were made with the first two engines and producers that were then working, but which have been added to since. At that time the conditions were rather different to those which now obtain. The engines were run at 160 revolutions per minute with about 52 explosions per minute (out of a possible 80) and drove two dynamos in parallel, generating about 25 kw. each. A test at that time lasted 5 hours 35 minutes, the output was 280 Board of Trade units generated, and the fuel consumption was as follows:

	Lbs.	Lbs. per unit.
Anthracite coal	448	= 1·597
Coke	52	= 0·186
	500	= 1·783

This represented a cost of ·22d. per unit for fuel without taking into account any stand-by losses. No reliable figures, however, as to working costs were available when that test was made. In March of this year, during a discussion at the Institution of Civil Engineers on gas-producer plant, I was able to give the results of working at Leyton in the previous month of February, when the output was 5,660 Board of Trade units sold, and the coal consumption was only 3·92lb. per unit sold. I then expressed the opinion that the fuel consumption would fall to less than 3½lb., and this has already been fulfilled, for in September the figures were as follows:

Coal per unit sold	3·281lb.	costing	0·3608d.
Coke ,, ,,	0·1611lb.	,,	0 0112d.
Total	3·4411lb.	,,	0·372d.

The corresponding figures per unit generated were:

Coal	2·24lb.
Coke	·111lb.
Total	2·351b.

I am indebted to Mr. H. Collings Bishop, the resident electrical engineer of the Council, for data as to the working during during the year. Table No. 1 gives a summary of the coal consumption and output for each month of this year. The units used at the central station for lighting and other purposes are not metered, and the current required for running the balancing transformers is also accountable for part of the difference between the units generated and the units sold, which in the early stages of working comes out exceptionally high. The records of the cost of fuel during the period given in Table 1 show that it was only ⅔d. per unit sold. Although this is very satisfactory, the fuel cost will be even less when the winter months are included. The figures for October, 1897, were somewhat abnormal, owing to an electrical exhibition being held at the town hall, for which current was supplied free of charge. The coal per unit sold, therefore, comes out considerably more than in September, but would not have done so in the ordinary course of events.

The prospects of further improvement are still considerable, and may be indicated under different heads, although all are more or less connected with the increase in demand. The steam-boiler is capable of blowing the generators to double the power as yet used, the extra fuel required being very small, and can be obtained from the siftings of the ashes that are raked out of the generators. The consumption of coke will, therefore, remain practically constant until double the present output is reached, when the amount required per unit sold will probably not exceed $\frac{1}{10}$lb. The increased demand will reduce the time during which the generators stand idle, and the stand-by loss will therefore be less. The generators will also work at full load for a longer period, and, inasmuch as the efficiency at full load is very much better than at lighter loads, there will be a distinct saving on that account, as well as from running the engines at full load for longer periods supplying direct, and thereby reducing the proportion supplied from the batteries.

Tests made on October 26 and 27, 1897.—On October 26 the test was carried out with one gas generator supplying gas to two engines driving dynamos at approximately the full load for which the latter were designed. The dynamos were coupled in parallel, and were employed to charge the storage batteries, as well as to serve the day load on the mains. The coal used was anthracite, as supplied under contract to the Leyton Urban District Council for ordinary working at 20s. 6d. per ton delivered at the works. The run was quite under normal conditions of working, and goes on every day of the week with very slight variations. The coal for consumption was weighed out in buckets, and the time of stoking noted. The level of the coal in the generator was noted at the beginning and end of the run, and at intervals throughout. The level of the gas-holder was also observed at intervals, but was not allowed to fluctuate largely. One of the engines was fitted with indicator gear, and several diagrams were taken every hour. The electrical output was noted by a Kelvin voltmeter and by the ordinary switchboard ampere-meters. The readings of the ampere-meters were confirmed by the readings of recording wattmeters in the dynamo circuits. The extent to which gas-driven dynamos give and take the current from each other when running in parallel is of course much larger than with steam-driven plant, and as the load decreases (and reduces the number of explosions per minute) the fluctuation becomes greater. It is a noteworthy fact that during the tests and in ordinary work the dynamos ran with practically no sparking, even when four machines were put in parallel at two-thirds of the full load. The second test (on October 27) was carried out under these conditions, and very little rheostat regulation was necessary to ensure a fairly equally distribution of the load; the recording instruments gave 87, 101, 105, and 109 units respectively as the outputs of the four machines during a five hours' run. The heat value of the gas was tested by Mr. Dowson's representative by means of a calorimeter at intervals throughout the trials, and the mean results are given in Table 2. The gas tested was taken from the inlet main of the gasholder, where all variations in quality would be noted. The heat values given are calculated at 60deg. F., the average temperature of the gas in the holder. The latent heat of the steam produced in combustion is included. The results of the two tests are set out in Table 2, and are also plotted in Figs. 2 and 3.

The second test was made with two gas generators working at about two-thirds of their full capacity and serving four engines, working at about two-thirds of their full load.

Fig. 4 gives three indicator diagrams taken from engine No. 4. Fig. 5 illustrates the variation of coal consumption at different loads, as ascertained by the two tests, and represents the electrical output for one of the dynamos on the horizontal scale and the corresponding coal consumption on the vertical scale. Assuming the variation to be represented by a straight line, as in the case of steam-engines,

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TABLE No. 1.—Monthly Data as to Fuel Consumption and Electrical Output, 1897.

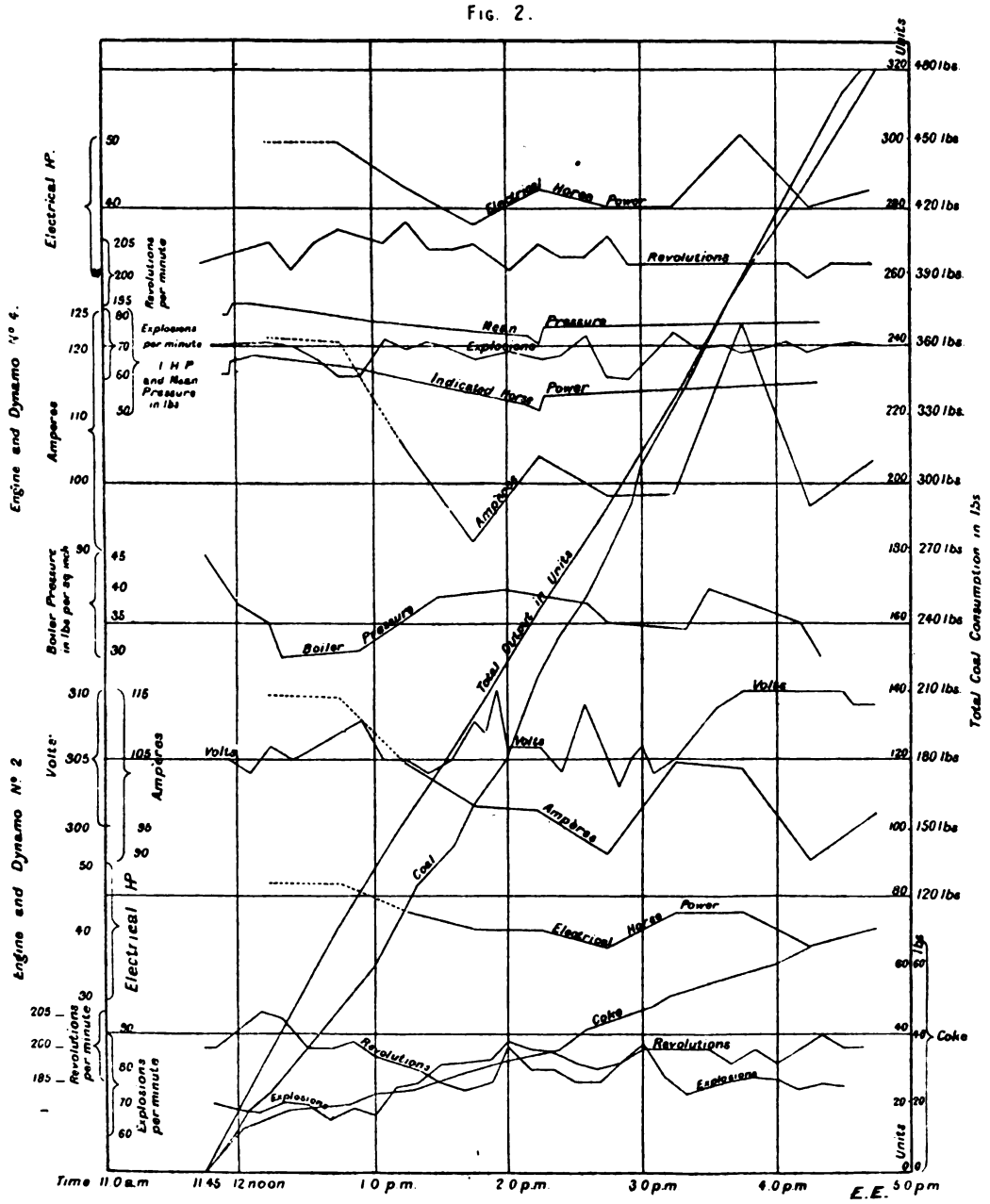
—	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	October.
Total units generated	8,892	9,417	13,464	11,588	10,630	8,552	9,319	10,744	12,573	17,893
Total units sold (private lighting)	2,512	2,215	3,154	2,109	1,500	1,196	1,349	1,642	3,228	5,230
Total units sold (street lighting)	2 393	3,445	4,844	4,645	3,892	3 146	3,247	4,349	5,383	6,332
Total units sold	4,905	5,660	7,998	6,754	5,392	4,342	4,596	5,991	8,611	11,562
Total units not sold*	3,987	3,757	5,466	4,834	4,238	4,210	4,713	4,743	3,962	6,331
Total pounds of coal consumed	22,311	22,237	31 543	29,359	26,600	21 737	22 650	27 030	28,256	42,970
Total pounds of coke consumed	1,202	1.220	1,164	1,239	1,377	1,100	1,024	1,182	1,384	1,301
Maximum current in amperes at 300 volts	130	190	175	180	176	150	162	215	270	370
Ignition gas used (cubic feet)	1,700	2,600	3,950	2,770	2,900	1,700	2,130	3,570	3,000	4,000
Coal per unit generated in pounds	2·55	2·36	2·34	2·535	2·50	2 54	2·43	2·51	2·24	2·40
Coke per unit generated in pounds	0·135	0·129	0·086	0·107	0·129	0·129	0·11	0·11	0·11	0·073
Coal per unit sold in pounds	4·55	3·92	3·94	4·33	4·93	5·00	4·93	4·51	3·28	3 72
Coke per unit sold in pounds	0·246	0·215	0·146	0·222	0·255	0·254	0·223	0·198	0·161	0 11
Ignition gas per unit sold in cubic feet	0·191	0·46	0·493	0·411	0 538	0·392	0 463	0·596	0·349	0·346

* The units not sold include much unmetered current such as that used at the central station and by the motor-transformers, as well as the loss in the batteries and in distribution.

LEYTON ELECTRIC LIGHTING.

Trial No. 1. 26 October 1897.

Fig. 2.



it appears that to keep one engine running at full speed with no electrical load involves a consumption of 24·4lb. of coal per hour, or about 4lb. per hour for each "full load" electrical horse-power, and the increased consumption as the electrical load is added amounts to 0·57lb. per hour per electrical horse-power. At full load, therefore, the consumption will be 1·07lb. per electrical horse-power per hour The light load consumption may appear excessive compared with the light load consumption of steam by steam-engines, but it should be borne in mind that these

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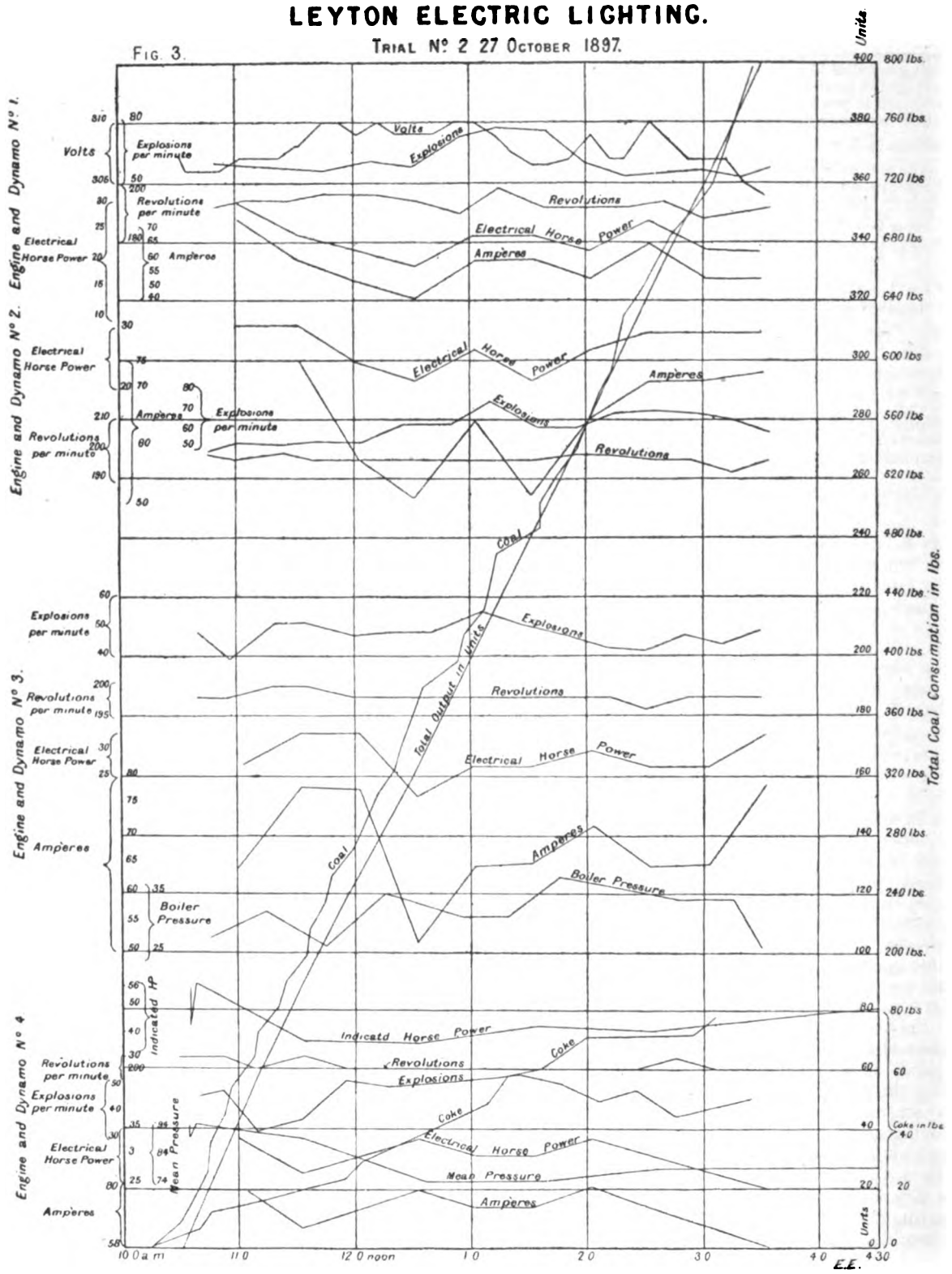
figures apply to the combination of gas-engines with gas-producers, and not to engines alone.

It is sometimes urged that gas-engines require more oil than steam-engines, but the results at Leyton prove that this is not the case. The first year's working only involved an expenditure of 0·03d. per unit sold for waste, oil, and water. All other engine-room stores (such as incandescent lamp renewals, arc-lamp carbons, etc.) were covered by ·045d. per unit sold. There are very few steam-engine by one man in four minutes. Then after an interval of nine minutes to get the gasholder into the position most suitable for the test, the dynamos were all on in another four minutes. On another occasion an engine was started within five minutes of the ignition burner. During ordinary work the stand-by engine is, of course, always ready with the ignition tube heated up. It should be explained that the coal consumption given in Table 1 is the actual quantity weighed and put into the generators. Some of



stations which can show lower figures, even on a much larger scale of working. It is not possible to give the details of the items up to date, as the accounts are only made up once a year. The starting arrangements on the engines consist of a hand-pump to force a charge of gas and air into the combustion chamber, and a winch handle with pinion engaging in teeth on the flywheel rim to turn the crank into starting position. The plan works remarkably well. On October 27, the four engines were all started and run up to full speed the coal received has to be sifted, as the dust cannot be used in the generator. The total amount of coal paid for is therefore slightly in excess of the figures given. The siftings are available for other purposes, but only at a reduced value. The consumption of coke per unit generated, as given in the table, is very much less than that used in the trial runs. The reason for this is that in ordinary working the siftings from the ashes raked out from the generators are used in the boiler furnaces, and

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TABLE 2.—Results of Tests, 1897.

—	October 26. Two engines at full load and one generator.	October 27. Four engines and two generators at two-thirds full load.
Number of engines at work	2	4
,, ,, gas generators at work.	1	2
Duration of test.....	Five hours	Five hours
Average consumption of coal per hour in pounds	98·5	151·2
Average consumption of coke per hour in pounds	14·4	17·2
Electrical output in B.T. units—		
Engine No. 1	—	87
,, 2	156	101
,, 3	—	105
,, 4	163	109
Total output in B.T. units.. ..	319	402
Average per hour ,, ,, ,, ...	63·8	80·4
,, I.H.P. of engine No. 4 ..	59·5	43·5
,, E.H.P. of dynamo No. 4...	43·7	29·2
Efficiency = $\frac{\text{E.H.P.}}{\text{I.H.P.}}$	0·734	0·67
Total I.H.P.	116·4	160·4
,, E.H.P.	85·5	107·6
Assumed brake horse-power (taking as a mean between the E.H.P. and I.H.P.).....	100·95	134 0
Coal consumption per I.H.P. per hour in pounds	0·846	0·942
Coal consumption per B.H.P. per hour in pounds	0·975	1·128
Coal consumption per E H.P. per hour in pounds	1 152	1·405
Coal consumption per B.T. unit generated	1·543	1·88
Coke consumption per B.T. unit generated	0 225	0 214
Total fuel per B.T. unit generated.	1·768	2·094
Gas consumption per I.H.P. per hour	—	80 cubic feet
Calorific value of one cubic foot of gas in British thermal units	153	156

represent a very substantial saving in coke, whereas on the trial runs the fuel used for the boilers was all coke. On October 27 the amount of ash and clinker raked out of the generator in the morning was 231lb., out of which 136lb. was fit for use in the boiler furnace. The quantity of coal put into the generator to make up the fire to the normal level after clinkering, and to prepare for starting work, was 214lb. There was a delay of some 15 or 20 minutes before starting the engines, during which the gas had to be blown off. It appears, therefore, that the amount of coal required to make up the losses in one generator (capable of serving 110 b.h.p.) after a day's run of about 10 hours at nearly full load is about 2cwt., and the ash siftings available for the boiler amount to over 1cwt. These figures, of course, only apply to the particular kind of coal used in this trial, but the 2cwt. is, I believe, higher than usual with more expensive coal. With higher-priced coal the amount of clinker and ash would be less, and therefore the making-up quantity would also be less, but, on the other hand, the siftings to go to the boiler would be less, and therefore the coke consumption would be greater. It is doubtful whether any substantial improvement would result from employing more expensive coal. The anthracite used in 1897, and up to July 22 this year, was different from that now in use and cost more, but the results show no perceptible difference in favour of either. The value of a trial run lasting about five hours is greatest when the conditions of working have previously been in existence for some time, and are continued without intermission after the test. Referring to the diagram of results of the trial on October 26, it will be seen that from 11.45 to 1 o'clock the output was above the average, whilst the coal consumption was below the average. This indicates that there must have been an abnormal quantity of fresh coal in the furnace at the start. After 1 o'clock the conditions settled down to fairly uniform lines. The coal consumption per unit over the whole period comes to 1·34lb., before 1 o'clock it was only 0·68lb. per unit, but after 1 o'clock it was 1·91lb. An average over the whole is fairer than taking either of the short periods.

So far as I am aware, such information as is contained in this report has not been previously obtained or published, and therefore it will be of interest to those who are concerned in deciding as to the relative merits of gas and

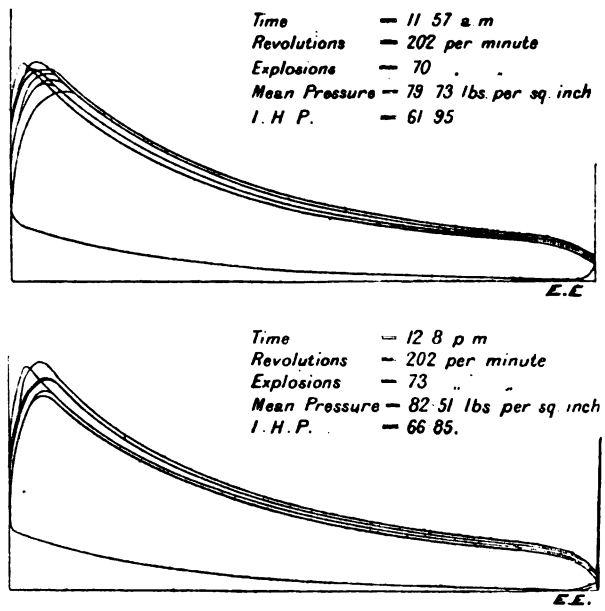
Time — 11 57 a m
Revolutions — 202 per minute
Explosions — 70 . .
Mean Pressure — 79 73 lbs. per sq. inch
I. H P. — 61 95
E.E
Time — 12 8 p m
Revolutions — 202 per minute
Explosions — 73 .. ..
Mean Pressure — 82 51 lbs per sq inch
I. H. P. — 66 85.
E.E.

FIG. 4.—Indicator Diagrams taken from Engine No. 4.

steam plants. The cost of fuel per unit sold being only two-thirds of a penny is very satisfactory for a period which does not include the months of November and December, and considering the large difference between

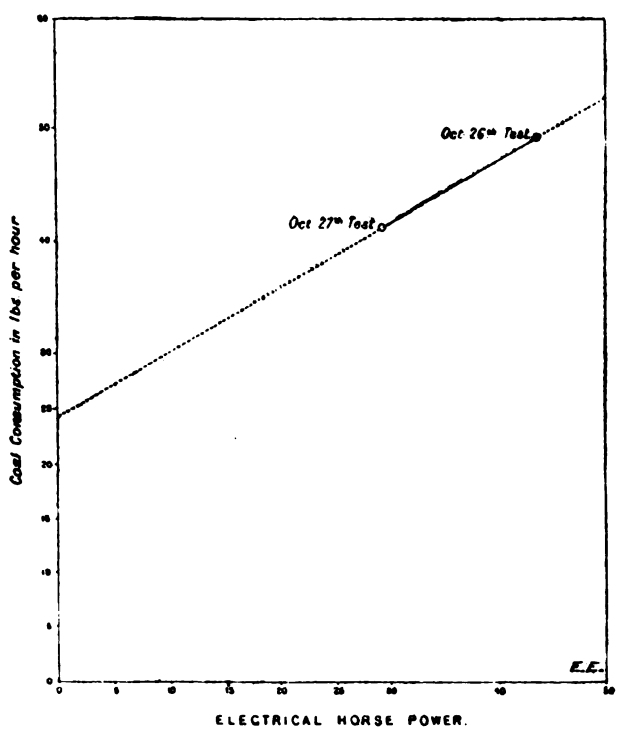

FIG. 5.—Diagram showing the Relation between the Coal Consumption and Output for Various Loads.

the amount of current generated and the amount sold, the proportion of which will, however, be steadily reduced as the load increases.

Mechanical Engineers' Pocket-Book.—We have received a copy of "Whittaker's Mechanical Engineers' Pocket-Book for 1898," which is a well got-up and handy-shaped book of great value to engineers. It consists of 360 pages of tables referring to water flow, pumps, temperatures, the attributes of gases, the weights, proportions, superficial areas, thicknesses, contents, speeds, gauges, and pressures of practically everything which comes within the range of the engineer's necessity for knowledge. There is also a carefully drawn-up index, and altogether the book is one which ought to be in the possession of every engineer.

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C Anonymous communications will not be noticed.*

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Vol. XIX. of new series of "THE ELECTRICAL ENGINEER" can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.

ALCHEMY REDIVIVUS.

The popular definition of alchemy would probably be the act of transmuting metals. The still more popular idea of an alchemist is one whose sole aim in life is to find a way to change some cheaper metal into gold. According to the *Daily Chronicle*, we are threatened with a recrudescence of this mediæval nightmare. A long telegram in our daily contemporary explained that an American of the name of Emmens—we have a recollection of having heard the name before—has discovered a method of transmuting silver into gold. The means by which such transmutation is obtained is not divulged, but it is said that a piece of the gold obtained has been sent to this country for scientific assay. If our surmise is true, that the name of the discoverer is not unfamiliar, the name has been connected with matters electrical; and if any discovery has been made, we suspect that electricity in some form or other plays a prominent part. At the present moment we are emphatic in saying the rumour is about as likely to prove true as that a railway to convey humanity will be completed to the moon by to-morrow evening. We happen to be in a good position to prove, if proof is necessary, that there is hardly any limit to human credulity. The wilder the scheme, and the more so if it be presented with a bouquet of verisimilitude, the greater the probability of reaping a rich pecuniary harvest from credulous men and women. The singularity of these American rumours arises from the fact that the more startling the matter, the easier it seems to get the representatives of our great daily papers to give credit to it and to publish it broadcast. Somehow or another, the words of Solomon the Wise do not penetrate into the walks of newspaper life, else such astonishing "new" rumours would be met with a cold shoulder. If a newspaper gives publicity to an inaccurate statement about a man, it is in danger of a libel action, and the judge not unnaturally says, you ought to have verified such a statement before making it. Yet the papers may and do publish anything startling in other directions without verification. The mere proclaiming that a piece of gold has been made from silver is of the nature of a theatrical effect, but it is not convincing. Such a statement, moreover, is made in direct opposition to the teaching of present-day chemistry. We may take the last edition of the "Encyclopædia Britannica" as certainly embodying the teaching of modern science, and this is what it says: "Alchemy was, we may say, the sickly but imaginative infancy through which modern chemistry had to pass before it attained its majority, or, in other words, became a positive science. The search for gold was only one crisis in this infancy. This crisis is over, and alchemy is now a thing of the past. There is no longer any need to exhort adventurous spirits, who hope to find Golconda at the bottom of their crucibles, to leave such visions and turn to the safer paths of science and industry." It seems that the writer in the "Encyclopædia" was wrong, and that one Emmens believes in the black art, and is more or less backed up in that belief by the notoriety that is given him by the newspapers. It may be said

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that we are assisting to give him notoriety; but we venture to believe otherwise. Our aim is to stop credulous people parting with real gold to get huge dividends from the output of the Emmens laboratory. We say that silver has not been turned into gold, not only from our knowledge of chemical science and the consensus of opinion of scientific chemists throughout the world, but also from our knowledge of human nature. The statement is either false or real. If false, it is promulgated by interested parties in order to obtain money. We do not mean to say that the *Chronicle* has this object in view, or its representative in America. In this case there may be a trustful dependence upon Shakespeare that, "There is more in heaven and earth," etc., and that there is just the off-chance of the transmutation claimed being possible; hence a go-ahead newspaper hearing the news—well, evidently accepts the doctrine of chances and publishes the information. It is the men who "tip" the newspaper representatives that more or less know that the news is false, and know also for what purpose they want it published. If, on the other hand, the statement of transmutation was true, the possessor of the secret would rather part with his life than his secret, for parting with it makes it valueless. The secret in the hands of one family would practically put that family in command of the whole world. Every man who takes but the slightest trouble to think over the matter would see this, hence we again say that silver has not been transmuted into gold. It would be easy to make a plausible tale up as to the views of the ancients and the success of the moderns in chemical matters—to hint that argon and helium were but forerunners of other discoveries, and to suggest that silver and gold possessed similarities which caused the discoverer to believe that silver was an alloy of gold and another substance, that gold was the principal ingredient, and that the discovery was in the releasing of the small quantity of the other ingredient. Ah! yes, a fine tale; and carried a little further would be to the effect that the cost of separation on a small scale is too great, but on a large scale would be a source of income more precious than even a diamond mine. Who will be credulous enough to enter the syndicate?

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE LATE MR. TRIBE AND THE FAURE ACCUMULATOR.—RULE OF PRECEDENCE AT THE INSTITUTION.

SIR,—In your report of the meeting of the Institution of Electrical Engineers on the 25th ult., Mr. J. W. Swan is stated to have claimed for the late Mr. Alfred Tribe whatever credit or honour there was in the origination of the Faure type of cell.

Now, with every disposition to give due credit to Mr. Tribe for the results of his collaboration with Dr. Gladstone, and especially for his intelligent recognition of the necessity for obviating local action on the peroxide support, I am unable to find any grounds for the statement that Mr. Tribe had anything to do with the origination of the Faure accumulator. Possibly such grounds may exist; and, if so, it would be a pleasant task to bring them into prominence. To the claims, in the same direction, of the president-elect of our society I endeavoured to do justice in my last contribution to your columns. But, with Mr. Tribe's various patent specifications before me, I fail to discover any invention that has been adopted, or that might be usefully adopted, in connection with the above type of accumulator—with the exception only of No. 2,073, 1884, which foreshadows the perforated celluloid so successfully utilised by Dr. Tommasi and some of his imitators.

I was present at the meeting in question, but did not catch the words spoken by Mr. Swan—nor, indeed, many others. I attended specially, and at some inconvenience, in compliance with a courteous invitation from our secretary to join in the discussion. But although my name was sent in the president did not call upon me to speak—probably in virtue of some rule of precedence which I do not understand. This can hardly involve the question of seniority, for I was the only original member of the society present.—Yours, etc., DESMOND G. FITZ-GERALD.

94, Loughborough-road, S.W.

CHITTY DYNAMOS.

SIR,—Our attention has been called from several quarters to the prospectus of the Chitty Dynamo and Motor Company, Limited, which, marked "for private circulation only," has, we know, been widely distributed. In it are printed, on pp. 8 and 9, two tables of tests carried out by us upon a small Chitty dynamo, and on p. 13 a diagram of certain curves of efficiency. The other diagrams at pp. 10, 11, and 12, were not compiled by us. The last paragraph of the prospectus, p. 6, states that "Copies of the report and tests by Messrs. Willans and Robinson are appended." No copies of reports by us are appended. The paragraphs on p. 7 are headed "The Chitty Dynamo: Messrs. Willans and Robinson's Tests," and the first paragraph commences, "Following are copies of the records of Messrs. Willans and Robinson's tests." It appears to us that these words, coupled with the statement on p. 6, that "reports" by us are appended, may be taken to mean that the statements on p. 7 are in the nature of a report from us. We shall be greatly obliged if you will allow us to state publicly in your columns that we are responsible only for the facts set forth in the tables on pp. 8 and 9, and in the diagram on p. 13 of the prospectus.—Yours, etc., WILLANS AND ROBINSON, LIMITED,
(C. S. Essex, Secretary).

Victoria Works, Rugby, December 8, 1897.

BOOSTERS.

SIR,—In last week's issue of your much-read paper you inserted two answers to a most important question—viz., No. 11: What is the best way of controlling from a central station the pressure of the supply when a number of feeders of various lengths are in use?

Mr. Locke suggests the use of the Edison-Swan "regulating transformer," and Mr. Pilling likewise suggests a similar apparatus, the arrangement of Mr. John H. Rider. I should like to enquire from these gentlemen who use the transformers whether they are giving satisfaction. If they are satisfactory in every respect, I should certainly like to see them in use in the station at which I am employed. I should be pleased if you could afford space in your valued paper to allow of this being inserted, so that engineers like myself could gain more information on such an important question.—Yours, etc.,

ONE WHO IS TROUBLED WITH THE SAME COMPLAINT.

THE AMERICAN PATENT LAW.

SIR,—Important amendments have recently been made to the patent law of the United States of America. These amendments, which will come into operation on January 1, 1898, seriously affect the rights which British inventors have hitherto enjoyed in that country.

By the existing law a United States patent can be obtained for an invention which has not been in public use or on sale in the United States for more than two years prior to the date of application for a patent there. By the law as amended it is provided that applications for United States patents must be filed within seven months of the

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date of the first application for a patent for the same invention in any other country. As will be seen, this is a serious limitation of the time within which a British inventor may obtain a patent in the United States.

In every case in which a British patent shall have been applied for before June 1, 1897, the application for the United States patent for the same invention must be filed before this Act takes effect, or the right of patenting the invention there will be lost.

As the Act comes into force on January 1 next, it is of the utmost importance that the applications be filed in Washington before the end of the present year.—Yours, etc.,

36, Chancery-lane, W.C., Dec. 8, 1897. F. W. GOLBY.

TRAGIC DEATH OF MR. E. GRAVES.

We regret to announce the death of Mr. E. Graves, assistant superintendent of the Persian Gulf Telegraph, which took place in Persia last week under particular shocking circumstances. Mr. Graves was inspecting the line between Jask and Chauber, at a distance of 90 miles from the former place, when, according to Reuter, he was attacked in camp by tribesmen, who entered his tent at dusk, and, pinning him to his bed, disembowelled and decapitated him. The native staff escaped, but the camp was looted and destroyed.

The following additional facts were published in the *Daily Telegraph* of December 8: "Enquiries made by a Dalziel representative confirm the report of the murder in Persia, at a point to the east of Jask, near the entrance to the Straits of Ormuz, of Mr. E. Graves, assistant superintendent of telegraphs under the Indian Telegraph Department. So far as is known at present, Mr. Graves had reached the Rafich River, between Jask and Gwador, and was there murdered while in bed, the object of the crime being robbery. No further details had been received at the India Office up to a late hour last evening. It is believed, however, from information received of Mr. Graves's movements that the murder must have occurred between Thursday night and Friday morning. Fortunately, Mr. B. T. Ffinch, C.I.E., Director-General of the Indo-European Telegraph Department of the India Office, who left England by the P. and O. ss. 'Rome' on November 4, was at Kurachi when the report of Mr. Graves's murder was received, and at once left for Jask, where active steps will immediately be taken for the detection and punishment of the murderers, who, it is believed, can be identified. In this work Mr. Ffinch will receive every assistance from the British Political Agent at Bushire (Lieut.-Colonel Talbot) and the naval force in the Persian Gulf. Further news of the punitive measures to be taken cannot be known for some days, as Mr. Ffinch will not arrive at Jask until Thursday or Friday. Everything possible is being done by the Persian Government to assist in securing the murderers. Mr. Graves, whose career has been brought to so untimely an end, has been over 30 years in the service of the Telegraph Department, and had only six months to serve when he could have claimed his pension. He was born on December 5, 1844, and had thus almost attained his fifty-third year. Mr. Graves was for some years in the Royal Engineers, in which he attained the rank of sergeant, and went out to Persia in August, 1863, where he has been principally engaged ever since. In 1878 he left the army, and was appointed to the civil staff of the Indian Telegraphs in that year. The sad news of his death was conveyed yesterday to his wife, who, with her son, is at present residing near London."

INSTITUTION OF ELECTRICAL ENGINEERS, Dec. 9.

The annual general meeting of the Institution was held last night, when the statement of accounts, as published in our last issue, was presented, and the election of President, Council, and Officers, as given in our issue of November 12, was duly proceeded with, no other nominations having been made.

The following were the candidates for membership balloted for:

Associate.—D. Smith, 25a, Cockspur-street, S.W.

Students.—M. Thomson, Bushbury-lane, Wolverhampton; J. F. Wakelin, 33, Robert-street, Regents Park, N.W.

FORTHCOMING EVENTS.

The following are some of the announcements for the forthcoming week:

TO-DAY (FRIDAY).—Physical Society, Burlington House, 5 p.m. An Exhibition for an Apparatus for Self-acting Temperature Compensation of a Standard Cell, by Mr. Albert Campbell. ("On Lord Kelvin's Absolute Method of Graduating Thermometers," by Mr. Rose Innes).—Institution of Junior Engineers, at the Westminster Palace Hotel, 8 p.m. ("Main Engine Auxiliaries in the Mercantile Marine," by Mr. Basil H. Joy).

SATURDAY, DECEMBER 11.—Chesterfield and Midland Counties Institute of Engineers, University College, Nottingham, 3 p.m. ("Electric Blasting," Part II., by Mr. W. Maurice).

MONDAY, DECEMBER 13.—Northern Society of Electrical Engineers, Palatine Hotel, Hunt's Bank, Manchester, 8 p.m., continuation of discussion on Mr. C. H. Wordingham's paper. At 8.30 p.m. ("The Management of Boilers and Steam Plant, including Details of Steam-Pipes and Fittings," by Mr. A. B. Mountain)—Society of Engineers, Royal United Service Institution, 7.30 p.m., annual general meeting.—Society of Arts, John-street, Adelphi, Cantor Lecture, 8 p.m. ("Guttapercha," by Mr. Eugene F. A. Obach, Ph.D., F.C.S.); last of series.—Camera Club, 28, Charing Cross-road, W.C., 8.15 p.m. ("The X Rays Up-to-date," by Mr. Wm. Webster).—Imperial Institute, 8 p.m. ("Canada's Metals," by Prof. W. C. Roberts-Austen).

TUESDAY, DECEMBER 14.—Civil Engineers, Great George-street, Westminster, 8 p.m. ("The Great Land-Slides on the Canadian Pacific Railway in British Columbia," by Mr. Robt. B. Stanton, M.A., M.I.C.E.).

WEDNESDAY, DECEMBER 15.—Institution of Electrical Engineers, students' meeting, 7.30 p.m. (Notes on the Dover Tramways," by Mr. J. M. Donaldson).—Society of Engineers, annual dinner.—Society of Arts, John-street, Adelphi, 8 p.m. ("The Purification of Sewage by Bacteria," by Mr. Samuel Rideal, D.Sc.—Royal Meteorological Society (at Institution of Civil Engineers), 7.30 p.m. ("Daily Values of Non-Instrumental Meteorological Phenomena in London, 1763-1896," by Mr. R. C. Mossman, F.R.S.E., etc.). ("The Rainfall of Seathwaite, Borrowdale, Cumberland," by Mr. Wm. Marriott, F.R. Met.Soc.).

THURSDAY, DECEMBER 16.—Chemical Society, Burlington House, 8 p.m.—Finsbury City and Guilds Technical College, Leonard-street, City-road, E.C., 8 p.m. (Mr. Philip Dawson on "Electric Traction").

FRIDAY, DECEMBER 17.—London Chamber of Commerce, distribution of prizes and certificates at the Mansion House, 3 p.m.—Institute of Electrical Engineers, extra meeting at the rooms of the Chemical Society, Burlington House ("Accumulator Traction on Rails and Ordinary Roads," by Mr. L. Epstein; continuation of discussion). — Civil Engineers, students' meeting, 8 p.m. ("The Elastic Properties of Steel Wire," by Mr. A. D. Keigwin, and "The Elasticity of Portland Cement," by Mr. W. L. Brown).

METER PATENTS.

[We have received the following series of letters from Messrs. Chamberlain and Hookham, Limited. As the matter seems likely to lead to a lawsuit, we refrain from all comments on the correspondence.—ED. *E. E.*]

[COPY.]

4, New Bartholomew-street, Birmingham,
November 15, 1897.

The Town Clerk, Huddersfield.

Dear Sir,—We are informed that you are using on your electrical circuits the Shallenberger meter, manufactured by the Westinghouse Company of the United States of America. You must be aware that such usure is an infringement of our patent rights, and renders you liable to damages for the past and an injunction for the future. We shall be glad to hear at your earliest convenience whether you admit this, in which case we will let you know what damages we have suffered up to now. On the other hand, if you are not prepared to admit our rights we shall be obliged to appeal to a competent court.—We are, your obedient servants (for Chamberlain and Hookham, Limited),

(Signed) ARTHUR CHAMBERLAIN, Director.

[COPY.]

Town Hall, Huddersfield, November 20, 1897.

Re METERS.

Dear Sirs,—Adverting to your letter of the 15th instant, herein I am instructed to ask you to be good enough to point out, for the information of the Corporation, in what

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particular or particulars you consider the Shallenberger meter infringes your rights.—Yours faithfully,

(Signed) F. C. LLOYD, Town Clerk.

Messrs. Chamberlain and Hookham, Limited,
4, New Bartholomew-street, Birmingham.

[COPY.]

4, New Bartholomew-street, Birmingham,
November 26, 1897.

The Town Clerk, Huddersfield.

Dear Sir,—INFRINGEMENTS OF OUR METER PATENTS.—In reply to your enquiry of the 20th, we do not quite know what information you expect. Of course, if it is your intention to defend the action, you cannot suppose that we shall give you details in anticipation of legal proceedings. We may, however, refer you to our specifications 4,225/87, 17,502/87, and 13,123/90. On the other hand, we must presume that you are acquainted with English patent law, and examined our patents before using foreign-made meters. Our circular of May 1 called your attention to our claims, and warned you that we should enforce them. The meters you are using clearly come within the judgment there referred to, besides infringing other patents of ours bearing later dates. Your letter confirms an impression we already had, that the scope of Mr. Justice Wills's judgment in its bearing on motor meters of this class has not yet been fully realised by electric supply companies.—We are, dear Sir, yours truly (for Chamberlain and Hookham, Limited),

(Signed) ARTHUR CHAMBERLAIN, Director.

[COPY.]

4, New Bartholomew-street, Birmingham,
December 3, 1897.

The Town Clerk, Huddersfield.

Dear Sir,—We shall be glad of a definite reply to our letter of November 15 last, with an assurance that you will at once cease the usure of which we complain. If we do not receive this by Monday we shall be reluctantly compelled to ask you to accept service of a writ, since our trade is being seriously interfered with by such infringements as yours.—We are, your obedient servants (for Chamberlain and Hookham, Limited),

(Signed) ARTHUR CHAMBERLAIN, Director.

[COPY.]

Town Hall, Huddersfield, December 4, 1897.

Dear Sirs,—I have your letter of yesterday, and in reply must ask you to be good enough to allow this matter to stand over for a few days, until I have had an opportunity of looking at the references in your letter of the 26th ult.—Yours faithfully, (Signed) F. C. LLOYD, Town Clerk.

Messrs. Chamberlain and Hookham, Limited,
4, New Bartholomew-street, Birmingham.

[COPY.]

4, New Bartholomew-street, Birmingham,
December 7, 1897.

The Town Clerk, Huddersfield.

Dear Sir,—In reply to your favour of the 4th inst., whenever you have had sufficient opportunity of studying our patents to cause you to wish to arrange terms with us, we shall be pleased to hear from you and to consider your proposals in a reasonable spirit and with a desire to spare you all possible convenience. Meanwhile, for the reason given in our last, we have instructed our solicitors (Messrs. Smith, Pinsent, and Co., of this city) to issue a writ.—We are, dear Sir, your obedient servants (for Chamberlain and Hookham, Limited),

(Signed) ARTHUR CHAMBERLAIN, Director.

The following is the circular referred to in Messrs. Chamberlain and Hookham's second letter:

NOTICE.

Infringement of Patents.

Chamberlain and Hookham, Limited, *v.* Johnson and Phillips.

This case came on for trial in the Court of Queen's Bench, before Mr. Justice Wills, in March, 1897, and, after a hearing extending over seven days, his Lordship gave judgment for the plaintiffs, with costs on the higher scale. He certified the validity of the plaintiffs' patent, held that the Perry meter manufactured by the defendants infringed it, and ordered an enquiry as to damages and for the delivery up of the infringing instruments. This decision gives the company a master patent for all motor meters having an electric brake, and in which the motor and brake run in a constant or nearly constant field. Manufacturers and others infringing the company's patents, by making, selling, or using such instruments as above, will be proceeded against.

OIL, WASTE, AND STORES.

The above items figure largely in the annual accounts of all our electricity works, and the actual amount so expended depends to a great extent on the types of machinery used. It also depends on the quality of the stores purchased, and in this, as in most other engineering works, the actual cost as a basis of comparison seldom represents the true value of the article in question. Thus, for instance, in gas-engines, oil quotations of widely different prices can be obtained; and it must not be forgotten that some samples of the oil tendered may be totally unsuitable for the purpose. In the event of bad oil being used the repairs' item is likely to be increased, as well as the item for stores generally. In such matters one cannot do better than patronise firms who have obtained a good reputation, and who cannot afford to risk their reputation by supplying inferior articles. The firm of W. H. Willcox, Limited, is one we have in our mind, and their exhibit at the Smithfield Show this week affords a good opportunity for an inspection of their many accessories. Thus their collection of oils is a most extensive one, amongst which should be mentioned Willcox special cylinder and valve oils, engine and thrashing-machine oils, including lard, neatsfoot, olive, Gallipoli, castor, sperm, etc. On account of this firm's long and varied experience in connection with machinery, they are able to advise as to the most reliable and best lubricant for any particular purpose.

FIG. 1.

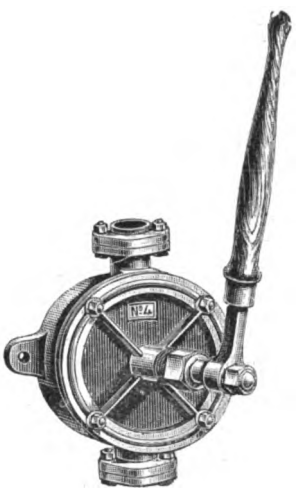

FIG. 2.

The patent Penberthy injector (Fig. 1) is a great speciality of this firm's, and of these they show an assortment of sizes from ⅜in. up to 3in. connections. They are used by the most important engineering firms in the United Kingdom, and by engineers and users of steam power in all parts of the world. Their automatic and restarting properties makes them a most important and indispensable boiler feeder for engines for temporary plants.

This firm have recently made many improvements in the patterns of their patent semi-rotary pumps (Fig. 2), increasing, if possible, their general utility as a simple and efficient pump. They have also introduced a special pattern of this pump with quadruple valves for high lifts and deliveries. We noticed one of these pumps doing invaluable service in an electric lighting station recently, where the automatic lubrication under pressure had got out of order on a large coupled set. The result was that the pressure of oil could not be maintained, and all lubrication ceased. The engine was then working on the mains, and there was not sufficient space in the station to enable it to be shut down. One of

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these pumps was at once obtained, and enabled the town supply to be kept going. At this time the prompt supply of the pump by the firm was not its least valuable attribute.

At the Smithfield Show the firm had a most representative exhibition of leather belting made from the best English butts, and also of many other articles in leather—such as pump-cup leathers, belt laces, etc. In their other exhibits of engineers' necessaries, engine packings of all descriptions are included—viz., Willcox self-lubricating soapstone, patent cork core, indiarubber with core, asbestos, square hemp greased, hemp and flax gaskin, etc., asbestos millboard, sheet, yarn, and mudhole rings, indiarubber valves, sheet, washers, corrugated brass rings for steam-joints, gauge-glass rings, tube brushes, cotton waste, sponge cloths, boiler-covering cement, felt, block and liquid composition, soap powder, soft soap, wheel grease, engine and boiler fittings, including patent traction engine gauges, Bourdon and Schaeffer gauges, asbestos-packed, gland, and plug water-gauges, test cocks (Ottewell and other varieties), tallow and grease cups, oil syphons, pet cocks, steam-cocks, stop valves, safety valves, needle lubricators, gauge glasses with patent safety rings for preventing the indiarubber washer blocking the gauge glass, donkey pumps, water-lifters, etc.

THE PRODUCTION OF INCANDESCENT LAMPS.*

The incandescent lamp, simple in appearance, is yet very complex in all its features. Probably in no other branch of the electrical industry does experience count for so much, nor any product in which the best results are absolutely dependent upon constant inspection and testing.

Perhaps the most noteworthy improvement introduced during the past two years is the new exhaustion process. By the adoption of this process the quality of the Edison lamp is said to be distinctly advanced beyond lamps exhausted by other methods. During recent years mechanical exhaust-pumps—that is, pumps operated without mercury—have from time to time been presented, but in each case the size of the pump has been too great, the object having been to exhaust a large number of lamps at one time. This practice being considered injudicious, such pumps have not been adopted, but the lamp works have succeeded in obtaining a small mechanical pump, with a rate of exhaustion such that it can practically be employed to exhaust one lamp at a time. Experiments with this pump lasted nearly two years, and showed that the lamps could be exhausted more nearly to the ideal lamp vacuum by this pump than by another. It is now used to exhaust the Edison lamp, and the mercury-pumps have been discarded. The final perfection of the vacuum, however, is not obtained by the pumps unaided.

In combination with these pumps a chemical process is introduced. It is said to be exclusively used in this country by the Edison Lamp Works, and as the various phenomena of exhaustion are clearly marked a very definite rule of operation has been formulated.

The natural residual gases of an incandescent lamp may be considered conducting gases, since they allow current to pass from one leg of the filament to the other. The residual gases, therefore, are not only injurious to the filament, but their necessary removal has previously involved long and tedious processes. By the new method of chemical exhaustion all the residual gases are thoroughly removed from the lamp by the introduction of a gas capable of combining with them. Previous to this introduction a blue glow fills the bulb when the filament is brought up to bright incandescence, but when the combination takes place between the residual gases and the new gas the blue glow suddenly disappears, and a lamp "sealed off" at this moment has a vacuum of perfect insulating properties.

The advantages of the chemical process of exhaustion are several. The combination of the gases in the bulb is a phenomenon so marked as to furnish an absolute proof that the proper vacuum has been obtained. The lamps are exhausted one at a time, and the whole attention of the operator is concentrated on a single lamp. This ensures a perfection of vacuum difficult to obtain in lamps exhausted in groups. The operator sits in a comfortable position, and, not unduly wearied, can do as accurate work late in the day as in the morning.

The injurious effects of mercury upon the health of the operator being avoided his uninterrupted service is secured, and the very highest skill dependent upon continued practice is retained.

* The *Electrical World* (New York).

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We shall also in future give *two shillings and sixpence* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared, and should be written on one side of the paper only. Questions may be sent at any time.

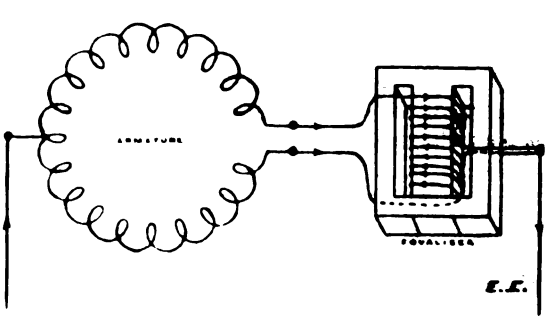
QUESTIONS.

18. What is your opinion on the use of the marine type of boiler for central stations?—NEMO.
19. What is the general type of ammeter or voltmeter you consider most suitable for giving accuracy when placed on switchboards at central stations?—K. T.

ANSWERS.

Question No. 13.—The armatures of Mordey alternators are sometimes connected with half the coils in series, the two halves being in parallel, and an equaliser is used. What is the object of this equaliser, and how is it constructed?

Best Answer to No. 13 (awarded 10*s.).*—The object of an equaliser is to prevent the circulation of local currents in the armature of an alternator, which has the coils arranged in two parallel circuits. Such an arrangement of the armature is usually adopted in order to bring those coils between which there is the greatest difference of potential, as far apart as possible. But it often happens that the two halves are unbalanced electrically, owing to slight differences in the field-magnet system, or in the angular positions of the coils. Then one side will have an E.M.F. slightly in excess of the other, and the consequence will be that a current will circulate round and round the armature itself, doing no useful work, but wasting power. The equaliser is designed to correct this.



It consists of a closed magnetic circuit transformer core, of any ordinary type, with two similar windings. The windings are connected up to form a single coil in the same direction, with a common terminal in the middle. The diagram shows the principle and the method of connecting to the armature and the external circuit. When the currents in the two halves of the armature are equal, there will be no magnetism in the equaliser core, as the ampere-turns will balance each other. But if, owing to want of balance, a local current tend to flow, it would have the effect of increasing the current in one coil of the equaliser and reducing it in the other. The coil with the greater current would act as a primary, inducing an E.M.F. in the other coil, such as would be added to the E.M.F. of its side of the alternator armature, and creating at the same time a back E.M.F. in itself in opposition to the alternator E.M.F. The result would be to tend to make the two sides of the alternator equal, and so to stop the local current. Mr. Mordey cites the case of a 250-kw. alternator, where the addition of an equaliser had the effect of reducing the local current from 16 amperes to 5 ampere.

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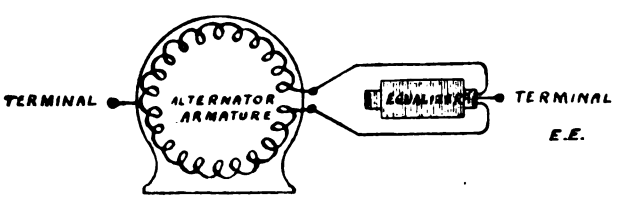
In order to get the full effect of an equaliser, it would be necessary to adjust the relation between its two coils in accordance with the want of balance in the alternator armature. Owing to the necessity of three connections to the armature, the equaliser is only used in alternators with fixed armatures.—T. A. LOCKE.

Answer to No. 13.—The best way is to consider what would happen if the equaliser was not there, and the pressure across one-half of the armature was greater than that of the other. Of course, on joining them together, the one which had the greater pressure would do all the work, and would also send a current in the reverse direction through the other half. This would probably cause the armature to burn out, and the equaliser is put in circuit to prevent this. It is built on the same lines as a transformer. It has two similar coils, the two coils being respectively in series with the two halves of the armature, the inner ends of which come out to a common terminal. The windings are in opposite directions, but owing to the connections the current will flow in the same direction in the coils. More current will flow through the coil which is connected to that side of the armature which has the higher P.D., which will raise the P.D. on the other coil; but the one which has the most current flowing through it will have a back E.M.F. of self-induction to contend with. In this way the potential difference on the dead side of the coils will be equalised.—P. AULEY.

Answer to No. 13.—The object of an equaliser is to prevent the current in the two portions in the armature being unequal, as might result from the coils being a little dissimilar in size or in position with regard to the poles. It is a device similar in principle to a transformer. It has two similar coils, these two coils being respectively in series with the two sides of the armature. By the action of its coils on one another, the equaliser ensures that the halves of the armature supply equal amounts of current. A glance at the following diagram will make the whole



thing clear. In large alternators the equaliser is placed in a special receptacle in the bed-plate casting. In others it is usually a separate piece of apparatus.—A. BROUGHTON.

Question No. 14.—Is it necessary and advisable to put fuses in the field circuit of large direct-current and alternate-current generators?

Best Answer to No. 14 *(awarded* 10*s.).*—The question involves a discussion as to the object and use of fuses generally, and is one on which there are many opinions. Speaking generally, a fuse is an arrangement, very crude and unreliable, for disconnecting a circuit when the current in that circuit exceeds a given amount. The current which will melt a fuse is affected by the length, size, and surface of terminals, temperature of surrounding air, the air currents which are allowed to pass over the fuse, the kind of contact made with the terminals, whether bad or good, the shape of the fuse, and no doubt other conditions. As there are so many variables, it is impossible to foretell the actual current which will melt the fuse. In applying them to the field circuits of dynamos, the conditions of working must be carefully considered. In the first place, as the current in the field can never exceed a certain amount under natural conditions, there is no need to provide for an excess of current unless something has gone wrong with the shunt winding. The accidents which can happen are: (1) an earth; (2) a short-circuit. In the case of an earth there is little immediate danger, and there is no need to disconnect the coil suddenly for this. The earth lamps will show this at once, and it can be traced and rectified. In the case of a short-circuit, which is almost an impossibility in a well-constructed shunt, the dynamo will be left without a field, to a more or less extent. This leads on to the great questions, (1) What will happen if there is no fuse? (2) What will happen if there is a fuse? If there is no fuse, a number of the turns will become short-circuited; the voltage of the dynamo will not drop very much if it is a continuous-current shunt machine, as the reduction in the number of turns will be made up by the increase in the current, as there will be less resistance. The same applies to alternators until the exciter becomes seriously overloaded. The increase of current will cause the windings to get hot and smoke; attention will be attracted to the matter, and the machine will be disconnected. Where the whole of the turns are short-circuited there will be a loss of field, and if the generator is paralleled with another, the main fuses will go and the machine will be disconnected. However, this is only one case out of many which can happen and which are much less disastrous. It is evident then, that, as a rule, there is no very serious danger if some, more or less, turns become short-circuited, as there is usually time to switch the machine off. (2) When there is a fuse in the circuit, as soon as the current increases sufficiently the fuse goes and the machine is immediately left without field, and if paralleled with another one or two it may be damaged before the main fuses go. Thus the existence of a fuse does away with the time which would otherwise be allowed for disconnecting the dynamo. Also fuses are liable to be neglected, especially if small ones, and the terminal contacts may become bad or the fuse oxidised, and may go when there is no excess of current flowing. It is thus pretty clear that for machines of all sizes there is no advantage in fuses, and, more than that, they increase the risk of breakdown and failure of the light, and are therefore to be condemned.

When we come to consider the effect of a fuse going in a large machine we come to another danger—viz., that of the voltage induced in the coils, which have enormous self-induction, when the current is suddenly broken. This induced voltage will in a large machine be enormous, and will possibly pierce the insulation. The edge is rather taken off this objection by the fact that the insulation should already be badly damaged or the fuse should not go. As, however, the editor hints that an explanation of the phenomena which will occur are desirable, I go into the matter briefly. The induced voltage is equal to the rate of change in the current flowing round the coils, and therefore if the rate of change of the current is made very rapid, as it is when the fuse blows, especially if it is in oil, as in many new fuses, the induced voltage is something enormous. This is easily seen, and may be gauged by the length of the arc in excess of that permanently kept up by the current. For instance, take the end of a shunt, and find the arc which will be permanently maintained; now separate the ends rapidly, and it will be seen that the length is many times the one previously maintained, thus proving that the voltage is greatly increased. This arc on breaking may be greatly diminished, and the induced voltage therefore greatly diminished, by paralleling a condenser of suitable size across the fuse. This is done in induction coils for the purpose of neutralising the effect of the self-induction of the primary, and it will do the same in the case of a field magnet. This answer is already too long, and no useful purpose will be served by going further into the matter and by introducing the calculus, as the use of fuses is condemned on other grounds—viz., that they are unreliable, do not serve to protect the machine as a whole, as they go suddenly and leave the machine without a field, and further, for this very reason, expose a machine and the lighting to danger, as otherwise the machine might have been disconnected before anything serious happened either to the shunt or to the armature. The great fact remains that field-magnet coils rarely short-circuit. Where series windings are used in direct-current generators, the main fuse is as good a protection for the field as for the armature—in fact, the current is fixed for the field by the output of the machine.—W. FENNELL.

Answer to No. 14.—It is neither necessary nor advisable to put a fuse in the field circuit of any generator. In fact, it is distinctly courting disaster to do so. Such fuses would generally be small, and in course of time would be sure to deteriorate. When least expected, they would "blow," even without a fault in the field coils, and then there would be "ructions." The generator, deprived of its excitation, would fail to give any current, and if it were in parallel with others, its armature would short-circuit them. The

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main circuit fuses of the faulty machine would not be of much service, as the other machines would not only have to produce enough current to blow them, but also to take up the load of the first machine. In so doing they would most likely blow their own fuses, and total failure would be the result. There are many stations in this country where fuses are used in the field circuits, and on pointing out the dangers to the engineer-in-charge, I have generally had the reply, "Oh! we put the fuses in big enough so that they won't go." Quite so, but why not leave them out altogether, and save the initial expense and also the risk? For some day a bad contact will "blow" the fuse, even if they are "big enough," and then the fun will begin.—H. L. S.

Answer to No. 14.—I do not consider it necessary or advisable to put fuses in the field-magnet circuit of any dynamo. Not necessarily, because with 20 years' experience I have never known an excess current do any harm to the field-magnet coils either in a direct or an alternating current dynamo, and not advisable, because if the fuse were to melt from any cause, then the sudden stoppage of the current in the coils would generate a dangerous E.M.F. by self-induction, and this might easily be sufficient to drive a spark from one layer to another and so injure the coil and impair or even quite spoil the dynamo. If this spark were very small, it would char the insulation and so make an easy path for another spark to do more mischief, and so on until the coil became useless. Of course, in a series machine the fuses in the outer circuit would be enough for all purposes, and with a compound-wound machine the breaking of the fuse in the outer circuit would make the dynamo act as a simple shunt-wound machine. With a shunt machine the breaking of the outer circuit fuses would naturally entail a rise in the E.M.F. of the dynamo, and so an increase of the current in the field-magnet coils, and most probably a good deal of sparking at the brushes on the commutator; but the attendant should be able to stop this by altering the position of the brushes a little, or by altering the rheostat so as to include more resistance in the field-magnet circuit, or else by stopping the dynamo. If in any case it should be thought necessary to put a fuse in the field-magnet circuit, then a non-inductive resistance should be put as a shunt to the fuse in order to avoid breaking the circuit altogether, but this resistance should be as low as possible. It must be borne in mind that fuses sometimes melt from other causes than excess current—*e.g.*, corrosion from noxious fumes—a screw becoming loose or from external violence, such as something falling upon them.—F. G. A.

LIGHT RAILWAYS.

The Light Railway Commission closed the books for receiving specifications for new light railways to be considered within the next three months on November 30, and an official list of those projectors of the new lines who had conformed to the rules, and had lodged their proposals in detail, has now been published. There are 30 new projects—21 for England, 6 for Wales, and only 2 for Scotland. It is proposed to work 16 of the railways by electricity, 13 by steam, and 1 by hydraulic power. The following is a list of the schemes:

ENGLAND.—Amesbury, Wiltshire (London and South-Western, Amesbury Light Railway), 10¾ miles, steam power, 4ft. 8½in. gauge; Bournemouth, Poole, 15 miles, electric power, 3ft. 6in.; Bradford and Leeds (F. Beanland), 5½ miles, electric power, 4ft. 5½in.; Brighton (British Electric Traction Company), 4¾ miles, electric power, 3ft. 6in.; Central Essex (Light Railways Syndicate), 27½ miles, steam power, 4ft. 8½in.; Christchurch and Poole (British Electric Traction Company), 13¼ miles, electric power, 3ft. 6in.; Cuckmere, Sussex (C. D. Gilbert), 8¾ miles, steam power, 4ft. 8½in.; Finchley and Hendon, Middlesex (Finchley and Hendon Light Railways Company), 9 miles, electric power, 3ft. 6in.; Folkestone and District (Folkestone District Electric Railways Company), 15½ miles, electric power, 4ft. 8½in.; Grimsby and Saltfleetby (B. M. Kilby), 17½ miles, steam power, 4ft. 8½in.; Hastings and Bexhill (Hastings, etc., Light Railway Company), 12½ miles, electric power, 3ft. 6in.; Hastings and St. Leonards (British Electric Traction Company), 4 miles, electric power, 3ft. 6in.; Isle of Axholme, Lincolnshire (J. Blaydes and others), 22 miles, steam power, 4ft. 8½in.; Kinver, Staffordshire (E. Garcke and another), 4 miles, electric power, 3ft. 6in.; Mid-Devon (J. Dickson and another), 14 miles, steam power, 4ft. 8½in.; Middleton, Lancashire (British Electric Traction Company), 8¼ miles, electric power, 4ft. 8½in.; North Shields, Tynemouth, etc (British Electric Traction Company), 2 miles, electric power, 3ft.; North Sunderland, Northumberland (North Sunderland Railway Company), 1½ miles, steam power, 4ft. 8½in.; Potteries Extension (British Electric Traction Company), 4 miles, electric power, 4ft.; Rochester, Chatham, etc. (Rochester, etc., Electric Railways Company), 14½ miles, electric power, 4ft. 8½in; Sheppey, Kent, (Light Railway Syndicate), 7¾ miles, steam power, 4ft. 8½in.; Ventnor, Isle of Wight (E. Wetherick), 3½ furlongs, hydraulic power, 5ft. 9in.

WALES.—Abergavenny and Monmouth (J. R. Walford and others), 12 miles, steam power, 4ft. 8½in.; Llanfair and Beaumaris (J. T. Firbank and others), 6½ miles, electric power, 2ft. 6in.; Monmouth and Abergavenny (W. V. Pugh and others), 11¾ miles, steam power, 4ft. 8½in; Penarth and Cardiff (Cardiff, etc., Light Railway Company), 4 miles, electric power, 4ft. 8½in.; Portmadoc, etc. (R. Davies and others), 11½ miles, steam power, 1ft. 11½in.; Vale of Rheidol (Aberavon extension), Cardigan (Vale of Rheidol Light Railway Company), 16½ miles, steam power, 2ft.

SCOTLAND.—Bank Fort, Perth (J. Paton and others), 3 miles, steam power, 4ft. 8½in.; Coatbridge and Airdrie, Lanark (British Electric Traction Company), 3 miles, electric power, 3ft. 6in.

HAMMERSMITH ELECTRICITY WORKS.

The prospects of the success of these works is exceedingly good, as the present load practically leaves the station without spares. We are glad to see that the Vestry recognise this, and have already obtained a report from their consulting engineer, Mr. A. H. Preece, on the extensions which he considers to be necessary. By a resolution passed on November 10, Mr. Preece was asked to give an estimate of the cost of plant and mains for completing the lighting of the three main roads, as well as such other extensions as are considered advisable. This report, which we print below, came before the Vestry on Wednesday last, when the Electric Lighting Committee recommended to the Vestry that the report should be adopted, and that it be referred to the committee to take the necessary steps to carry out the scheme. The report is addressed to the chairman and members of the Electric Lighting Committee, and reads as follows:

Extensions.—I have the honour to send herewith a draft of the estimated cost of the extension scheme. The scheme generally consists of the extension of the generating plant to enable every possible demand to be met in your present area and in the extended area during the next 15 months. It also contains the extension of the public lighting to the extremities of your main roads, and the extension of the private lighting mains in same roads and a small portion of other areas which promise to be of importance from a purely commercial aspect.

Generating Station.—(*a*) Buildings.—It is proposed to add a sufficient length to the engine-room to contain three new engines and dynamos of double the present size. The estimated cost of this addition will be £2,500. (*b*) Generating plant.—The capacity of the generating plant will be increased so as to enable it to supply, allowing 30 per cent. as spare plant, 15,000 8-c.p. private lamps burning at one time, and 150 arc lamps. The estimated cost will be:

Two 400-h.p. engines and dynamos	£7,000
One water-tube boiler	850
Steam-pipes exhaust-pipes, and other pipes	450
New condenser for 800 h.p.	900
Air-pump, feed-water heater, and sundry connecting pipes	850
Travelling crane	250
Additional switchboard and testing instruments	300
	£10,600

Public Lighting.—Fifty new arc lamps will be spread over the extension, as stated in the next paragraph. For these lamps

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two new rectifiers will be required. The estimated cost of this portion will be :

Two rectifiers, with switchboard and connections	£900
Fifty lamp-posts and erection	800
Fifty-five arc lamps, switches, and incandescent lamps	910
	£2,610

Public and Private Mains.—The number of arc lamps and the cost of the different extensions will be :

	No. of arc lamps.	Cost of mains.
Uxbridge-road to boundary	5	£800
Askew-road and Starch-green	8	600
Goldhawk-road (extension)	9	900
King-street to boundary	4	600
Bridge-road	5	400
Hammersmith-road to boundary	6	300
Brook-green (both sides)	8	400
Blythe-road and Maclise-road	3	225
Great Church-lane	0	600
Total	48	£4,825

Sub-Stations.—For the above extended area it will be necessary to instal eight sub-stations. The cost of these will be :

Eight sub-stations at £50	£400
Eight 25-kw. transformers	480
Six 10-kw. transformers	240
Equipments	320
	£1,440

Contingencies.—There must be added a sum to cover meters, demand indicators, consumers' connections, which, if 200 consumers are allowed for, will amount to £2,000. There will also be a sum to cover pure contingencies and engineering, which may be put down at £1,025.

The summary will be :

Buildings	£2,500
Generating plant	10,600
Public lighting plant	2,610
Mains	4,825
Sub-stations	1,440
Meters, house connections, etc.	2,000
Contingencies and engineering	1,025
	£25,000

The total expenditure will, therefore, be not less than £25,000. (Signed) A. H. PREECE, A.M.I.C.E.

ELECTRIC LIGHTING AT PERTH.

The following extracts give the purport of Mr. W. C. C. Hawtayne's report on the electric lighting of Perth, which was considered at a special meeting of the Perth Police Commissioners on Saturday, the 4th inst. Lord Provost DEWAR presided, and explained that the meeting had been called to enable Mr. Hawtayne to give any explanation that the members might desired to have as to the details of his report.

Mr. Hawtayne, in his report, states that in accordance with instructions he had gone carefully into the question of the establishment of electricity supply works at Perth. He understood that two or three companies or syndicates had served notices on the Corporation of their intention to apply for powers to establish electricity supply works in the burgh. Two of these companies also offered, in the event of the Corporation applying for a provisional order, to take over the order when obtained, paying all reasonable expenses to which the Corporation may have been put, to establish suitable works, supply current for public lighting at a reduced price, and give the Corporation the right to repurchase the whole undertaking at the end of a term of years at cost price plus a good percentage. The Corporation had acted wisely in deciding themselves to apply for a provisional order. They could evidently dispose of it very readily, if they so desired, but he thought it would be far from wise for them to do so. If a company could do well out of an undertaking of that nature, he submitted that a corporation could do much better. A commercial company would have to show that a dividend of at least 6 per cent. was to be expected before the capital would be subscribed, and this after payment of heavy charges for depreciation, directors' fees, secretarial management, and office expenses. The corporation, on the other hand, could borrow their capital on the security of the rates, repay the whole of the sum borrowed in 25 or 30 years by equal annual instalments of principal and interest amounting to about 5½ per cent. The undertaking then became the property of the ratepayers. A corporation could supply electricity to the general public at a much lower rate than a company, as it need only make sufficient profit to provide for the repayment of the capital borrowed, and it could supply all public lamps at cost price. A provisional order gave power to its users to break up footways and roadways and interfere with gas and water mains. These powers should not be given away by the Corporation without serious consideration. The offers made by the two companies differed a good deal. The one undertook to supply the general public at 8d. per unit and public lighting at 4d. per unit, while the other was to charge 5d. for the one and 3½d. for the other. The one company agreed to the works being purchased by the Corporation at the end of 10 years on payment of the capital expended plus 15 per cent.; the other would agree to the works being purchased by the Corporation at the end of 10 years by valuation as a going concern. The progress of municipal electricity supply in this country, he said, had been remarkable, and was well worth the notice of all those interested in the question of the control of the public lighting of any town. The Board of Trade returns made up to the end of last September showed that up to that time 283 provisional orders had been issued for electricity supply undertakings, of which no less than 202 had been granted to local authorities, and many applications by local authorities had been lodged for consideration during the coming session. When it was considered that no genuine movement towards the work was made until after the passing of the Electric Lighting Act of 1888, these figures were sufficiently remarkable; but when on closer examination it was seen that of the orders obtained in the following session, 1889, nine were held by companies and only one by a local authority, while of those applied for last year for the establishment of new works, 42 were held by local authorities and only one by a company, the growing importance of the movement in the eyes of the local authorities was most clearly demonstrated. Although in the early days of the movement the local authorities of the country hesitated—no doubt wisely—to risk their ratepayers' money in what might have proved to be an experimental undertaking, or one of which the whole nature might before long be altered, yet electricity supply undertakings were now proving successful in so many towns that there was no longer reason to doubt that, with careful management, they could be made most remunerative. It was an ascertained fact that, with one or two exceptions, every such undertaking in the kingdom under municipal control that had been at work for more than three years was now yielding a substantial sum annually towards the reduction of town rates. Another fact that went far to prove public confidence in the future of these undertakings was that within the last year or two no less than eight local authorities had purchased or agreed to purchase the works of the companies supplying electricity in their districts. The Corporation of Sheffield were trying to force the local company to sell them their undertaking, and had offered them £200 for every £100 of their capital plus 5 per cent. for each year the works had been in operation. Dealing with the area to be lighted, Mr. Hawtayne said in their application to the Board of Trade for a provisional order the Corporation sought powers to supply electricity over the whole district within the boundaries of the parliamentary burgh, and as the Board of Trade, safeguarding the ratepayers' interests, would not grant a provisional order unless the applicants undertook to do part of the work within a period of two years from the date when the order was given, the Corporation had undertaken to lay mains for supplying private consumers in the following streets within that period : Tay-street, George-street, John-street, Princes-street, High-street from Tay-street to South Methven-street, South-street from Tay-street to South Methven-street, County-place, York-place, Glasgow-road from west end of York-place to the west end of the bridge carrying the Glasgow-road over the Caledonian Railway, the entrance to the Perth General Station from the said Glasgow-road bridge, the railway bridge carrying the Caledonian Railway across the River Tay from Tay-street to Barnhill, Scott-street, Kinnoul-street, South Methven-street, King-street, Marshall-place, King's-place from Tay-street to Perth General Station. These streets form what is generally called the compulsory area. Sometimes those whose premises lay outside the compulsory area got the idea that they would be incurring a certain risk for the benefit only of those inside the area. This was not the case, for though an undertaking of this sort must have a commencement, there was nothing to hinder the Corporation from covering the whole district with mains long before the two years for lighting the compulsory area had elapsed. The mains could easily be extended into other portions of the town when the demand arises. The following streets, etc., which were included in the above list might well have been omitted, and he had not allowed for laying mains in them at present : (1) the entrance to the Perth General Station from the Glasgow-road bridge; (2) the railway bridge carrying the Caledonian Railway across the River Tay from Tay-street to Barnhill. He would strongly urge the Corporation to popularise the new lighting by introducing it for lighting all the streets named above. This could be done in two ways—one by arc lamps of 2,000 c.p., such as can be seen in Princes-street, Edinburgh, erected on new posts; and second, by incandescent lamps of, say, 16 c.p. or 32 c.p., as can be seen in many of the side streets of our town adapted to the existing gas lamp-posts. The former gave, of course, the finest effect, and he should recommend that

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37 such lamps be erected in Tay-street, South-street, County-place, York-place, George-street, High-street, St. John-street, New-street, and South Methven-street, the remaining streets being lighted by incandescent lamps. Each of the columns carrying arc lamps could be also provided with two incandescent lamps, which could be turned on in place of the arc lamps, say, at 11 p.m. At the present time the streets mentioned were lighted by 221 gas lamps, costing altogether about £800 per annum, and these would be replaced by 37 arc lamps and 76 incandescent lamps. The majority of the lamps installed in business premises, houses, etc., were of 16 c.p. For large halls and outdoor lighting, lamps of greater power were often used, but it was more convenient to reckon the total lamps of 8 c.p.; and he considered that within a few years the equivalent of 20,000 lamps of this size would be in use at Perth. Of that number he estimated that 10,000 would be taken up within a comparatively short time. Of the latter number they might safely assume that not more than a half would be ever alight at one time, and he considered that works ought to be established capable of dealing with that number of lights, together with the public lighting. The works should be arranged for easy enlargement, and it was of great importance that the mains should be of ample size, and so laid down that they could be easily added to without again disturbing the foootways and roadways. The greatest load at the supply station when the public lamps were lighted would therefore be 190,000 watts, and the plant to do this work would be subdivided so as to avoid the risk of a total breakdown. To that he would add for reserve plant 100,000 watts, making the total plant capacity of 290,000 watts, or 290 kw., together with battery of storage cells. If the Corporation considered smaller plant advisable, the cost would be proportionately reduced. With one or two exceptions, electricity was now supplied by one or other of the two following systems: (1) the high-tension alternating-current system with low-tension distribution; and (2) low-tension direct-current system. After carefully working the matter out, and making direct comparison of the cost of the systems, having regard to the character of the district and the possibility of acquiring a fairly central site for the works, he was of opinion that the low-tension system should certainly be adopted. It was desirable that the site of the works should be as nearly as possible in the centre of the district where the principal demand was likely to be. He thought the Corporation would have no difficulty in obtaining what they required somewhere in the neighbourhood of the old gasworks, or perhaps adjoining the railway, where a siding for the delivery of coal could be made. For the purpose of his report he had considered that the supply station was erected close to the old gasworks. He had been asked to consider the feasibility of burning house refuse in order to generate steam for driving the plant at the electricity supply station. He understood there was a growing need of a destructor at Perth, and he considered that this method of disposing of town refuse was far and away preferable to any other. The waste heat produced by a destructor could be very well used for generating steam for electricity supply, and was so used at many places, and he saw no reason why a combined electricity and destructor works should not be put down at Perth. As such combined works would naturally cost more than an ordinary electricity supply works, part of the first cost should be borne by the sanitary department. The principal makers of destructors were now prepared to guarantee 1lb. of steam generated for every 1lb. of refuse destroyed at the average town, and if a similar result could be obtained at Perth, it would be a distinct advantage to the Corporation to erect a destructor in combination with the electricity works. This would add about £2,700 to the cost of the scheme. Without a destructor the undertaking was estimated to cost £25,250. He submitted the total annual output for public lighting at 56,000 Board of Trade units, and for private lighting at 160,000 Board of Trade units. At 6d. per unit (the equivalent of gas at 3s. per 1,000 cubic feet) the revenue would be £4,800. The working cost without a destructor would be about £2,160, or equal to 2·4d. per unit. At Dundee the works' costs were 2·3d., and at Edinburgh 1·13d. per unit. The profit therefore would be £2,640, and after providing £1,389 for repayment of capital and interest, there was £1,251 available for reduction of rates or other purposes. If current were supplied to private consumers at 5d. per unit, the gross revenue and net profit would be reduced by £666. In framing his report, Mr. Hawtayne said that he had been largely guided by the ascertained results of other similar undertakings, and had under-estimated rather than over-estimated the profitable nature of the business. He had dealt entirely with the supply of electricity for lighting, and had said nothing about its many other possible applications. From the figures given above, he thought the Corporation would see that, were such an undertaking once started at Perth and put into full working order under the control of the ratepayers, each one of whom would become, as it were, a shareholder in the undertaking, a substantial profit would undoubtedly be realised; and he therefore strongly advised the Corporation to retain their powers, when obtained, in their own hands, and to put their provisional order into effect with all reasonable dispatch.

After several questions had been asked of Mr. Hawtayne by a commissioner, he was thanked for his attendance there that day.

LEGAL INTELLIGENCE.

SHEFFIELD CORPORATION v. THE ELECTRIC LIGHT AND POWER COMPANY, LIMITED.

The *Sheffield Daily Telegraph* of the 8th inst. devoted 2½ columns to the reverse judgment obtained by the Corporation in this case, and advises the Corporation to come to terms with the company, at the same time saying that it might have been cheaper to do so at once instead of going to court. On the question of good faith as to the original agreement to buy out the company by the issue of original stock, the *Sheffield Daily Telegraph* says: "Now, fortunately, there is no question of bad faith in the business. There was power to issue irredeemable stock at the time the arrangement was entered into, but by one of those singular coincidences which belong more to the region of romance than the sober records of civic life, it came about that on the very day the Royal assent was given to the Act under which the Electric Light and Power Company carry on their undertaking, all municipalities were deprived of the power to issue such stock. That step was taken by the Legislature in recognition of a conviction which had dawned upon the Local Government Board that such a power was a dangerous instrument, which might be used by corporations to unduly penalise posterity. Although posterity has not done much for us, that consideration does not prevent our paternal Government from being tenderly mindful of the sacred interests of those yet to come." Now it appears from other similar cases that the Council need not be in any hurry to rush at what they consider a bad bargain, as it is more than probable that, always provided good faith is proved, a short Bill will afford them the relief required, and as soon as they are in position to issue irredeemable stock, they appear to have an undoubtedly excellent chance for a successful action upon the issue The case is reported as follows:

Mr. Justice North, on the 7th inst., delivered judgment in the action brought by the Sheffield Corporation against the Sheffield Electric Light and Power Company, Limited, to enforce specified performance of a statutory contract for the sale to them of the undertaking of the defendants, payment for which was to be made by the issue or transfer of Sheffield Corporation stock sufficient to provide a 5 per cent. annuity upon the capital sum expended on the undertaking. The contention of the defendants was that the stock referred to was irredeemable stock, which the Corporation had no power to issue.

Mr. Swinfen Eady, Q.C. (Mr. Ingle Joyce and Mr. R. J. Parker with him), on behalf of the plaintiff Corporation, contended, first, that they had power to purchase the electric lighting undertaking in manner proposed in consideration of the issue or transfer to the undertakers of such an amount of the only Sheffield stock existing or now capable of being issued—namely, stock redeemable in 1925—or, in the alternative, that they had power to issue irredeemable stock for the special purpose of purchasing the undertaking.

Mr. Cozens-Hardy, Q.C., Mr. Cripps, Q.C., and **Mr. Theobald,** on behalf of the defendant company, argued that the statutory price for the purchase of the undertaking in manner proposed was the issue or transfer of irredeemable stock, the power to issue which had been taken away, and that as there was no stock of the kind, the Corporation could not fulfil their part of the statutory contract, and, consequently, the action failed. The arguments were completed on Saturday.

His **Lordship** described the nature of the action which was brought by the Corporation against the company in respect of one of the powers given by the defendants' provisional order for the plaintiff Corporation to purchase the undertaking of the company. The issue rested upon the construction of apparently conflicting clauses in two provisional orders, the Acts legalising which received the Royal assent on the same day—June 27, 1892. Previously to that date the Sheffield Corporation had power under the Sheffield Corporation Act, 1883, to issue irredeemable stock. The provisional order under which the defendant company obtained power to carry on their undertaking contained a clause giving the local authority power at any time before the expiration of 42 years to require the sale of the undertaking upon terms of issuing or transferring to the undertakers "such an amount of Sheffield Corporation stock as will produce 5 per cent. per annum upon the sum expended by the former upon the undertaking, chargeable to capital account"; and also to make up a dividend of 5 per cent. for the past on the share capital of the undertakers. The Electric Lighting Provisional Order Confirmation Act, 1892 (No. 4), which comprised the Sheffield order, received the Royal assent June, 1892. On the same day the Royal assent was given to the Local Government Board Provisional Orders Confirmation (No. 9) Act, 1892, which dealt with a provisional order relating to Sheffield that provided that so much of the Sheffield Corporation Act, 1883, or of any Act or provisional order amending that Act, as conferred upon the Corporation the power to create and issue irredeemable stock should be repealed. The Corporation gave notice in April last to the defendant company, requiring them to sell their undertaking on the terms stated. The power of the Corporation to issue redeemable stock is now regulated by the Act of 1889, and the result of this enactment

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and what has been done under it is that the Corporation may now issue stock to be paid off in 1925, bearing interest at the rate of 3 per cent. The Corporation admitted that the present Sheffield Corporation stock is redeemable in 1925. His Lordship then proceeded to deliver judgment, and cited in considerable detail the various local and other Acts referred to above which had been discussed during the hearing of the case. The Sheffield Corporation Act of 1883 gave, he said, the Corporation power to exercise their borrowing powers by the creation and issue of stock, either redeemable or irredeemable. The redeemable stock could be redeemed at such times as was fixed by statute, but the irredeemable stock could not be redeemed except by agreement between the Corporation and the holders. Both classes were, however, covered by the term Corporation stock. In 1892 the Corporation obtained power to purchase the undertaking of the defendants on the terms "of selling or transferring to the undertakers such an amount of Sheffield Corporation stock as would produce, by the interest or dividends thereon, an annuity of 5 per cent. per annum upon the sum properly expended on the undertaking." If there was any question as to what the sum properly expended was, he took it that the Board of Trade would have to settle it. Now, if the contention of the plaintiffs was correct, they had the power to issue redeemable or irredeemable stock. The issue to the defendants of the former would mean that they would have to accept an annuity of 5 per cent. for a longer or shorter period as the case might be, and that then it would cease. Could that be the meaning of the provisional order? He did not think it could. What was pointed to was an annuity of 5 per cent. which was to be a continuing annuity, and not an annuity redeemable, say, at the end of five years. Therefore what they were bound to issue was irredeemable stock, though, of course, under the Act it was always open to them to agree with the undertakers whether it was to be redeemable or irredeemable. They could not, however, redeem compulsorily. Well, then, this further complication came in. On the same day on which the Act authorising the purchase received the Royal assent—that was on June 27, 1892—another Act also received the Royal assent, which so altered the Sheffield Corporation Act of 1883 as to repeal their right to issue irredeemable stock. The question was discussed as to which of those two Acts had precedence, but he thought the difficulty thus started did not arise, because it was settled by the Acts themselves. The one order came into effect on the day upon which the Act confirming the order was passed, and the other order provided that it should have effect "from and after the date of the Act of Parliament confirming the order." The distinction was a clear one, for it had been laid down that "from and after the date" meant the day after the date on which the Act was passed. Therefore, when the provisional order authorising the purchase came into operation, the Corporation were still in a position to issue both redeemable and irredeemable stock, though no doubt on the following day that power came to an end. In this way the difficulty had arisen in considering what the effect of the statutory contract was. In his opinion, then, the Corporation would have to issue irredeemable stock to comply with the terms of the contract, but that on the day following the order they had no longer power to do so. It was urged on behalf of the plaintiffs that the two orders must be read together, and that the repealing order must be taken as implying an exception, so far as it was necessary to comply with the terms of the contract. He could not assent to that argument. The provisional orders were perfectly clear. He had not referred to anything that modified or qualified the express provisions of the order that the right to issue irredeemable stock should be repealed. He had looked at recent decisions in the House of Lords, in the case of the West Derby Union, as throwing some light upon the mode in which one must deal with a matter of this kind, and he thought he should be acting contrary to the principles laid down in that case if he were to say that it was intended that the express provisions of the Act were to bear implied qualifications. He could not find anything containing an implied continuing power to issue irredeemable stock. It was urged that the two Acts were inconsistent, but it was impossible for him to modify one by the other. The conclusion he came to was that the contract could only be performed by the Corporation by issuing or transferring irredeemable stock. The action was one for specific performance, but he was not disposed to deal with that part of the case at present, for the reasons that under Sections 297 and 303 of the Public Health Act the Local Government Board had power to repeal the existing provisional order. If there had been a mistake, they had the power of correcting it by authorising the issue of irredeemable stock in the future to such an extent as was necessary to give effect to this contract.

Mr. Cozens-Hardy (for the defendants): Then I ask your Lordship to dismiss the action. There must be fresh legislation, of course, by the Corporation, either by a private Act, or provisional order, and until that event happens your Lordship's decision is that they cannot perform their part of the contract.

Mr. Justice North: I don't quite see why a fresh notice to the defendants is necessary, but, if that is so, the action must be dismissed.

Mr. Cozens-Hardy: The notice is requiring us forthwith to sell. They are not in a position to do so, and we ought not to be placed in the position in which we shall find ourselves if the action is not dismissed. The defendants have statutory obligations to continue to lay down electric mains and construct works, and if the action is not dismissed we must expect to be told next year, or at some future time when the Sheffield Corporation obtain power to issue irredeemable stock, that they are entitled to get specific performance by the issue of this stock, requiring us forthwith to sell at a price which they say is to be ascertained on the capital expended at the rate of the notice.

Mr. Justice North: Would not that point have to be settled by the Board of Trade under Section 2 of the Electric Lighting Act of 1888?

Mr. Cozens-Hardy: I don't think that has occurred to anybody hitherto. But I submit that the plaintiffs having come here for specific performance of a contract which they are not able to carry out, we are, therefore, entitled to have the action dismissed.

Mr. Justice North: Perhaps it will suit you if I dismiss the action, but without prejudice to any action the Corporation may think fit to take, if they are at a future time able to transfer to the undertakers irredeemable Sheffield Corporation stock.

Mr. Cozens-Hardy: If your Lordship pleases. And with costs?

Mr. Justice North: Yes.

Mr. Parker: Then your Lordship will not make a declaration?

Mr. Justice North: I will read this: "The Court being of opinion that the Corporation stock, which, according to the true construction of the Act, is to be issued to the defendant company, is irredeemable stock."

Mr. Parker: And that the Corporation have no power to issue it?

Mr. Justice North: That we need not go into.

Mr. Parker: That is really the point which came to be tried.

Mr. Justice North: Well, then, I will add the words, "And that the plaintiff Corporation are not now able to issue such irredeemable stock." The order will therefore be: "The Court being of opinion that the Corporation stock, which, according to the true construction of the Act, is to be issued to the defendant company, is irredeemable stock, and that the plaintiff Corporation are not now able to issue such irredeemable stock, the action is dismissed, but without prejudice to any action which the Corporation may be advised to bring to enforce such contract if they are able at a future time to issue irredeemable stock."

DONNISON v. BERESFORD.

This was an action heard before Mr. Justice Mathew and a special jury, and was brought by Messrs. F. A. Donnison, Berlyn, Evans, and Co., electrical engineers, of Great Portland-street, against Lord Charles Beresford, of 2, Lower Berkeley-street, to recover £140. 6s. 2d. for work done and goods supplied. Defendant pleaded that the work was carelessly done, and the prices charged for goods supplied were excessive.

Mr. H. Reed, Q.C., and Mr. Hollams appeared for the plaintiffs, while Mr. Lawson Walton, Q.C., and Mr. J. E. Bankes represented the defendant.

The case occupied a large part of Tuesday, the whole of Wednesday, and till well on in the afternoon of Thursday of this week. The simple question was if the work was done according to contract. The defendant pointed out that upon an examination of the work grave defects were found, which had been remedied by another firm, and counter-claimed for the amount. Certain questions were left to the jury, which it is needless to state, and all were answered in favour of the plaintiff. The parties will try to agree upon the amounts of claim and counter-claim, and if they can do so the action will not come again before the court.

[There are certain general features in this case to which we intend to call attention in our next issue.—ED. *E. E.*]

J. C. HOWELL v. THE CYMMER GLYNCORRWG COAL COMPANY, LIMITED, AND W. R. RANDALL AND R. K. PRITCHARD.

This case occupied three days at the Glamorgan Assizes. It was heard before Mr. Justice Grantham and a special jury, and the plaintiff—an electrical engineer—preferred allegations of fraud and misrepresentation against the defendants, in respect of an agreement to supply the colliery company with electric pumping plant, into which the plaintiff had been induced to enter in consequence of such misrepresentation and fraud. Plaintiff further claimed damages against the defendants Randall and Pritchard, and asked for an order setting a certain agreement aside.

Mr. J. Eldon Bankes and Mr. S. T. Evans, M.P., appeared for the plaintiff, while Mr. B. Francis Williams, Q.C., appeared for the colliery company, and Mr. W. R. Randall, Mr. Abel Thomas, Q.C., M.P., and Mr. Bailhache appeared for Mr. R. K. Pritchard; while Mr. Arthur Lewis was entrusted with a watching brief on behalf of the Metropolitan Bank, that had advanced £3,000 to the defendant company on the security of the B debentures. Defendants denied the fraud and misrepresentation, and made various allegations.

A verdict was found for the defendants.

FRAUDULENT USE OF THE TELEPHONE AT NORWOOD.

Reginald Cornish, aged 18, of Portland-road, South Norwood, was summoned at Croydon on Wednesday for fraudulently using the electricity of the National Telephone Company on October 25. The inspector explained that at the Norwood office there were two methods of communication, one by key and another by means of a slot machine. The operator at the other end was able to tell whether the key or money had been used to open communication. The defendant was seen to open one of the boxes with a key, which afterwards was found to be a false one, and was acknowledged by the defendant to have been made by himself. The Mayor fined him 5s. and 14s. costs, reminding him that he was liable to a penalty of £25.—*Daily Chronicle.*

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CONTRACTS FOR ELECTRICAL SUPPLIES

CONTRACTS OPEN

Bucharest.—Tenders are invited for 20,000 porcelain insulators. Specifications are to be obtained from, and tenders addressed to, the Railway Department, Bucharest, by December 30.

Bucharest.—Tenders are invited for 10,000 insulator brackets. Specifications are to be obtained from, and tenders addressed to, the Railway Department, Bucharest, by December 29.

Bedford.—The Electric Light Committee are prepared to receive tenders for the supply and erection of plant, for particulars of which we refer readers to our advertising columns. Tenders by January 10.

Bucharest.—Tenders are invited for 22,500 kilogrammes of galvanised iron wire. Specifications are to be obtained from, and tenders addressed to, the Railway Department, Bucharest, Roumania, by December 28.

Reus (Spain).—Tenders are invited for the electric lighting of the town. The deposit is 2 500 pesetas. Specifications are to be obtained from, and tenders addressed to, the Municipality of the town by 2 p m. on December 31.

Novorossisk (Russia).—Tenders are invited for the construction, etc., of an electric lighting installation for the town. The deposit is 5,000 roubles. Specifications may be obtained from and tenders addressed to, the Municipal Authorities of the town by March 1 (13).

Dundee.—Tenders are advertised for a supply of service fuse boxes for the electric lighting station. Specifications may be obtained from the Electrical Engineer, Dudhope-crescent-road, Dundee, and tenders are to be lodged not later than 12 noon on December 20.

Hammersmith.—The Vestry invite tenders for the supply and erection of two 375-h.p. slow-speed vertical engines, and two 300-kw. flywheel alternators, coupled direct to the engines, for particulars of which we refer readers to our advertising columns. Tenders by December 22.

Gloucester.—The Electricity Supply Committee of the city of Gloucester are prepared to receive tenders for the supply and erection of plant on the low-tension system, for the municipal electricity works, for particulars of which we refer readers to our advertising columns. Tenders by January 18.

Villarramiel (Spain).—Tenders are invited for lighting the town by electricity. The provisional deposit required is 3,000 pesetas (about £120). Specifications are to be obtained from, and tenders addressed to, the Municipal Authorities, Villarramiel, province of Valencia, Spain, by 2 p.m. on December 16.

Catanzaro (Italy).—Tenders are invited for electric tramway or other light railway between the town and the railway station. The deposit required is £400. Specifications are to be obtained from, and tenders addressed to, the Municipal Authorities by December 30.

Novorossisk (Russia).—Tenders are invited for the construction, etc., of an electric tramway. The deposit required is 5,000 roubles. Specifications, etc. (in French), are to be obtained from, and tenders addressed to, the Municipal Authorities, Novorossisk (Russia), by March 1 (13). The time has been extended from November 15.

Utrera (Spain).—Tenders are invited for an electric lighting installation. The provisional deposit required is 8,805 pesetas (about £340) and 17,640 pesetas final Specifications are to be obtained from, and tenders addressed to, the Municipal Authorities at Utrera, province of Seville, Spain, by 2 p.m. on December 27.

Laredo (Spain).—Tenders are invited for an electric lighting installation. The estimated cost is 8,500 pesetas, and the deposit required is 2,125 pesetas (provisional) and 2,125 pesetas (final). Specifications are to be obtained from, and tenders addressed to, the Municipal Authorities, Laredo (Santander), Spain, by 2 p.m. on December 22.

Hackney.—The Joint Public Health and Electric Lighting Committee of the Vestry are considering the question of lighting Hackney by electricity, either combined with a dust destructor or without, and are prepared to consider any scheme for this purpose from parties in a position to carry it out. Particulars may be had of the Vestry Clerk, Town Hall, Hackney. All schemes and particulars are to be sent to the Town Hall, Hackney, by 6 p.m. on December 14.

Glasgow.—The Corporation invite tenders for the supply of 2,000 tons of steel straight track rails, 200 tons of steel curve rails, and about 120 tons of steel fishplates. Specification, with form of tender and section, can be obtained on application to Mr. John Young, general manager, 88, Renfield-street, Glasgow. Tenders, sealed and marked on cover "Tender for Tramway Rails," to be lodged with Mr. J. D. Marwick, town clerk, City Chambers, Glasgow, by 10 a.m. on December 28.

Dublin.—Tenders are invited by the Dublin United Tramways Company for the supply of general stores and sundries during year ending December 31, 1898. Forms of tender (price 1s. each), conditions, and all information can be obtained, and patterns seen, at the Company's Office, 9, Upper Sackville-street, Dublin, from December 13 to 27. Tenders, sealed, and marked on outside "Tender for Stores," and addressed to the Chairman, to be lodged with Mr. Wm. Anderson, secretary, by January 3.

Worcester.—The City Council invite tenders for the following kinds of coal, delivered at the electricity generating station at Lower Wick, near Worcester, during 12 months ending December 31, 1898: best large Welsh smokeless coal, Welsh nuts, large Staffordshire coal, Staffordshire nuts. Tenders, marked "Tender for Coal," and stating the kinds of coal to be supplied, and price, to be delivered at the office of Mr. Samuel Southall, town clerk, Guildhall, Worcester, by December 18. No special form of tender is required.

Newport.—Tenders are invited by the Corporation for an electric lighting plant for temporary lighting at Wentwood waterworks. The plant will be required to light about 350 16-c.p. lamps, or their equivalent. Oil or steam driven machines may be tendered for. Second-hand plant preferred. Further particulars may be had upon application to the Borough Engineer, Newport. Tenders, marked "Electric Light Plant," must be delivered at the office of Mr. Albert A. Newman, town clerk, Town Hall, Newport, before 10 a.m. on 15th inst.

Worthing.—The Electric Light Committee of the Town Council invite particulars and conditions under which any person, firm, or company is willing to instal and maintain the electric light in the borough for a term of years, with power to the Corporation to acquire the undertaking upon agreed terms and at stated periods. The provisional order of the Board of Trade, which is in the usual form, may be inspected, and a plan of the town, showing the compulsory area and other particulars, obtained, on application at the Town Clerk's Office, Liverpool-road, Worthing.

Canterbury.—The Corporation are prepared to receive tenders for the provision and erection, complete, of refuse destructors for the city, to be worked in conjunction with the electricity works about to be established. General site plan and arrangements proposed, together with description of works and general conditions of contract, may be obtained on deposit of £1. 1s., returnable on receipt of a bona fide tender, by application to the City Surveyor, 28, St. Margaret's street, Canterbury. Tenders, on printed forms, to be lodged with Mr. Henry Fielding, town clerk, by December 31, at 12 noon.

London, N.W.—Tenders are invited by the Vestry of St. Pancras for the supplying and erecting of arc lamps, posts, and circuits, complete; also feeding and distributing mains. Copies of specification, conditions of contract, and forms of tender to be obtained upon application to the Chief Clerk, Electricity Department (offices, 57, Pratt-street, N.W.), on payment of a deposit of £1, which will be returnable on receipt of a bona fide tender, accompanied by the specification. Tenders to be sent to Mr. C. H. F. Barrett, vestry clerk, Vestry Hall, Pancras-road, London, N.W., endorsed "Tender for Arc Lighting Extensions," by 12 noon on 28th inst.

Leicester.—The Sanitary Committee invite designs and tenders for motor vehicles for the collection of house refuse. The motive power, capacity, and all other particulars are to be described in a full specification, accompanied by drawings and delivered at the office of Mr. E. George Mawbey, C.E., borough engineer and surveyor, Town Hall, Leicester, addressed to the Chairman of the Sanitary Committee, by January 31. The loaded wagons would have to ascend an incline of 1 in 20, turn in a limited space, back and tip over a beam about 14in. high by 12in. in width, and when empty descend a road having a gradient of 1 in 15. The Committee do not bind themselves to accept any proposal, and firms tendering must do so at their own cost, no fees being allowed for the preparation of drawings, etc.

Barking.—The Urban District Council desire tenders for the erection of an electric light station at the rear of the public offices, East-street, Barking Town. Drawings, specification, and conditions may be seen, and bills of quantities (prepared by Mr. G. Lamb, East-street, Barking) and forms of tender obtained, on application to the surveyor to the Council, Mr. C. J. Dawson, F.R.I.B.A., Public Offices, Barking. Contractors will be required to deposit a £10 Bank of England note with their tender, which will be returned on rejection of the tender, or, if accepted, on the contract being signed. The contractor will be required to pay the trade union rate of wages to all men employed on the works, and to observe the recognised hours of labour. Sealed tenders, marked "Electric Light Station," to be sent to Mr. Edwin H. Lister, clerk, Public Offices, Barking, by 5 p.m. on December 21.

Bootle (Lancs.).—Tenders are invited by the Corporation for the supply and erection of (1) Lancashire boilers and Green's economiser; (2) engines, dynamos, switchboard, condensers, condensing and feed-water pumps, balancing transformers, boosters, piping, tanks, crane, meters, wiring of electricity supply works, and alterations and additions to wiring at town hall; (3) secondary batteries and accessories; (4) feeder and distributing mains (solid system), potential leads, network and surface boxes, and service connections; (5) running of the electricity supply works for period not exceeding three years. Specifications, drawings, and form of tender can be obtained at the office of Mr. J. H. Farmer, town clerk, Town Hall, Bootle, on payment of £5. 5s. (or £1. 1s. per section), which will be returned on receipt of a bona fide tender. Any further information can be obtained from the consulting engineer, Mr. Thomas L. Miller, M.I.E.E., 7, Tower-buildings N., Water-street, Liverpool. Contractors may tender for any section or sections, but not for part of a section, and contractor for No. 2 section must also tender for Section No. 5. The contractor whose tender is accepted will be required to enter into a

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formal agreement under seal, with sufficient and approved securities, for the fulfilment of contract. Sealed tenders, endorsed "Tender for Electric Lighting," and addressed to the Chairman of the Watch Committee, must be sent in by 12 noon on January 10.

Barrow-in-Furness.—Tenders are invited by the Corporation for erection of electric lighting station near the top of Buccleuch-street, and on the north-east side of the Board schools. Plans and specifications may be seen and bills of quantities and forms of tender obtained at the office of the Borough Engineer, Town Hall, Barrow-in-Furness, on payment of £1. 1s., which will be returned on receipt of a bona fide tender. The contractor will be required to pay the rate of wages and observe the hours of labour recognised and agreed upon between the trades unions and the employers respectively in the locality in which the work for carrying out the contract is to be performed, or such rate of wages and hours as are equivalent or approximate thereto. The contractor whose tender is accepted shall enter into a formal agreement under seal with sufficient sureties for the fulfilment of contract. Tenders, which must be on the form provided by the borough engineer, are to be sent in, addressed to the Chairman of the Electric Lighting Committee, and endorsed "Tender for Electric Lighting Station," by 12 noon on 15th inst.

Canterbury.—The Electric Lighting Committee of the Corporation are prepared to receive tenders for the supply and erection of plant as follows: (Section A) boiler-house plant—Lancashire boilers and accessories, mechanical stokers, feed-pump, injector, economiser, electric motor: (B) engine-house plant—steam dynamos and accessories, condensers, oil-filter, steam, exhaust, feed, blow-off, and sundry pipes, valves, feed-water and storage tanks, &c.; (C) overhead travelling crane; (D) switchboard and instruments; (E) accumulators; (F) mains—insulated cables and trenching; (G) public lamps—arc and incandescent street lamps, lamp-posts, and brackets; (H) meters. The whole bound up in one specification, price £2. 2s., returnable on receipt of bona fide tender. Further copies £1. 1s., not returnable. Tenderers are at liberty to tender for any section, but not for part of a section. Specifications, with terms and conditions of tender and contract, may be obtained at the offices of Mr. Robert Hammond, consulting engineer to the Corporation, Ormonde House, Great Trinity-lane, London, E C., on payment of £2. 2s., which sum will be refunded on the return of the specification, filled up, with a bona fide tender. Tenders, sealed, and marked "Tender for Electricity Works," must be addressed to Mr. Henry Fielding, town clerk, 15, Burgate-street, Canterbury, and delivered by December 20.

Barrow-in-Furness.—Tenders are invited by the Corporation for the supply and erection of (Section A) boilers, pumps, steam and water pipes, tank, crane, economiser, ironwork; (B) engines, generators, switchboards, instruments, accumulators, motor-transformers, sub-station equipments; (C) high and low tension feeder and distributor cables, house connection boxes; (D) conduits, drawing-in boxes. Specifications and forms of tender can be obtained at the Town Hall, Barrow-in-Furness, or at the offices of the engineers, Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, on payment of a fee of £3. 3s., which sum will be returned on receipt of a bona fide tender. The contractor will be required to pay the rate of wages and observe the hours of labour recognised and agreed upon between the trades unions and the employers respectively in the locality in which the work for carrying out the contract is to be performed, or such rate of wages and hours as are equivalent or approximate thereto. Contractors may tender for any one of the sections or the four sections complete, and the contractor whose tender is accepted shall enter into a formal agreement under seal, with sufficient sureties for the fulfilment of contract. Sealed tenders, endorsed "Electricity Supply, Contract No. 2," must be sent to Mr. C. F. Preston, town clerk, Town Hall, Barrow-in Furness, at or before 12 noon on December 15.

Madras.—Tenders are invited for the utilisation of water flowing from the Periyár Lake for purposes other than irrigation and not incompatible with the use of the water for drinking. The irrigating season extends over nine to ten months, during which time the discharge is likely to be from 1,100 to about 500 cubic feet a second, according to the demands for irrigation and the available quantity in the lake. Subject to the risk of interruption by accident or drought, supply can be given throughout the irrigation season. No supply can be guaranteed at other times, but, so long as water is available, the Government will be prepared to issue it in such daily quantities as may seem to it advisable with reference to the time which is likely to elapse before the supply is replenished by the setting in of the rains. The fall from the tunnel to the foot of the hills is approximately 900ft., and the distance measured along the course of the stream about 6,800ft. One cubic foot per second falling 900ft. is estimated to produce over 60 effective horse-power. Intending lessees should state the quantity of water required in cubic feet per second and the annual rent offered for each cubic foot per second. No rent will be charged for the first year from the date of the concession; for the second year the charge will be one-fifth, and an additional charge of one fifth will be made every year until the full rent is reached. The whole or part of the concession may be surrendered on a year's notice being given. Lessees will construct at their own expense, on plans to be approved by Government, all the weirs and other works required to divert the water from the river below the tunnel. For further information, application may be made to the Chief Engineer for Irrigation, Madras, by whom tenders will be received up to July 1, 1898.

BUSINESS NOTES.

Islington.—The London County Council at the meeting this week decided to lend the Vestry £14,250 for electric lighting purposes.

Bexhill.—A Local Government Board enquiry is to be held concerning the Council's application to borrow £20,000 for the purposes of electric lighting.

Loughborough.—The plans for the Falcon Works, to be erected for the Brush Electric Engineering Company, have been approved of by the Town Council.

Darfield.—The Council is in correspondence with a firm of parliamentary agents in order to obtain a provisional order for the lighting of the district by electricity.

Brighton.—The erection of several lamps and the extension of various mains has been decided upon, and the surveyor has been instructed to report as to the lighting of Burlington-street.

Commercial Cable Company.—The directors of the Commercial Cable Company have declared a quarterly dividend of 1¾ per cent. on the capital stock, and a bonus of 1 per cent., payable on January 1.

Darlington.—The Council have instructed Messrs. Durnford and Co. to act as parliamentary agents in connection with the application for the extension of the electric light supply area in the borough.

Bangor.—At the City Council meeting on the 8th inst. a very lively discussion took place upon a motion to upset the recent resolution in favour of the electric light. Ultimately the motion was defeated.

Dublin.—Mr. Cotton, Local Government Board inspector, held an enquiry on the 7th inst. in connection with the proposal of the Corporation to borrow the sum of £20,000 for the renewal of the cables used for the electric lighting of the city.

Peterborough.—At the last monthly meeting of the Town Council, the question of the engagement of Dr. Fleming as consulting electrical engineer was raised by the Borough Engineer, but the consideration of the matter was adjourned.

Darwen.—An Electric Lighting Sub-Committee has been appointed for the ensuing year, the members to consist of the Chairman (Alderman Davies), Vice-Chairmen (Alderman Cocker), Aldermen Duxbury and Lightbown, Councillors Ballantyne, Carus, Forrest, Rawlinson, and Shackleton.

New Transmitter.—We are informed that a new patent friction transmitter, manufactured by the Unbreakable Pulley and Mill Gearing Company, Limited, of Manchester, will be on exhibition at the stand of Messrs. R. Lloyd and Co., of Birmingham (stand No. 76), at the National Cycle Show.

Sheffield.—The decision in the case of the Corporation *v.* the Electric Lighting Company, noticed in another column, was mentioned at the meeting of the City Council on the 8th inst., and the Town Clerk stated that the matter would, of course, be considered further by the Parliamentary Committee.

Carnew.—The proposition, referred to in our last issue, for the Board of Guardians to be constituted as an urban sanitary authority for the purpose of lighting the town by electricity, has been discussed by the Board of Guardians, when it was decided to apply to the Local Government Board for the necessary powers.

Castleford.—The Urban District Council have received a letter from the Treeton Parish Council (in reply to an enquiry from the clerk) giving particulars of the cost of installing and maintaining the electric light in that village, and the same has been referred to the Gas and Water Committee for further consideration.

Leith.—The monthly meeting of the Town Council was held on the 7th inst. At the close of the meeting it was officially stated, as the result of the private proceedings, that the Council had resolved to drop negotiations with the Edinburgh Street Tramways Company in connection with the proposed purchase of their concern.

Knottingley.—The question of gas *v.* electricity was prominently before the Council at the last meeting. A motion that a committee of enquiry be appointed to ascertain if lighting by electricity was feasible, and what would be the cost, was deferred, pending a report to be made by the deputation who waited upon the gas company.

New Book Received.—"Electric Traction," by E. Wilson, Whit.Sch., M.I.E.E., assistant professor of electrical engineering in the Siemens Laboratory, King's College. This is one of the volumes of a series of science manuals published by Edward Arnold, London and New York, under the editorship of Prof. R. Meldola, F.R.S.

Liverpool.—The Lighting Committee of the Liverpool Corporation held their first official inspection of the street-lighting of the city on the 8th inst., and immediately prior to visiting various parts of the town, the members and officials of the department met at dinner at the Adelphi Hotel on the invitation of the chairman, Councillor Charles Petrie.

Long Buckby.—At an adjourned meeting held last week, to consider the question of adopting the Lighting and Watching Act for the whole of the parish, it was stated that as far as the suburb of Long Buckby Wharf was concerned, if they required lights they themselves could provide them; probably they might light the place by electricity.

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Accident.—A fatal accident is reported from Loughborough on the 7th inst. At the Brush Electrical Engineering Works, William Bray, a fitter, was turning brass rings in a powerful lathe when his head became jammed between the shaft lathe and a large piece of brass from which the rings were being made. The lathe caught his head, and he was picked up dead.

Stourbridge.—A special meeting of the Urban Council was held on the 6th inst., at which it was decided to support the opposition of the Amblecote Parish Council and other local authorities to the application of the Kingswinford Rural District Council for electric lighting power as regarded the part of the district lighted by the Stourbridge Council.

Worthing.—At the meeting of the Town Council on the 7th inst., the proceedings of the Electric Light Committee were passed without discussion, an assurance having been obtained that this did not pledge the Council to the committee's opinion that the time has arrived when the Corporation should take the necessary steps to supply the borough with the electric light.

Folkestone.—Meetings and counter-meetings continue to be held on the electric tramway question. A deputation of those opposed to the scheme was presented to the Council. The Council decided to refer the whole question to a committee of the whole house A meeting was also held at the town hall, the Mayor presiding. A motion in favour of the scheme was declared carried.

Tipton.—At the last monthly meeting of the District Council the Clerk read replies he had received from about a dozen local authorities as to their attitude on the electric lighting question, and also stated that the Midland Electric Corporation for Power Distribution, Limited, had deposited plans, etc., with the Board of Trade. The Council decided to lodge an objection forthwith.

Weston-super-Mare.—At a committee meeting of the whole Council held last week, Mr. Hawtayne appeared before the Council, and various modifications were made in connection with the electric lighting scheme, reducing the estimated cost to £20,000. A motion to the effect that the Council be recommended to accept such modifications was carried upon the casting vote of the chairman.

Huddersfield.—The General Purposes Committee, which consists of the whole of the members of the Corporation, adopted a recommendation on the 7th inst. made by the Electric Lighting Committee that an endeavour should be made to secure the municipalisation of the local telephone service, and this decision will probably be confirmed by the Town Council at its next meeting, to be held this day week.

Fulham.—A poll has been demanded upon the following questions: (1) erection of dust destructor by the Vestry; (2) electric lighting of the parish by the Vestry. If voters object to the carrying out of electric lighting as a municipal enterprise, they are asked to state whether they are in favour of allowing a company to do that work without cost to the rates, the Vestry retaining the right to subsequently take it over.

Leeds.—The sub committee of the Leeds Corporation for the electric lighting of Boar-lane and Briggate are greatly disappointed at the delay which has taken place in carrying out the scheme. but hope that the installation will be completed before Christmas. They state that they have done everything in their power to expedite the work, and have appointed a deputation to interview the firm supplying the lamps.

Coventry Electric Tramways Company.—The directors of the Coventry Electric Tramways Company have declared a dividend for the half-year ended 3rd inst. of 8 per cent. per annum, being the same rate as that paid in the preceding half-year. The contracts have been let for the works requisite in the electric tramways extensions, and stipulations are provided that the whole of such works shall be carried out before October 1, 1898.

Maidstone.—The Electricity Committee have reported that they had instructed the town clerk to take the necessary steps to oppose the application being made by the Municipal Electric Lighting Company for powers to supply Maidstone with electric light They were considering the desirability of combining electric light with the destruction of house refuse, and would report to the Council at an early date. The report has been adopted.

Newington.—It is proposed that, pending the provision of a central generating station for the parish, the new stables be lighted by electricity from the baths installation, and an electric motor provided with oat-crushing machinery, maize and bean splitter, chaff-cutter, lifting hoist, friction hoist, shafting and belting, etc., with all cutting, fixing, etc., at an estimated cost of £509. 5s., being an excess of £180 over the estimate for chaff-cutting, etc., by means of a gas-engine, and lighting the building by gas.

Bootle.—With regard to the electric lighting station, the Borough Engineer submitted to the Town Council on the 8th inst. a report of Mr. Caulton as to the nature of the subsoil of the new electric lighting station. It was resolved by the Watch Committee that the borough engineer provide a bed of concrete, 4ft. wide and 2ft. thick, where necessary under the walls of the station, at the necessary depth, instead of taking the foundations of the walls down. Mr. Reid was appointed quantity surveyor by the committee.

Eastern Extension Telegraph Company.—The directors of the Eastern Extension, Australasia, and China Telegraph Company, Limited, have declared an interim dividend for the quarter ended September 30 last of 2s. 6d. per share, free of income tax, payable on January 15. The coupon of the Company's 5 per cent. Australian Government subsidy debentures, due on January 1, will be paid on and after that date at Messrs. Barclay and Co.'s Bank, 54, Lombard-street, E.C., coupons to be left three clear days for examination.

Belfast.—At the last meeting of the Electric Committee Councillor Andrews, J.P., was re-elected chairman. The consideration of applications for current for lighting and motor purposes occupied almost the entire sitting. The delay in the erection of the new station was again a subject of complaint, and the town clerk was instructed to intimate to the contractors that the penalty clauses in their contract would be enforced. The engineer was authorised to sell 20 arc lamps in stock not required, and to submit any offers he receives for the remainder to the committee.

Nelson.—The Borough Surveyor submitted plans and estimate of the refuse destructor at the last meeting of the Town Council, and after considerable opposition it was resolved that the plans and estimate be approved, and the town clerk be authorised to make application to the Local Government Board for borrowing powers for £7,000, for the erection of a refuse destructor at Reedyford.—The Council have resolved that the chairman and gas engineer report to the next meeting as to further borrowing powers required by the electric lighting department, and with respect to a proposed extension of supply district within the borough.

Rotherhithe.—The Vestry have received notice of the intention of the County of London and Brush Provincial Electric Lighting Company, Limited, to apply to the Board of Trade, on or before December 21 next, under the provisions of the Electric Lighting Acts, 1882 and 1888, for a provisional order in respect to the parishes of Bermondsey and Rotherhithe and the districts of Greenwich and Lewisham, and plan showing electric lines to be laid down in the following streets in the parish within a period of two years from the commencement of the order: Union-road, Albion-street, and parts of Rotherhithe-street, Lower-road, and Swan-lane.

Bromley.—A meeting of the directors of the Bromley Electric Light and Power Company, Limited, was held last week, when the solicitor was directed to forward the necessary evidence as to the ability of the company to carry out the undertaking. The report of the expert, Mr. Lacey, M.I.E.E., showed that the price agreed upon for the works and buildings and the method of supply was satisfactory. It is expected that the agreement submitted to the Board of Trade for their approval will be returned in time for the next Council meeting, when the sealing of the agreement, and the payment of the costs agreed upon, and the subsequent costs incidental to the transfer, will be the only matters remaining to be done.

Gloucester.—A long debate took place at the City Council's last meeting referring to the proposed electric lighting. It was finally agreed that, instead of the sum to be spent being £40,000, it should be "not more than £50,000." The rest of the report of the committee was adopted as follows: Resolved that Councillor Clutterbuck be appointed chairman of this committee for the ensuing year. Resolved that it be recommended that the general conditions and specification for works by the engineer be approved. Resolved also that the Council be recommended to apply to the Local Government Board for sanction to borrow not exceeding £40,000. The question of site was again discussed and adjourned.

Copper.—The Cape Copper Company's report shows that in no period in the history of the company, even during the spell of inflated prices ruling at the time of the French Copper Syndicate in 1887, have the profits of the company reached the high total now recorded by the directors in their report for the past year; and the dividend of 6s. 6d., as against 3s. for the corresponding period of last year, and 2s. 6d. for the first half of the current year, has given an impetus to the whole copper market on the Exchange. There can be no doubt that the extension of electricity in various ways for traction and other purposes has a great deal to do with this. Copper is at the present time one of the metals of which the supply is limited, as far as paying quantities are concerned.

St. Marylebone.—A meeting of the Vestry was held on the 9th inst., when the vestry clerk presented a report on the railway and other plans deposited with him as affecting the parish—viz., Central Electric Supply Company, County of London and Brush Provincial Electric Lighting Company, Marylebone Electric Supply Company, Great Central Railway, Metropolitan Railway, New Cross and Waterloo Railway. Later on a special meeting was held to consider a motion to the effect, "That application be made to the Board of Trade for the grant of a provisional order authorising the Vestry of the parish of St. Marylebone to erect and maintain electric lines and works, and to supply electricity for public and private purposes throughout the said parish."

Bath.—The city electrical engineer, in a recent letter to the Watch Committee, explained that the defects in the electric lighting of the streets, of which numerous complaints had recently been made, were due to the worn-out condition of the plant which had been hired by the Corporation from the late company during the fixing of the new plant, and stating that everything was being done to keep the lamps going on as well as circumstances would permit. The Electric Lighting Committee also resolved to recommend the Council to formally appoint Mr. Metzger electrical engineer to the Corporation at a remuneration of £500 a year inclusive. The committee found that last year, under the old system of payment, the salary and bonuses totalled £495.

Hastings.—The Roads Committee have considered a notice from the secretary of the Hastings and St. Leonards-on-Sea Electric Light Company, Limited, of the intention of the company to construct a sub-station in the road at the back of 20, Robertson

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street, and to replace the existing main in the centre of the road by a concentric main, lead sheathed and steel armoured, and at a depth of about 18in. below the surface, for the purpose of supplying the houses in Robertson-street and Robertson-terrace, and the plan has been approved so far as the Town Council has power to do so, subject to the work being carried out to the satisfaction of the borough engineer, and to the company obtaining the consent of the Commissioners of Woods and Forests to the execution of the work.

Torquay.—The Town Council held its meeting on the 7th inst., at which Mr. Trentham, electrical engineer, reported on the progress of the electric lighting works. The boilers were practically completed, and he hoped to complete the steam test this week. One of the three sets of engines and alternators had been delivered. He thought another set of machinery would be delivered this week, and he hoped the light would be supplied in the town by January 15 next, unless some unforeseen obstacle occurred. Attention was called to the building of the refuse destructor, and to the fact that all the offers to contract for the work had been rejected. The Town Clerk said he had a letter from Mr. R. F. Yeo, one of the contractors, but he hinted that it might be well to read it in committee.

Bedford.—The Council at the last monthly meeting adopted a report of the Electric Light Committee recommending (*a*) that notice be given to the Bedford Gaslight Company to discontinue, from July 1 next, the public street lighting in the area on the plan produced; (*b*) that tenders be obtained for the supply of a 250-unit combined plant; (*c*) that tenders be invited for building offices and storerooms at the electricity works; (*d*) that three transformers be purchased from Messrs. Johnson and Phillips at an estimated cost of £200; (*e*) that four additional gas lamps be placed in the neighbourhood of the Queen's Park Estate, also that the existing lamps in the same district be rearranged in accordance with the plan prepared by the borough surveyor; (*f*) that an electric lamp be placed in the Old George-yard, and that an additional electric lamp be placed in Foster Hill-road.

Buxton.—At the fortnightly meeting of the Council the Chairman stated that Prof. Kennedy had telegraphed that he could not attend the public meeting, called at the request of the ratepayers, on the question of the town being supplied with electric light, on the day set apart for it. He could attend on another day, and the date was altered accordingly. The subject of Buxton being lighted with electricity was again introduced, and it was said there must be more in it than they knew, as people wanted to cram it down the throats of the Council. It could not be believed there would be no profit when the company was in such a hurry to get hold of it. The Council's position in undertaking it themselves was worth £3,000. The Chairman read a requisition from a number of ratepayers, the ground upon which they asked for a public meeting being "a wide divergence of opinion as to the best means of adopting electric lighting in the area."

Appointments Vacant.—The Tramways Committee of the Sheffield Corporation invite applications for the post of resident electrical engineer, in connection with the reconstruction of certain of the existing tramways into the electric overhead system, and the construction of extensions of tramways on the same system. The gentleman appointed will be required to devote the whole of his time to the duties of the office, and will have to superintend and carry out the electrical equipment of the various lines and extensions, and also the working of the same. Candidates must state their age, qualifications, experience, salary required, and when the duties could be commenced. Applications to be sent to Mr. H. Sayer, town clerk, Town Hall, Sheffield, by 13th inst., marked "Resident Electrical Engineer." Personal canvassing will disqualify.—As seen by our advertising columns there are several other vacancies open to electrical engineers, etc.

Norden.—The question of supplying private houses with the electric light was raised at a recent meeting of the Council. The Chairman observed that the installation would not be available for houses, because it would not be used when the moon was at full. [Why not?] The Clerk (Mr. R. D. Matley) said that before they could do that they would want a provisional order. The Chairman asked whether the Rochdale Corporation could interfere if the Norden Council sought such powers? The Surveyor (Mr. J. W. Sunderland) remarked that the powers of the Rochdale Corporation on that matter did not extend outside the borough. The Council was asked to supply electricity for two lamps in Red Lumb-lane. The engine and dynamo were of sufficient power to supply those additional lights, and the firm with which he was connected were prepared to pay one-sixth of the cost incurred. After some conversation it was decided to defer the consideration of the matter for a month.

Wimbledon.—The surveyor was directed by the Urban District Council at its last meeting to have the necessary repairs done to the boilers at the pumping station at the least possible cost, bearing in mind that they would be superseded when the electric lighting plant is established. During the debate it was stated that when the electric light was installed the Council would have 500-h.p. engines, and the existing 14-h.p. machines would be dispensed with, thus economising matters. In the course of the next five years they would probably require more sewage pumping machinery, and they would then take the opportunity of bringing their machinery up-to-date. Instead of having old-fashioned, expensive, wasteful low-pressure engines, such as they were using now, they would have triple expansion or compound engines of an economical type. So that indirectly the placing of electric lighting plant at the sewage farm would bring about considerable economies in connection with the pumping of the sewage.

Aberdeen.—The Tramways Committee of the Town Council on the 6th inst. arranged that two members of the committee, with the convener, should attend each meeting of the tramway company directors until the system is taken over by the Council. It was decided that copies of the reports furnished to the Corporations of Manchester, Sheffield, and Glasgow on the most improved systems of traction for tramways, should be procured and supplied to the members of the committee, who intend soon to consider this question. The committee also resolved to get a sketch plan prepared showing all the sections of the tramway system in the city, with distinctive colours showing the double and single lines, in view of early consideration of the question of extension. Some discussion took place as to the best method of procuring the necessary funds for the carrying on of the system, and proposals were made either to issue stock or take money on deposit, with a view to getting it cheaper than at present, but this subject will be more fully considered afterwards.

Burslem.—At the last meeting of the Town Council the Electric Lighting Committee reported that a letter had been received from Messrs. Sharpe, Parker, and Co., stating that they had had an interview with the officials of the Board of Trade, and explained to them that the Wolstanton Rural District Council were quite willing that the Corporation should obtain powers to supply electricity in their district, and pressed them to dispense with the formal notice, which should have been served on the Rural District Council in July, but the Board refused to do so, and, under the circumstances, it would be useless to apply for an order to supply electricity outside the borough until next session. They also stated that the London costs of a provisional order in respect of the borough alone would be about £200, and the cost of obtaining an amending order next year for Wolstanton alone would probably amount to £150. The committee recommended that the application for a provisional order so far as relates to the borough of Burslem be proceeded with. This was confirmed.

Worcester.—The City Council have adopted the Electricity Committee's unanimous recommendation to increase the salary of Mr. E. T. Ruthven Murray (the city electrical engineer) by £100 per annum. In proposing the increase, the Chairman of the committee said he thought the report with regard to the accident quite exonerated Mr. Murray. It was an accident over which Mr. Murray had no control, and the insurance company would have to pay for it. It had been stated that Mr. Murray received a considerable sum from taking pupils. By his agreement he was entitled to take pupils; but at the present time he had only one pupil, who did not pay a premium, and who did work which the Council would otherwise have to pay for. Mr. Murray had saved the Council considerable expense, and he was saving them the fee of a consulting engineer for work which was being carried out at the station. A consulting engineer's fee would probably have amounted to £500. It would be suicidal to lose Mr. Murray's services when they were putting in new machinery by his advice.

West Bromwich.—At the last meeting of the Town Council, the General Purposes Committee reported that they had considered a report and plans as to the proposed area for compulsory electric lighting, the probable cost of putting down installations, also the annual income and expenditure, and how the gas department would be affected by the adoption of electric lighting in the compulsory areas which were discussed at the special meeting on the 15th ult., and they recommended that the streets to be included in the notice for the proposed provisional order should be Birmingham-road from Roebuck-street to High-street, High-street, Carter's-green, and Old Meeting-street. A discussion ensued, and a scheme involving an outlay of over £17,000 was proposed in opposition to the recommendation of the committee. An amendment that the area for the supply of electricity be High-street from Spon-lane to Carter's-green, Old Meeting-street, Hill Top-road from Carter's-green to Witton-lane, Dudley-road, Swan-road, and from Carter's-green to the boundary of Great Bridge, was defeated.

Perth.—At a special meeting of the Police Commissioners on the 4th inst. a report of Mr. W. C. C. Hawtayne on the proposed scheme for the introduction of electric lighting into the city was considered. Mr. Hawtayne said it is an ascertained fact that, with one or two exceptions, every undertaking of the kind in the kingdom under municipal control that has been at work for more than three years is now yieiding a substantial sum towards the reduction of town's rates. Mr. Hawtayne recommends the erection of 37 arc lamps of about 2,000 c.p., such as can be seen in Princes-street, Edinburgh. For business premises, houses, etc., he estimates that 10,000 lamps of 8 c.p. will be taken up within a comparatively short time. He recommends the adoption of the low-tension current system, and estimates the cost at £25,250. If a destructor of refuse is introduced, the cost will be increased to £27,950. The gross revenue he estimates at £4,800. The working cost of the scheme is put down at £2,158, and under the profit and loss statement he brings out that there will be profit available for reduction of rates or other purposes amounting to £1,251.

Dundee.—At the last meeting of the Town Council the joint agreement which has been unanimously approved of by the shareholders of the Dundee and District Tramway Company, was agreed to. The disapproval of a minute of the Gas Committee recommending the acceptance of the tender of Mackenzie Bros. to supply 30 arc lamp-pillars, at a cost of £315, was agreed to. A councillor stated that by the time the work was carried out the winter would be about done, and then when summer came round the Council would possibly resolve upon something that would necessitate the removal of the whole of the pillars. In support of the approval of the minute, another councillor said that, in the

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manner of electric lighting, Dundee should keep pace with other cities; and called upon the town clerk to read a letter from Messrs. Mackenzie Bros. to the effect that the pillars could be erected within four weeks of the date of the order, and that they could be strengthened to carry trolley brackets. Then, should it be deemed necessary to remove them at any future time, they could be taken down and erected again at a cost of 25s. each. The pillars, he further argued, would not be in the way of electric traction.

Leeds.—The Parliamentary Committee of the City Council on the 8th inst. decided to recommend the Corporation to purchase the system of the Yorkshire House-to-House Electricity Company. The Highways Committee approved the minutes of the sub-committee having oversight of the working of the city tramways. One of the resolutions had reference to the appointment of a special committee to consider the future management of the tramways. It was resolved that the investigations should be extended to all questions bearing upon the working of the tramway undertaking The chairman of the Hackney Carriages Committee has received from a London company a letter asking for permission to run one motor-cab in the streets for the benefit, it is understood, of the gentlemen who contemplate the formation of a local company. They suggested that the vehicle should be sent to Leeds, and stated that the question would be brought before the committee next Wednesday. It is probable that the motor cab will arrive in Leeds within the next day or two.—The formal leave of the Council has been given to construct the tramways authorised by the Act passed this year. This means the construction of 24 miles of single track.

Bournemouth.—On the agenda for the last meeting of the Town Council was the following notice: "To resolve into committee for the consideration of the following recommendations of the Roads Committee of November 16, referred to committee of the whole Council by the Council of November 24: Electric tramways—the committee considered the applications received by the Council, printed copies of which had been circulated among the members of the Council, together with draft order under the Light Railways Act to be applied for by the British Electric Traction Company, Limited. Also draft Bill to be promoted by the General Electric Traction Company, and letter from Messrs. Burt and Haviland thereon. Recommended that the following resolution be passed: (*a*) That in the opinion of the Council, any scheme for tramways within the borough should be carried out by the Council; (*b*) that the town clerk be instructed to take the necessary steps to oppose any applications for powers to construct tramways within the borough; (*c*) that the Chairman, Alderman Cutler, and Councillor Stockley be appointed a sub-committee to confer with the town clerk. To resume the meeting of the Council and, if deemed advisable adopt the recommendations of committee." Some discussion ensued, and finally an adjournment was voted without any decision having been arrived at.

London County Council.—The agenda of the last meeting contains a report of the Highways Committee to the effect that they had considered a notice, dated November 8, from the County of London and Brush Provincial Electric Lighting Company, under its orders of 1892 and 1897, of intention to lay power and high and low tension mains in Rosebery-avenue, Laystall-street, Clerkenwell-road, Charles-street, St. John's-street, Charterhouse street, and Carthusian-street; power and low-tension mains in Saffron-hill, Hatton garden, Gray's-inn-road, Cowcross-street, and Benjamin-street; high and low tension mains in St John's square, Farringdon-road, Cross-street, St. John's-lane, and Leather-lane; and low-tension mains in Back-hill, Fox-court, Kirby-street, Baldwin-gardens, Ely-place, and Charterhouse-square, and also to construct four transformer boxes. They saw no objection to the laying of the proposed mains, and they thought the works might be approved. With regard to the construction of the transformer boxes, however, they were still of the opinion, which they had previously expressed, that such large portions of the public streets should not be appropriated for the purposes of a private undertaking; and, with a view to the matter being again considered by the Board of Trade, they thought the Council should withhold its sanction, against which decision the company would no doubt appeal, to the construction of the four transformer boxes referred to in the notice. There was also a notice of motion to grant the permission without specially referring to the transformer boxes.

St. Pancras.—A general meeting of this Vestry was held on the 8th inst. The business included the consideration of that part of the report of the Electricity and Public Lighting Committee relating to the charges for the supply of electric current; also an amendment to a previous report of the Electricity and Public Lighting Committee relative to the extension of mains to Highgate, to the effect that the Vestry approve of the mains being extended from Gordon House-road to The Gate House at Highgate, such mains and feeder to be sufficiently large to extend to the side streets as the demand for current requires, any resolution or resolutions to the contrary notwithstanding. It was proposed that the extension of the electric lighting system to the Highgate district be postponed until such time as the demand for supply may reasonably be expected to prove remunerative, as recommended by the Electricity and Public Lighting Committee in their report of November 4, 1897. With reference to the adjourned report of the Electricity and Public Lighting Committee, relative to rebate on charges by maximum demand indicator, and inasmuch as the committee have had one in practical working for the past three months at one of the largest consumer's premises, and on a report by the engineer as to the working of the same he estimates the revenue, if adopted, would result in a reduction of some £1,600 per annum, which rebate would go to less than 7 per cent. of the consumers of electricity, it was proposed that the subject be referred back to the committee for further consideration and report, and that that they be instructed to prepare a scheme, if possible, which whilst protecting the interests of the long-hour consumers would at the same time be applicable to the other customers.

Swansea.—A special meeting of the General Purposes Committee of the Swansea Corporation was held on the 3rd inst., with the object of considering a scheme suggested by the Mayor with a view of having the new market lit by electricity. The Mayor said that the deputation from Swindon which had inspected the new market complained of the light. Now, there were only two ways of improving this—the use of incandescent lights or the adoption of an electric lighting installation. He had consequently seen Mr. Brown and Mr. Legg, electrical engineers, and they suggested that 24 lamps of 2,000 c.p. would meet all requirements; and this would cost, with wiring, £576, while cleaning, replacing, and recarbonising would cost £30 a year, and other incidentals, with interest at 6 per cent., would come to £17 a year. As to generating power, he said there was no place nearer where there could be the necessary power than the United Breweries; and he had ascertained from that company that they would supply electricity at 2d. per unit. The reason he had called them together in such a hurry was that he wanted a good light before Christmas. As to the cost of the power, they would require the light on an average six hours per week, which would amount to the total of £94 per year. The lessee was anxious for the light, and he found he paid for 1,046 gas-burners, 736 of which are used in the area, £150 a year. Hence they would have a bigger light for a far less sum of money, while he had from the manager for the lessee a guarantee that the amount paid would be at least in proportion to what he now paid for gas. This would not apply to the wiring of the stalls, which could be connected by the stall-holders. The arc lights were for the main areas. After an informal discussion, a committee was appointed to take the necessary steps towards carrying out the work.

Smithfield Market Electric Supply Company.—This Company is to be advertised next week, when applications will be invited for 12,000 ordinary shares of £5 each, and for £50,000 4 per cent. debenture stock. Details of the board of directors and officials of the Company will be found in our advertisement columns. The prospectus of the Company states that this Company has been formed to acquire, as a going concern, the station and plant which have been erected in Charterhouse-street, on a site held from the Corporation of the City of London, on building agreement for lease for 80 years from December 25, 1892, for the supply of electric light to the Corporation markets at West Smithfield, under a concession for 21 years, dated July 28, 1892, granted by the Corporation, and now vested in Sir John H. Morris and J. Van den Bergh. Full details of the property now supplied with electric light by the station is given, and it is stated that the units sold during the nine months ending September 30, 1897, was 564,917, which, allowing for the remaining heavy quarter, would be at the rate of about 800,000 units a year; owing, however, to a large number of customers having been supplied by contract at an inclusive price, there was extravagant consumption in many cases. It has therefore been considered reasonable to take the consumption, on the present meter basis, at 600,000 units, which, at an average of 4¾d., would yield a revenue for the year of £11,875. The prospectus goes on to give an estimate by the consulting engineer of the cost of production, but we should have preferred the actual figures, although 3¼d per unit should err on the right side. Another point we miss in the prospectus is the financial results obtained by the present owners of the station, which are required to give a true estimate of the value of the undertaking. The scale of charges for electricity now being introduced by Mr. V. D. B. Cooper, the consulting engineer of the Company, are decidedly novel, and tends to give the cheapest price to the consumer who has the biggest blaze of light in his shop front. The rates are as follows: 4d. per Board of Trade unit when consumption shall be at the rate of two units or upwards per square foot of floor space, per quarter; 5d. per Board of Trade unit when consumption shall be at the rate of one unit and less than two units per square foot of floor space, per quarter; 6d. per Board of Trade unit when consumption shall be at the rate of less than one unit per square foot of floor space, per quarter. And, irrespective of the above scale, at 4d. per unit to any customer whose yearly account shall at that rate amount to £100. For every 100,000 units in excess of 600,000 per annum sold to the markets (inclusive of public lighting), the above rates of 5d. and 6d. will be reduced ¼d., until 1,000,000 units are reached, when the 4d. rate will be reduced to 3¾d., and the higher rates will be reduced 1d. Incandescent lamps will be renewed free of charge by the Company, who also do the necessary wiring.

Dudley.—At the monthly meeting of the Council the Railway, Tramway, and Electric Lighting Committee reported that the Midland Electric Corporation for Power Distribution, Limited, are applying to the Board of Trade for a provisional order to supply electricity for public and private purposes within the borough, and that the committee have instructed the town clerk to take all the necessary steps to oppose the application. Since the public enquiry respecting the proposed electric tramways the Mayor has forwarded to the Light Railway Commissioners a letter in which his worship points out that Dudley represents more than one-half of the population of the districts affected by the scheme laid before Lord Jersey

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at the enquiry by the British Electric Traction Corporation, and is the only corporate body. The Town Council had had great cause to complain of the condition of the highways over which the present tramways run, and as their right of purchase accrues in about four years, they considered it important that no other trading company should have the power to interfere with the roads. The lines and the power to repair must be vested in the Corporation of the town. They objected to the application of the promoters being made under the Light Railways Act, which does not repeal the Tramways Act, and consider that the proposed line to Cradley could be constructed either by the Corporation themselves, or in conjunction with the authorities of the parish of Rowley Regis. The Dudley Corporation have recently obtained a provisional order for supplying electric light and power within the borough, and naturally desire to find a customer to take electric power in the daytime. They looked to the tramways to do this, and considered that to permit a trading company to supply electric power within the limits of the borough would be prejudicial to the interests of the town.

Norwich.—It is proposed to carry a tramway line from the city along Thorpe-road, and along the Norwich and Yarmouth main road, within the county, from the Redan Tavern to 4·60 chains east of the entrance to Thorpe Old Hall. There will be two crossings in this length, the remainder being single line carried down the centre of the road. The proposed line will now stop short of Thorpe village.—The Norwich Electric Lighting Company propose to obtain powers to include within their area the parishes of Thorpe, Postwick, Sprowston, Costessey, Colney, Bowthorpe, Arminghall, Trowse, Markshall, Catton, Hellesdon, Cringleford, Bixley, and also the Shirehall and Castle ditches. It is also proposed to lay a main along the Norwich and Yarmouth main road in Thorpe parish up to Thorpe church.—The Council have adopted the report of the county surveyor that the various parliamentary schemes which affect main roads be referred to the Bills Committee, giving them power for this purpose to add to their number local members, such committee to have power to negotiate and report further to this committee.—The Norwich Electricity Company, Limited, are now supplying electric motors on the hire-purchase system. These motors range from ½ h.p. upwards, and are adapted for driving all classes of machinery. It appears that a low tariff has been arranged for current for motors, which makes the cost of using them compare favourably with that of either gas or steam, and that the motors can be paid for in quarterly payments spread over a period of several years. Firms using power intermittently should find motors of that description useful, because no expense is incurred except when the motor is actually at work. As no heavy foundations are required, they can be used in places where a gas, steam, or oil engine would be out of the question. The company state they are also prepared to wire houses, shops, etc., without any charge to the consumer, or to do so on the hire-purchase system, extending the payment over a term not exceeding five years, but the rate for current will be 8d. per unit until the fittings are paid for.

Commercial Steel Company of Great Britain, Limited.—The list of applications for this Company opened on Thursday, December 9, 1897, and will close for both town and country on or before Monday, December 13, 1897. The capital is £80,000 in shares of £1 each. The Board comprises Robert W. Blackwell, contractor and consulting engineer in electric traction (chairman); Philip Dawson, M.I.E.E., A.M.I.C.E., etc.; William Goff (director of Messers, Limited); Hampton K. Ingham (director of Catton and Co., Limited), of the Yorkshire Crucible Steel Casting Foundry, Hunslet, Lincs. The prospectus states that this Company has been formed for the purpose of acquiring a license, dated May 7, 1895, granted by the Harvey Steel Company of Great Britain, Limited, to Mr. John Adams Norton, to use and exercise at any place within the United Kingdom of Great Britain and Ireland and the Isle of Man various inventions in connection with the manufacture or treatment of ball bearings, balls for ditto, barrels for military and sporting rifles, Gardner and sporting guns, gun gauges, gunlock parts, gun sights, standard gauges, mining drills, horseshoes, milling cutters under 10lb. in weight, axles, Gardner gun shields, ore-crushing machinery (parts of), plates $\frac{3}{16}$in. to 1in. thick (except for gun shields), safe steel, shoes and dies, shoes for traction engines (the last seven articles not to exceed 56lb.), stamps and dies, tubes, hammer heads, chisels, geared wheels, jaws for vices, pins (various sizes), jaw spanners (these articles not to exceed 10lb.), and projectiles (not exceeding 6lb.); also for the manufacture of milling cutters, plates for safes, geared and worm wheels, and many other of the articles scheduled, which are in everyday use, and for all purposes of bicycle construction, more particularly those parts which are subjected to the greatest strain and friction, such as ball bearings, cranks, axles, and pins for the continuous chains, this process should be practically unrivalled. The "Harvey" process consists of improvements in the treatment of low steel, such as Bessemer steel, or articles manufactured from same, whereby such steel or articles are given the qualities of refined crucible steel. It is claimed that the advantages are that articles previously only made of the best or most expensive steel can now, under the "Harvey" process, be manufactured from the low-grade or cheapest steel, because by it low steel in bars or plates can be manufactured into tools or other articles, and subsequently hardened or tempered in the same way as if made of cast steel, with the additional advantage that a soft core of the original low steel is still left, thus giving the strength of mild steel, together with a hard wearing surface or the cutting and tempering qualities of the best crucible steel. The armour plates and gun shields of a large number of her Majesty's battleships and cruisers notably the "Magnificent," "Majestic," "Terrible," and "Powerful" (the latest additions to the British Navy) were manufactured by this process.

TRAFFIC RECEIPTS.

Bristol Tramways.—The traffic returns for the week ending December 3 were £2,206. 9s. 10d., compared with £1,892. 5s. 10d. for the corresponding period of last year, being an increase of £314. 4s. 0d.

Dover Tramways.—The traffic receipts for the week ending November 27 were £85. 3s. 1d. The total receipts up to the same date were £1,423. 18s. 4d. The mileage open at present is only two miles.

Birmingham Tramways.—The traffic receipts for the week ending December 4 were £3,498. 8s. 9d., as compared with £3,201. 14s. 0d. in the corresponding week in 1896, being an increase of £296. 14s. 9d.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended December 5 amounted to £1,286, as compared with £1,069 in the corresponding week of the previous year, being an increase of £217.

City and South London Railway.—The returns for the week ended December 5 were £1,097, compared with £1,052 for the corresponding period of last year, being an increase of £45. The total receipts for the half-year 1897 amounted to £21,880, compared with £21,947 for the corresponding period last year, being a decrease of £67.

South Staffordshire Tramways.—The traffic returns for the week ending December 5 were £563. 0s. 0d., as compared with £551. 18s. 4d. in the corresponding week of the previous year. The aggregate receipts so far this year were £30,425. 12s. 1d., as compared with £29,494. 5s. 10d. in the corresponding period in 1896.

S.D. Tramways, Dublin.—The traffic receipts for the week ending December 3 were £338. 3s. 10d., as compared with £399. 11s. 11d. in the corresponding week in the previous year, being a decrease of £61. 8s. 1d. The number of passengers carried was 59,465 in 1897 and 61,307 in 1896. The aggregate returns up to date are £14,286. 7s. 2d., as compared with £14,992. 8s. 9d. last year, being a decrease of £706. 1s. 7d. The mileage open is the same as last year—viz., eight miles.

PROVISIONAL PATENTS, 1897.

NOVEMBER 29.

28023. An improvement on the ordinary "tumbler" switch for use with the higher-voltage electric current. Arthur Jackson, 63, Wheeldon-road, Fenton, Stoke-on-Trent.

28024. Improvements in electrical switches. John Henry Tucker, 16, Oozells-street, Birmingham.

28028. Improvements in and relating to automatic transformer switches. Francis Alan Wilkinson, Holford, Middle-road, Bournemouth.

28116. An improvement in holders for electric glow lamps. Henry Charles Gover, Charles Faraday Proctor, and William George Pipkin, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

NOVEMBER 30.

28159. Means for use in lighting railway cars or carriages by electricity and for regulating the current for the same. Stephen Watkins, Prince's-chambers, Wolverhampton. (The American Railway Electric Light Company, United States.) (Complete specification.)

28212. Improvements in the electrolytical treatment of ores and slimes for the recovery of precious metals therefrom and apparatus therefor. Hugo Riecken, 35, Therapia road, Honor Oak, London.

28225. Improvements in electric railways. William Milton Brown, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

28238. An improved coupling for electric light fittings. William D'Arcy Gardiner O'Halloran, 16, Kensington Garden-terrace, Hyde Park, London.

28242. Improvements in or relating to negative plates for secondary batteries. Paul Joseph Rodolphe Dujardin, 322, High Holborn, London.

28246. An improvement in safety electric fuses. Henry Charles Gover and William Müller, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

28254. Improvements in electric switches. Henry Max Salmony, 226, High Holborn, London.

28268. Current collectors for electric railways with overhead wires. Ignaz Timar, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

DECEMBER 1.

28325. Improved means for attaching lead-covered electric cables to connection boxes. Gerald Carlyle Allingham and William Fennell, 27, Bower-road, Victoria Park, London.

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28338. Improvements in pumps for exhausting electric incandescent lamps. Frederick James Satchwell, 55, Lightfoot-road, Hornsey, London.

28350. Improvements in and relating to dynamos and electric motors. John Evelyn Liardet, 9, Warwick-court, Gray's-inn, London.

28351. Improvements in and relating to electric lamps for cycles. Charles Heap and Thomas Oddy, 9, Warwick-court, Gray's-inn, London.

28362 Improvements in the method of and means for transmitting electric currents in railway and tramway systems. Edward Maurice Grant, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

28382. Improvements in and relating to commutator brush carriers for electric machines. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Compagnie de L'Industrie Electrique, Switzerland).

DECEMBER 2.

28414. Improvements in or relating to electric indicator fittings. Arthur Ford-Lloyd and Albert Edgar Mondey, 106, High-street, Southampton.

28457. Improvements in apparatus for regulating and controlling electric motors. Lloyd Higginbottom, John Henry Hindle, and Thomas Mannock, 5, Victoria-street, London.

28458. Improvements in and relating to electrically-controlled submarine mines. Peter Christian Friedrich Hoffmann, 45, Southampton-buildings, Chancery-lane, London.

28460. An improved electrical accumulator. Clément Payen, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, May 4, 1897, being date of application in Belgium.)

28461. Improvements in or relating to the globe carriers of arc lamps for retaining ash or loose particles. August Wilhelm Riebel, 18, Buckingham-street, Strand, London. (Complete specification.)

28490. Improvements in or relating to the application of electric propulsion on railways and tramways. Ladislav Vojáček, 8, Quality-court, Chancery-lane, London. (Complete specification.)

28492. Improvements in variable electrical resistances. Walter Rowbotham, 18, Southampton-buildings, Chancery-lane, London.

DECEMBER 3.

28519. Improvements in electrical tumbler switches. Alfred Watson, 24, Temple-row, Birmingham.

DECEMBER 4.

28689. Methods and means for supplying electrical energy to electric furnaces or to individual pairs of electrodes. Hudson Maxim and William Henry Graham, 377, Norwood-road, London.

28716. Improvements relating to controlling devices for electric circuits or to apparatus for indicating when the current in an electric circuit exceeds a given limit. Frederick John Anson, 37, Essex-street, Strand, London.

28721. Improvements in the manufacture of electrical resistances of metal foil. Hugo Helberger, 18, Buckingham-street, Strand, London.

28726. Improvements in lamp and shade holders for incandescent electric lamps. James Booth, 50, Cherry-street, Birmingham.

28727. Improvements in insulating blocks connected with holders for incandescent electric lamps. James Booth, 50, Cherry-street, Birmingham.

28728. Improvements in holders for incandescent electric lamps. James Booth, 50, Cherry-street, Birmingham.

28729. Improvements in electrical switches. James Booth, 50, Cherry-street, Birmingham.

28737. Improvements in or relating to telegraphic systems and to apparatus for use in connection therewith. Sydney George Brown, 45, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1896.

25644. Type-printing telegraphic apparatus. Higgins.

25701. Secondary batteries. May and King.

26059. Electrodes. Connor.

26099. Means for electrically lighting railway carriages. Dick.

26546. Motor carriages and the adaptation of same to electrical advertising. Sandow and Adamson.

27227. Method of lighting pianofortes by electricity. Ryan.

27449. Means or apparatus for igniting and extinguishing gas from a distance by means of electricity. Chatfau.

27753. Electrical measuring apparatus for comparing differences of potential. Smith, Elphinstone, and Heap.

28314. Electrical storage batteries and cells. Kennedy.

28736. Direct-current dynamo-electric generators. Belfield. (Lamme.)

29473. Armatures for dynamo-electric machinery. Jackson and Co., Limited, and Lewis.

1897.

15. Electric light fitting. De Tunzelmann.

425. Secondary batteries. King.

550. Conduits for electrical conductors and joints therefor. Bathurst.

1521. Adjustable liquid resistances for starting and regulating electric motors. Holmes.

11413. Electrical signalling apparatus for transmitting commands and the like. Abel. (Allgemeine Elektricitäts-Gesellschaft.)

18122. Transmitting and receiving sounds by telephony. Gibbouey

18466. Printing telegraph apparatus. Boult. (Printing Telegraph News Company.)

20497 Surface-contact electric railway systems. The British Thomson-Houston Company, Limited. (Potter.)

20498. Surface-contact electric railway systems. The British Thomson-Houston Company, Limited. (Potter.)

20499. Closed-conduit or surface-contact electric railways. The British Thomson-Houston Company, Limited. (Potter.)

20503. Surface-contact or closed-conduit electric railway systems. The British Thomson-Houston Company, Limited. (Potter.)

20522. Electrical signalling systems, applicable to in and out indicators and the like. Owen, Williams, and Donaldson.

21111. Attachment of pole-pieces to the armatures of dynamos. Wheatley. (Allgemeine Elektricitäts-Gesellschaft.)

22044. Electric batteries, electrodes, and method of making the same. James. (Bell Electric Company.)

22045. Electric batteries. James. (Bell Electric Company.)

22306. Alternating-current dynamo-electric generators. Bradley.

22345. Junction boxes for use in electric distribution systems. Cloos. (Date applied for under International Convention, March 6, 1897.)

22349. Electric signal bells. Szubert.

23123. Electrolyte for carbon and zinc elements suitable for lighting and other purposes. Johansen.

23422. Electromagnetic clutches. Heys. (Singer Industrial Company.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	11½
Brush Company, Ordinary	2	13-4
—— Non. Cum., 6 per cent. Pref.	2	2½-3
—— 4½ per cent. Debenture Stock	100	107-111
—— 4½ per cent. 2nd Debenture Stock	100	101-104
Callender's Cable Company, Debentures	100	108-113
—— Ordinary	5	7-8
Central London Railway, Ordinary	10	9½-10
——	6	5½-6
Charing Cross and Strand	5	12½-13½
Chelsea Electricity Company	5	10½-11
—— 4½ per cent. Debentures	100	113-116
City of London, Ordinary	10	26½-27½
—— 6 per cent. Cumulative Pref.	10	17-18
—— 5 per cent. Debenture Stock	100	131-136
City and South London Railway, Consolidated Ordinary	100	86-88
—— 4 per cent. Debenture Stock	100	138-140
—— 5 per cent. Pref. Shares	10	15½ 16
County of London and Brush Provincial Co., Ordinary	10	14½-15½
—— 6 per cent. Cum. Pref.	10	15½-16
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2 2½
—— 5 per cent. Debentures	—	89-94
Edison and Swan United Ordinary	5	2½-3
—— 5 per cent. Debentures	5	4½-5½
Electric Construction, Limited	2	2½-2¾
—— 7 per cent. Cumulative Pref.	2	3½-3¾
Elmore's Copper Depositing	1	1-1⅛
Elmore's Wire Company	2	1-1⅛
W. T. Henley's Telegraph Works, Ordinary	10	20-21
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	9½-9¾
—— 7 per cent. Preference	5	11-11½
India Rubber and Gutta Percha Works	10	22½-23½
—— 4½ per cent. Debentures	100	103-107
Kensington and Knightsbridge Ordinary	5	14½-15½
—— 6 per cent. Pref.	5	8-8½
London Electric Supply, Ordinary	5	2½-2¾
Metropolitan Electric Supply	10	19-20
—— 4½ per cent. First Mortgage Debenture Stock	100	119-123
National Telephone, Ordinary	5	6¾-6¾
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	14-16
—— 5 per cent. Non. Cum. Third Pref.	5	6-6½
—— 3½ per cent. Deb. Stock	100	104-109
Notting Hill Company	10	17½-18½
Oriental, Limited, £1 shares	1	1½-2 xd
—— £5 Shares	5	8-8½
—— £4½ shares	4½	7-7½ xd
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	104-106
South London Electric Supply, Ordinary	2	2½-3
St. James's and Pall Mall, Ordinary	5	16½-17½
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	36-39
—— 5 per cent. Bonds	100	103-105
Waterloo and City Railway, Ordinary	5	12½-13
Westminster Electric Supply, Ordinary	5	15-17
Yorkshire House-to-House	5	8-8½

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NOTES.

Lecture on the X-Rays.—An instructive lecture was given by Dr. Carl Weber, D.Sc., at St. Annes-on-Sea, last week, on the Röntgen rays, which was much appreciated.

The American Electric Light Association.—The next annual meeting of the National Electric Light Association of America is to be held at Chicago during the month of June, 1898.

Refuse Destructors.—On Tuesday evening, Mr. Ernest Sykes, A.M.I.C.E, of London, read a paper on "Refuse Destructors" before the members of the Gloucestershire Engineering Society.

Electricity for Docks.—The Tees Conservancy Commissioners have equipped their dry dock with a complete electric installation, an interesting description of which will be found among our "Business Notes."

Electric Bell-Ringing.—The new church of St. George in Berlin has been supplied with a set of bells which are to be rung by electricity. A 10-h.p. motor has been put in for the purpose, and another electric motor of 2½ h.p. fitted to work the organ blowers.

Our Coal Supply.—On Tuesday evening, Mr. Courtney, M.P., delivered an address at a meeting of the Royal Statistical Society on "Jevons's 'Coal Question': thirty years after," in which he contended that the views put forward by Prof. Jevons in that work had been justified by subsequent experience.

Telegraphs in China.—Now that Germany has got her foot in China, it is probable that she will not take it out in a hurry. According to the *Tageblatt*, preparations are being made for the erection of telegraph lines in Shantung. Before long, we suppose, they will be pushing their machinery and electric plants in.

Electricity in Valparaiso.—The Chilian Congress, lately in session, passed a law empowering the municipality of Valparaiso to grant for a term of years, not to exceed 30, the use of the streets, roads, and squares of the city, for the installation of electric lighting and a system of tramways with electricity as the motive power.

Electricity in Vacuo.—A most interesting lecture was delivered last week before the members of the Doncaster Scientific Society by Mr. T. Cuttriss, who took as his basis the theory that electricity is a wave motion of ether. He experimented with Geissler tubes and Crookes tubes, and concluded by an exposition of the X-rays.

The Tottenham Polytechnic.—Another polytechnic has been opened, this time at Grove House, High-road, Tottenham. It has been acquired at a cost of £6,000, and will accommodate at least 1,200 students. Classes have been in existence for the past six years, but they have been cramped for room, and great success is now anticipated in the new house.

The Argentine Exhibition.—We have received a copy of a memorial from the president of the Industrial Union of Argentine referring to the meeting held in October last at Buenos Ayres, from which it appears that great progress is being made with the final arrangements for the National Industrial Exhibition of 1898, to which we have already referred.

Waking Up.—In Hang-Chow-Foo, the capital of Che-Kiang, and in Han-Kow, on the Upper Yangtse, Chinese syndicates have been formed to erect electric lighting works. Even in Chang-Sha, the capital of the Province Hunan, which is noted for its bitter feeling against foreigners, electricity works have already been put in operation for the lighting of private houses.

Fire Communication.—We learn from the evidence given by Commander Wells at the official enquiry into the recent great fire in London, that the Fire Brigade Committee are considering the question of connecting the fire-alarms by telephone. We alluded to this proposal some weeks ago, and we hope that the committee will be able to arrive at a satisfactory decision in favour of it.

Electric Railroads.—The *Financial Times* says that prominent Maine capitalists have formed a syndicate in Lewiston, Maine, for the purpose of building a network of electric roads throughout that state. The Maine Central road is to be paralleled. Members of the syndicate already control important electric roads, which with connections to be built will give a road from the Massachusetts line direct to Portland, Maine.

Tariffs in Guatemala.—By a decree recently promulgated by the Government of Guatemala, electric batteries, uncharged, for public purposes, are admitted free of duty. Galvanised iron wire and copper wire (insulated) for electrical transmission, electric apparatus (with the exception of certain chemical substances comprised in the tariff), and glass globes for incandescent electric lights pay duties on their gross weight.

Insulated Wire Combination.—A movement is on foot, says the *American Electrician*, to form a combination of all the larger rubber-covered wire manufacturers in the United States with a view to ameliorating the present situation with respect to ruinous competition. Those interested claim that the proposed combination will result in reducing expenses to such an extent as to give manufacturers a fair profit without advancing prices to the consumers.

Tramways in Argentina.—La Capital Tramways Company, Limited, the first company to apply electricity practically to traction in Argentina, state that 9¼ miles of their track in Buenos Ayres, being the Flores extension just constructed, and part of the old line lately converted from horse traction, were, with the power house and equipment, last week officially inspected on behalf of the municipality, and were opened for traffic on the trolley system on the 5th inst.

Necessity is the Mother of Invention.—We have heard of electrical engineers taking upon themselves the responsibilities of volunteer soldiers, and now we hear of soldiers taking upon themselves, although only in a minor degree, some of the responsibilities of electrical engineers. A corps of 300 men under the British South Africa Company has, we are informed, during the past few months introduced and erected over 200 miles of telephone wires in Matabeleland, in addition to their regular police dutie of garrisoning and patrolling the country.

The Skilled Labour Market.—The monthly memorandum of the Labour Department of the Board of Trade states that, on the whole, the state of employment was well maintained during the month, the slight increase in the percentage of unemployed being more than accounted for by the indirect effect of the engineers' dispute. Excluding the persons directly on strike or locked out, the percentage of unemployed among the trade unions making returns was 4·79 per cent., as compared with 4·70 per cent. at the end of October, and 3 per cent. at the end of November, 1896.

Hawaiian Importations.—In 1896 there were imported into the Hawaiian Islands electric and telephone instruments and materials to a total value of £649,840. Of this, £261,397 represented the value of the goods on which duty was paid when imported, and £387,843 the value of the goods entered free. In addition, there were also entered free, under the provisions of the Civil

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Code, 210 packages of wire for electrical purposes, valued at £14,622; 106 packages of various articles, valued at £82,342; and one lot of electric materials, valued at £3,780.

Electricity on the Belgian Railways.—Trials have been made by the Belgian State Railway authorities with a view of installing between Schaerbeck and Ans a system of electric traction. These trials gave excellent results, the new engine doing the journey in 60 minutes, whilst the ordinary engines took 90 minutes. Other experiments of a similar nature have been carried out in view of the application of electric traction to the express trains on the Belgian railways. The trials took place on the line between Brussels and Malines, and it is said that the journey will be effected in 13 minutes.

Institute of Engineers and Shipbuilders.—The second general meeting of the session of the North-East Coast Institution of Engineers and Shipbuilders was held last week at Sunderland. The engineering medal for last session was awarded to Prof. R. L. Weighton, M.A., for his paper on "The Experimental Engines at the Durham College of Science, with some results from the same." As no medals were awarded in 1895, the council agreed to award another engineering medal for last session to Mr. R. Wallis for his paper on "Liquid Fuel." A paper on "The Theory of the Centrifugal Pump and Fan" was read by Mr. C. H. Innis, M.A. (Cantab).

Canada's Metals. — Prof. Roberts-Austen, C.B., chemist to the Royal Mint, delivered an interesting lecture at the Imperial Institute on Monday evening, on "Canada's Metals." With the aid of some fine slides, he showed the close resemblance between the splash formed by the impact of a metallic pellet on a liquid and the hole made in thick armour plate by a projectile. He had found that when steel was alloyed with nickel its resisting power was immensely increased. This fact was of importance to Canada, where nickel was so plentiful. By means of a mirror, representations of silver, nickel, and chromium burning in an electric furnace were thrown on the screen. These had never before been shown, except at Toronto.

A Gas-Engine Coupled Plant.—In the new house of the American Society of Civil Engineers, which was opened in New York at the end of last month, the electric light is furnished by a complete isolated gas-engine plant direct coupled to 15-kw. Crocker-Wheeler dynamos. The *Electrical Engineer* of New York says that the lack of steadiness, which has hitherto proved the great drawback to the employment of gas-engines, has been entirely overcome in this plant. A special clutch coupling is employed, which automatically compensates for any residual fluctuations in the speed of the engine, and, says our namesake, "the regulation is equal to that of the best steam-driven plants." No further details are given of the solution of the difficulty. The building is wired for 500 lights, and the generating plant is capable of operating the full number when required.

The Trans-Mississippi Exposition. — As has already been announced, the Trans-Mississippi and International Exposition will be held at Omaha, Nebraska, from June to November, 1898. The *American Electrician* says that Prof. R. D. Owens is in charge of the electrical department, and Mr. Luther Steiringer has been retained as consulting electrical engineer. Mr. Steiringer is preparing plans for night illustrations, among which will be an electric garden showing the various hues and tints of the flowers by means of coloured screens and powerful searchlights. Some fine effects will also be produced on the waters of the Missouri River, which flows by the exhibition grounds. A large number of applications for space for electrical firms have already been received.

Extension of Electric Lighting in London.—The County of London and Brush Provincial Electric Lighting Company, Limited, have deposited plans with the Board of Trade with reference to no less than four applications by them for separate provisional orders for powers to supply electricity within important London areas. The first of the proposed orders embraces the parishes of Bermondsey, Rotherhithe, Greenwich, and Lewisham. The second proposed order covers the parish of Bethnal Green and the districts of Poplar and Whitechapel. The third proposed order comprises the districts of St. Giles and Holborn, including Lincoln's-inn, Gray's-inn, Staple-inn, and Furnival's-inn. The fourth proposed provisional order comprises the area within the jurisdiction of the parish of St. Marylebone.

The Telephone Monopoly.—The *Daily Chronicle*, in a special report, says that Sheriff Jamieson, who held an enquiry on behalf of the Treasury into the condition of the telephone service in Glasgow, has sent in his report on the evidence. The questions upon which evidence was heard were: "Is the present service (1) efficient; (2) adequate; and (3) is the charge reasonable?" "Was the refusal of the Town Council to give up the use of the streets to the Telephone Company reasonable on grounds of policy or otherwise?" The *Chronicle* understands that Sheriff Jamieson, while he points out that the service is inefficient and inadequate, does not recommend a municipal undertaking. The Treasury has, however, they learn, returned the report in order to obtain more particulars.

The Engineers' Conference.—The ninth sitting of the conference was held on Wednesday, and the hopes of "satisfactory progress" held out on Tuesday night seem to have been realised. According to Mr. Biggart's report, some of the proposals remained to be debated, and by a simple process of deduction the Press Association says it became at once apparent that the committee's efforts had not been fruitless. The points actually reached were understood to have been (1) freedom of employment; (2) piecework; (3) overtime. On the foregoing three separate points of detail it was elicited at the close of the day that what was regarded as practically a provisional agreement, subject to confirmation by the full conference, had been arrived at. The conference reassembled yesterday (Thursday), but at the time of going to press the result of the sitting had not come to hand.

X-Rays Up-to-Date.—A lecture was given at the Camera Club last Monday by Mr. Wm. Webster, R.A., on "X-Rays Up-to-Date." The lecturer dwelt particularly upon the English achievements in this branch, and he produced a coil which had been made by an English firm in 1872, and which still did splendid service. He said the best appliances could be and were made in England, but discoveries were often perfected in Germany while scientists in England were still seeking for the same object. This was owing to the want of help from the Government. The lecturer also produced a Crookes tube with which Dr. Jackson, as early as 1894, had shown rays penetrating opaque bodies and thrown their shadows on a fluorescent screen. The screen used by Dr. Jackson was so small that he could not actually see the bones of his hand, and probably it was due to that circumstance that he missed the discovery made by Röntgen two years later.

Electricity in Mining.—We observe from the columns of the *British and South African Export Gazette* that there is a brisk and a growing demand for electrical mining machinery. It usually consists of pumping machinery,

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and plant for lighting and gold-extracting purposes. The equipment of the Luipaard's Vlei mine includes two 50-unit four-pole continuous-current dynamos of 440 volts, a 35-h.p. hauler, one of 15 h.p., and motors for cyanide plant, and fitters' and carpenters' shops. The lighting dynamo supplies 300 16-c.p. lamps. The installation is being supplied by Messrs. Easton, Anderson, and Goolden, Limited, through Mr. F. W. Stokes, their Johannesburg representative. The new electric equipment at the De Beers mine has been supplied by the General Electric Company, of New York, and includes three tandem compound engines of 175 i.h.p., two 50-kw. six-pole compound dynamos of 220 volts and 115 volts respectively, a large switchboard furnished with voltmeters and ammeters, and 12,000ft. of large copper cable.

The Death of Mr. Graves.—The India Office has received a telegram from Mr. Ffinch, head of the Telegraph Department of the India Office, who happens to be on a tour of inspection of the Indian telegraph system in the Persian Gulf, stating that Mr. Graves was murdered in his bed on the night between December 1 and 2 at Rapch River, which is between Jask and Choubar, in the Persian Gulf. He reports that the murderers are known, and will be punished. There is reason to believe that Mr. Ffinch and Colonel Maude, the Indian Political Resident, have proceeded to the neighbourhood of the outrage. The *Times* of December 16 published a telegram from Teheran, dated December 15, stating that the British Resident at Bushire had left by the despatch vessel "Lawrence" for the Mekran coast to make investigations into the circumstances of the murder of Mr. Graves. The Persian steamer "Persepolis," with Persian troops on board, sailed a week ago. Further particulars show that the outrage was of a most brutal character, the unfortunate man having been hacked to pieces.

Electric Carriages.—Mr. H. J. Dowsing, M.I.E.E., gave a lecture last Saturday evening at the Public Buildings, Ealing, before a large audience on "Electricity as a Means of Motion." He first introduced his subject by drawing attention to the fact that there was a close relationship between the motion of heat and electricity, and illustrated this by means of a Cox thermopile, showing how readily it was transformed into electricity. He then explained the electrical properties of a current passing through a wire, introducing the electromagnet, and finally describing the construction of the electromotor. The lecturer stated that these motors were in use with great success in large works and private houses, but perhaps the most interesting use of the motor at the present time was for locomotion. The various systems used in electric traction—of overhead trolley, the underground conductor, and storage—were then explained and illustrated with various models, and a large selection of views was shown on a screen illustrating electric and other motor carriages. At the conclusion of the lecture, Prof. Henslow, the president of the Ealing Natural Science Society, under whose auspices the lecture was delivered, proposed a vote of thanks to the lecturer, which was carried with applause.

The Automobile Club.—The new club premises at 4, Whitehall-court were opened last week. Amongst those present were Lord Suffield, General Sir Arthur Ellis, Sir Douglas Galton, Sir Bernhard Samuelson, Major-General England, Colonel Lee, Captain the Hon. C. Duncombe, Captain Cunningham, Mr. Hiram Maxim, Mr. Walter Bersey, Mr. F. R. Simms, Mr. Swinburne, Mr. Singer, Mr. E. H. Brewster, and Mr. C. Harrington Moore (secretary *pro tem.*). The proceedings commenced with a luncheon, after which the company adjourned to another room, where a general meeting was held, with Mr. R. W. Wallace, Q.C., in the chair. The chairman, in opening the proceedings, briefly reviewed the present position of the club, and announced that they had already received about 200 applications for membership, among the applicants being the Earl of Shrewsbury and Talbot, the Earl of Carnarvon, the Earl of Galloway, Lord Suffield, Sir Douglas Galton, Prof. Kennedy, Sir Bernhard Samuelson, Mr. W. H. Preece, Mr. Hiram Maxim, and Herr Daimler. The members would be afforded information and advice with regard to motorcars; exhibitions, races, and competitions would be organised from time to time; facilities would be given for holding lectures and discussions; in fact, in every way in its power the club would endeavour to protect and encourage automobilism. One of their principal objects, he need hardly say, would be to bring pressure to bear on the Government in order that legislation might be suitable to the requirements of the industry. An interesting display of motorcars followed, some 20 vehicles—including an electrically-propelled omnibus, several electrical cabs, and a number of oil motors, being driven along Whitehall-court and the Thames Embankment.

Electric Light in Russia.—The annual report of the St. Petersburg and Moscow Electric Lighting Company for the year 1896-7 has recently been published, and is interesting as showing the position of affairs in far-off Russia. The report states that the total gross takings were £168,100, divided pretty equally between the two towns of St. Petersburg and Moscow, and the expenses were £101,000. The net receipts amounted to £59,160, and after deducting £5,060 for cost of administration for both towns there is a profit remaining of £54,100, of which £10,820 is written off for depreciation, £2,160 for Government taxes, and £4,640 for the reserve and insurance fund, leaving a net profit of £36,480, to which was added the sum of £11,300 carried over from the previous year, giving a total available for distribution of £47,780. A dividend at the rate of 6 per cent. was declared. Several large debts had been paid off during the year, which had reduced the working capital. The erection of the new St. Petersburg station had been retarded, and the station would not be in operation till next summer. The work at the new Moscow station had progressed so much that the regular supply of current was started on November 1 last. These works, which have a capacity of 20,000 16-c.p., will be increased to 40,000 when the new enlargement is completed. The length of the streets in which cables have been laid is 33 miles, and next spring it is contemplated to put in 13 miles more, as the applications for connections are very numerous. Since the enlargement of the works commenced, there have been during the year 1,774 new lamps connected in St. Petersburg and 2,888 in Moscow, making the total lamps connected up to date 47,970. The latest statistics to hand show that up to October 1 last this number had increased to 60,671.

Royal Meteorological Society.—The monthly meeting of this society was held on Wednesday evening at the Institution of Civil Engineers, Mr. E. Mawley, F.R.H.S., president, in the chair. Mr. W. Marriott read a paper on the "Rainfall of Seathwaite, Cumberland." This place has long been noted for its heavy rainfall, being, in fact, one of the wettest spots in the British Isles—the average yearly amount is 137in. The spring months of April, May, and June are the driest, so they not only have the least rainfall but also the least number of rainy days. August, the month when the Lake District is thronged with visitors, has the greatest number of rainy days. The heavy nature of the rainfall may be

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gathered from the fact that 21 per cent. of the falls are above 1in., 2 per cent. being above 3in. The greatest fall in one day was 8·03in. on November 12, 1897. The author has investigated the atmospheric conditions under which the heavy rainfalls occurred at Seathwaite, and he finds that these heavy falls are due to the direction and force of the wind. When the wind is blowing strongly from the south-east or south-west, it will be concentrated in the valleys on the windward of Scafell and rush up them with considerable force, the air current consequently being projected to a considerable altitude beyond Scafell. Owing to the reduction of temperature with elevation, the air parts with a great deal of its moisture, which falls as rain. With such a process going on continuously for a whole day, the heavy rainfall at Seathwaite is fully accounted for. Mr. R. C. Mossman, F.R.S.E., also read a paper on the daily values of non-instrumental meteorological phenomena in London from 1763 to 1896. The phenomena discussed were thunder-storms, lightning without thunder, fog, snow, hail, and gales.

Colour Photography.—At a meeting of the Royal Photographic Society, held in the rooms of the Society of Arts on Tuesday night, Prof. Gabriel Lippmann described his system of colour photography, whereby a photograph showing the colours of nature is obtained by a direct process and with one exposure of the plate. He explained that the film, which might be of any sensitive substance, was exposed, developed, and fixed in the usual way, but it must be transparent and grainless, and, also, must be in contact with a metallic mirror during exposure. The ordinary appliances—slide and camera—are used, with the addition of a small reservoir on the former, from which an indiarubber tube conducts the mercury behind the plate. The mirror was formed by running a layer of mercury in behind the plate, and its effect was to reflect back the incident coloured rays and thus make the incident light waves stationary. These stationary vibrations, falling in the interior of the sensitive film, impressed their own wave dimensions upon it. By virtue of the structure thus imparted to it the brown deposit of silver, when viewed by reflected white light, appeared clothed with the same colours as were possessed by the image in the camera. The colours were produced by "interference" in the same way as those of the soap bubble, raindrops, or mother-of-pearl, and he said this was proved by the fact that the tints of a negative changed if it were damped in consequence of the gelatine swelling slightly, and thus altering the structure of the silver deposit. The colours produced by this process were true and bright, provided that exposure and development had been properly conducted; they were, moreover, completely fixed and resisted the action of light and time. He had not yet succeeded in taking prints from his negatives, but was convinced that to do so would be found possible. In the course of the lecture a number of the results achieved by M. Lippmann were exhibited in the lantern, including coloured photographs of the spectrum, stained glass, landscapes, fruit and flowers, and the portrait of a little girl. The latter photograph was taken by Lumière Bros., and it is one of the strongest proofs of the correctness of the professor's statements that others have been able to obtain similar results. In the course of the discussion, Prof. Lippmann said that in order to make the films perfectly transparent he advocated an equal mixture of cyanine and quinoline of lead, one-fiftieth milligramme to 100 grammes emulsion.

Power Transmission.—An interesting description, accompanied by some excellent illustrations, of the Mechanicville power station and the transmission to the General Electric Works at Schenectady, recently appeared in the *Electrical World* of New York. The generators are 40-cycle untoothed three-phase revolving-field type of 40 poles and 750 kw. rating, but wound to generate directly 12,000 volts, so as to avoid the necessity of step-up transformers. The revolving-field type was adopted in preference to the revolving-armature type, because the stationary-armature winding of the former allows the construction of a generator to produce directly the transmission voltage. It was also preferred to the inductor type, since the latter requires very high density in the magnetic structure; and thus gives a lesser margin in voltage and in speed than the revolving-field type, which latter allows the use of fairly low saturation of the magnetic circuit, thus giving a nearly straight saturation curve. Such a saturation curve, while making the machine slightly inferior in regulation to the same machine with an over-saturated magnetic circuit, is preferable in power transmission. It allows a considerable increase of voltage when needed, and permits the voltage to be maintained even if the speed is low, as in the case of high water, etc. The generators are arranged to be operated in parallel at constant voltage in the generating station. At first, 2,000 h.p. will be transmitted to the General Electric Company's factories at Schenectady, over a line of about 18 miles' length, consisting of three wires of No. 000 B. & S. This large size of wire has been chosen in preference to the use of several small wires in multiple, in order to give the line as high a self-induction as possible. While in the early days of power transmission self-induction in transmission lines was carefully avoided in transmissions where a large part of the power is taken up by synchronising apparatus, such as rotary converters and synchronous motors, a considerable amount of self-induction in the lines is now considered desirable. In fact, if the line has too small a self-induction, as when cables are used, it is intentionally inserted in the form of reactive coils. Synchronous motors were chosen to induction motors. The author (Mr. Charles P. Steinmetz) of the article from which we are quoting says it is considered very undesirable ever to use an induction motor where a synchronous motor can be used, because the latter does not produce lagging current as induction motors always do, so that the question of power factor does not enter into consideration, but the phase displacement in the synchronous motor and its power factor can be made anything desired by controlling its field excitation. Synchronous motors are necessarily more constant in speed and more efficient than induction motors. When of the revolving-field type, they are self-starting from rest with light load, and even with fairly heavy load, and also have an overload capacity limited only by the heating of the motor. In other words, any well-designed synchronous motor will easily carry two or three or even more times its full load without dropping out of step for a time limited only by the heating of the motor, while induction motors, when built for such overloads, necessarily give at ordinary loads a very low power factor and poor efficiency. In a footnote the author adds that he has never been able to drop a synchronous motor out of step by overload, but he had succeeded in dropping a 75-kw. synchronous motor out of step by a load of 140 kw. when reducing the impressed voltage to one-half. Considering the output as proportional to the square of the impressed voltage, this would represent an overload of 7½ times full load.

Physical Society.—At the meeting on December 10, Mr. Shelford Bidwell (president) in the chair, Mr. Albert Campbell exhibited an experiment to illustrate alternate exchange of kinetic energy. Two brass spheres, each about 1in. diameter, are suspended from the same point by equal

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wires. One of them is then thrown so as to describe a circular orbit. The second sphere, starting from rest, gradually takes up motion from the first sphere, and in turn describes a circular orbit. The first now comes to rest, and the reverse process takes place. This alternating action repeats itself until all the energy is lost in the wires. He also exhibited an experiment to illustrate the low heat conductivity of glass, and the expansion of glass by heat. A long tube is clamped at the lower end, in a vertical position. One side of it is then heated with the flame of a Bunsen burner, and the glass is observed to bend, moving over a fixed mark near the top of the tube. When the flame is withdrawn the first position is quickly regained. Mr. Campbell then read a paper on "Temperature Compensators for Standard Cells." Some account of the methods adopted by the author has already been published; he now described the apparatus. The first compensating arrangement (3) can be used for keeping the potential difference between two points of a conducting system constant at all room temperatures. Or it can be adapted to modify the voltage of a standard cell to some convenient whole number. This arrangement resembles a Wheatstone's bridge with the galvanometer branch removed. One pair of opposite arms is of copper, the other pair is of manganin. The bridge battery is a Leclanché cell; this supplies the auxiliary voltage, which is utilised at the two galvanometer points of the bridge, and is there applied in series with the standard cell. In an alternative method, suggested by Mr. C. Crawley, only one of the four arms is made of copper. The second compensating arrangement is intended to maintain constant potential between two points, at all room temperatures. For this purpose two wires, *a* and *b*, are connected in parallel. One of them, *a*, is all of manganin; the other, *b*, is partly copper and partly manganin. Constant current is applied at the ends of *a* and *b*. The various resistances are chosen so as to give constant difference of potential between the ends of the manganin portion of *b*. By this method the potential difference can be maintained to within 1 in 2,000. Mr. Swinburne said that 12 or 13 years ago he had given a good deal of thought to compensation by wires of different temperature coefficients. The first thing he tried was a Wheatstone's bridge. This was compensated by making the bridge arms of wires whose temperature coefficients differed—as, for instance, platinoid and copper. He then applied the same principle to the compensation of standard cells, using a potentiometer method that gave direct readings, and to the compensation of voltmeters and wattmeters. These results were published between 1885 and 1890 in the electrical journals. He believed that Mr. Evershed had also developed this idea by putting "back" turns on voltmeters, and by other differential devices. The details of Mr. Campbell's apparatus had a few points of special interest. The way in which he connected up the bridge (3) seemed particularly worthy of notice. Prof. Ayrton asked whether thermo-electric effects produced difficulty in the compounded arrangement. Mr. Campbell said the system was symmetrical, and the thermal currents were consequently neutralised. Mr. Appleyard, referring to experiment (2), said it was identical with one that had been shown for the past eight years at lectures at Cooper's Hill College. It was specially interesting as illustrating the deflection that occurs with girders and bridges when exposed on one side to sunshine.

Spark Telegraphy.—In the first of Prof. Slaby's experiments near Berlin, in connection with "spark" telegraphy, to which we referred in these columns on Dec. 3, the transmission of the current through the air was by means of two captive balloons at a height of 600ft. The two stations were about two miles apart, and the earth contact was made by means of sabres, which were stuck into the earth and connected by wires with the apparatus, which was placed on a table. The current was transmitted to the balloons by means of the cables which kept them captive. The experiments lasted two hours, and were very successful. The words were very distinct, in spite of the rather unfavourable weather. A second attempt was made at a distance of over 13 miles. It was intended at first to use the wire cables attached to the balloons for receiving and sending the electric waves, but it was seen immediately that the effect was too strong for the apparatus. A second experiment with the double telephone wire was better, but even then the messages were not distinct, and eventually a copper wire ·04mm. in thickness was used, and gave very satisfactory results. Some time afterwards an experiment was made in the cellar of a house. A radiator was put up, and from this a copper wire went through the window, which was provided with iron bars, and then up to the flagstaff, which was fitted as a lightning conductor. The receiver was placed in the auditorium of the technical college, and from thence the wire went through the window of the adjoining room and up to the roof. From this experiment also very good results were obtained. Prof. Slaby says that the extent of the transmission is dependent on the length of the receiving wires, and in transmitting through clear and also through vitiated atmosphere the efficacy varies as much as 100 per cent. To communicate between Dover and Calais the wires would have to be 240ft. long, and for a connection with America 6,000ft. would be required. It is questionable whether it is possible to extend the system as much as that at present, since there is no experience to show the relation of the electrical waves to the curvature of the earth. If they go in a direct straight line, then they would have to go through an earth section of 119 miles. It appears from experiments with hyperbolic mirrors that they do go in a straight line, but all these experiments have been conducted over such a very short distance that it might only be in an apparently straight line. Another defect in Prof. Slaby's system is that anyone who has a properly constructed receiver can intercept any messages, and this raises the question as to whether it is not possible to construct receivers so delicately that they shall only respond to a correspondingly arranged transmitter. The invention is said to possess great value for marine purposes, and for establishing communication between vessels and lighthouses and lightships. The origin of the invention of wireless telegraphy will no doubt be the subject of many a controversy. It is a curious condition of the human mind that so many men make scientific discoveries, the full significance of which is not apparent at the time, and therefore they are forgotten, till in after years the rediscovery by another brain recalls the fact of the original discovery. The *Dundee Advertiser* claims the honour of discovering wireless telegraphy for a Scotchman named James Bowman Lindsey, who died in Dundee in 1862 in great poverty. It is said that he had worked on the problem since 1831, but did not obtain any practical results till 1857, when in the presence of several scientists he sent a message without a wire from one end of the Earl Grey Docks to the other, using the water for the conductor. Later on he succeeded in sending a message over the Tay, a distance of two miles, and in 1859 he read a paper before the British Association at Aberdeen. Mr. Lindsey had great hopes of communicating with America by establishing one station in Cornwall, and one in Scotland, and two other stations in America. His ideas excited considerable attention at the time, but nothing was done.

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NOTES ON ACCUMULATOR CONSTRUCTION.

BY DESMOND G. FITZ-GERALD.

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XL.

Before referring to the important invention patented by the present Sir Edward Frankland in 1882, some notes on the chemistry of the oxides of lead may be useful, more especially in relation to the theory of the lead secondary couple.

At the outset, spongy lead (obtained by decomposing a solution of lead acetate with zinc, [XXVIII.], and sometimes by electro-deposition) or minium—*i.e.*, red lead—were usually employed as the active material for both elements. In the former case, as we now understand, the resulting peroxide element was usually defective by reason of the loose molecular structure of the peroxide. In the latter case an economic error was involved in regard to the spongy-lead element, since red lead contains more oxygen than litharge (PbO), and requires, therefore, the expenditure of more energy for its reduction. The present practice for "pasted" plates is to use red lead for the peroxide and litharge for the spongy-lead elements.

Much misconception still prevails in regard to the constitution of minium, and to the degree of stability of its essential component. Most chemists and electro-chemists greatly underrate, I think, the affinity between plumbic peroxide (PbO_2) and plumbic protoxide (PbO); and the existence of any affinity between plumbic sulphate ($PbSO_4$) and the protoxide has not been recognised. Minium is regarded rather as a mixture than as a stable compound of the two oxides; it is assumed that the peroxide can be reduced to the condition of protoxide without passing through an intermediate stage, in which the two oxides enter into combination to form a new body—a plumbic compound differing essentially from its two components; and the action of sulphate of lead in reducing the *E.M.F.* which should be due to the residual peroxide is referred to the same "clogging" or "screening" effect, by which the *resistance* of the cell is augmented.

Some 12 years ago I wrote: "The spent negative* material always contains some sulphate of lead; but it is essentially a compound analogous to minium or red lead, and, like this body, variable in composition."†

To this Mr. James Swinburne replied: "Though I do not like to differ from such an authority as Mr. Desmond Fitz-Gerald, I must do so in the question as to whether sulphate of lead is formed when a secondary cell is discharged. Mr. Fitz-Gerald argues that a sesquioxide of lead is formed. *This is a doubtful, unstable compound, if it exists at all, and it cannot exist in the presence of sulphuric acid*, as lead peroxide and lead sulphate would be formed. The high E.M.F. of the secondary battery shows that there are very powerful chemical affinities at work, and the mere change of degree of oxidation can hardly produce such an effect." . . . "The appearance of the coating of an ordinarily discharged peroxide plate does not prove the absence of sulphate, for only a very small proportion can be sulphate." . . . "I found that in no case more than 6 or 7 per cent. of the coating is used, even when the cell is completely run down." . . . "We know that no oxide of lead but peroxide can exist in the presence of sulphuric acid."‡

The late Mr. Alfred Tribe also answered as follows: "Mr. Fitz-Gerald controverts the now generally accepted explanation of the chemical changes involved in the discharge of a secondary cell ($Pb + 2H_2SO_4 + PbO_2 = 2PbSO_4 + 2H_2O$), and puts forward the idea that *the unstable* Pb_2O_3, *which, as chemists well know, is decomposed by weak acids*, and therefore could hardly be expected to exist in a secondary cell containing sulphuric acid, is formed by the reduction of the PbO_2 on the negative plate." . . . "I have found that the amount of sulphuric acid which actually passes from solution in the discharge of a secondary cell substantially agrees with the amount calculated from the equation deduced from our observations, which not only confirms our conclusion, but shows that Mr. Fitz-Gerald's speculation has no foundation in fact."*

More recently Mr. E. J. Wade has stated: "Under the best conditions not more than half the active material is really acted upon, unless the cell is run down below the normal limits, because the sulphate formed on its surface effectually screens the inner portions."† And the same writer further observes: "Various theories have been propounded from time to time regarding the reduction of the lead peroxide at the positive electrode. It has been suggested that it is first reduced to metallic lead, and then sulphated by local action; while Mr. Fitz-Gerald has maintained that it is only reduced to sesquioxide (Pb_2O_3) before sulphating. As, however, these theories have never been widely held, and have very little, if any, evidence to support them, it is not worth while going into the details of their thermo-chemical reactions; but if worked out, it will be found that the calculated E.M.F. falls far short of what is required."‡

XLI.

The red lead of commerce usually approximates in composition to Pb_3O_4—*i.e.*, one molecule of peroxide combined with two atoms of protoxide of lead. Since it is manufactured by heating the levigated protoxide to about 608deg. F. until the desired change of colour is obtained (which may be in about 48 hours), it is desirable, commercially, that, *cæteris paribus*, it should contain the largest percentage of protoxide in combination with the higher oxide; and fine samples of the pigment have been produced of the composition Pb_4O_5. But, from a chemical point of view, pure minium is Pb_2O_3—*i.e.*, a compound of one molecule of PbO_2 with one atom of PbO. By treating any commercial sample of peroxide of lead with a solution of caustic alkali, or of normal plumbic acetate ($Pb2C_2H_3O_2$, $3H_2O$), both of which solutions exert a powerful solvent action upon lead protoxide, the compound Pb_2O_3 is obtained. From this, no further portion of protoxide can be removed by the action of the above solvents—a fact that goes far to prove the stability of the compound. In regard to the action upon it of acids, the expressions, "it is decomposed by weak acids," and "it cannot exist in presence of sulphuric acid," may convey an entirely wrong impression. To effect its *complete* decomposition by means of any acid, weak or strong, is a somewhat difficult matter. The most efficacious process—that usually adopted to obtain from it the anhydrous peroxide of lead—is to levigate the minium very finely, and to digest the powder in boiling nitric acid diluted with four or five times its bulk of water; the residue is washed with fresh nitric acid, and then with water, till everything soluble is removed.§ Even then, if the boiling has not been sufficiently prolonged, the residue may contain some of the compound Pb_2O_3. Next to nitric acid, the most powerful agent in effecting the separation of the components is sulphuric acid, since hydrochloric acid is itself decomposed by the compound. But if we take, say, 1oz. of sulphuric acid (H_2SO_4), diluted with water to any required extent, and add to it minium in sufficient quantity to neutralise this acid on the hypothesis that the latter will combine with the protoxide component—*i.e.*, 4·68oz. of the compound Pb_2O_3, very finely levigated and well stirred into the fluid—the acid will not become neutralised, however long the stirring may be continued. And if another 4·68oz. be added, so as to allow twice the quantity of protoxide sufficient, according to the hypothesis, to neutralise the acid, a large proportion of the latter still remains uncombined, or, in other words, a large proportion of the minium remains undecomposed. If, instead of trying to neutralise the acid, we add this in great excess to ordinary red lead, then, as Frankland has

* *i.e.*, the peroxide. The above was written prior to the meeting at Paris, when a few gentlemen, more or less unacquainted with chemistry, solemnly decided that the plate supporting the most electro-negative body known—viz., peroxide of lead—was to be called the *positive* element; whilst that holding as active material a very electro-positive body—viz., spongy lead—was to be called the *negative* plate.

† *Electrician*, July 3, 1885, p. 136.

‡ *Ibid*, July 10, 1885, p. 157.

* *Electrician*, July 10, 1885.

† *Ibid*, September 21, 1894, p. 605.

‡ *Ibid*, October 5, 1894, p. 659.

§ "Elements of Chemistry," by W. A. Miller, fourth edition p. 719.

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shown, we may ultimately obtain a compound analogous to the ordinary variety of red lead—viz., $PbO_2 2PbSO_4$—in which the two atoms of lead oxide are replaced by two atoms of lead sulphate. But this compound cannot, of course, be obtained from Pb_2O_3; nor is it easy to obtain from this, by the action of dilute sulphuric acid, the compound $PbO_2 PbSO_4$ free from protoxide. The analysis of spent peroxide plates, from cells which have been run down to 1·85 volts, shows the existence of this sulphate compound together with varying amounts of Pb_2O_3; the percentage of the latter being small in the case of plates that have been left in the acid electrolyte for some time after the discharge of the cell, and comparatively large in the case of plates which have been withdrawn from the acid, and washed with water, immediately after the cessation of the discharge current.

The results of the comparatively recent experiments of M. Darrieus* have led him to traverse the statement that the lower oxides of lead cannot exist in presence of sulphuric acid. He digested minium for 48 hours in sulphuric acid of different densities, and the maximum amount of sulphatation he was able to obtain was 56 per cent. of the available protoxide. His results will be further referred to in a note on the protoxide of lead.

Not only does the compound Pb_2O_3 resist to a surprising degree the action of powerful acids, but the peroxide and also the protoxide of lead in this combination lose their ordinary properties, apparently in virtue of a strong counteracting affinity, which cannot be ignored in the theory of the lead secondary couple. Thus oxalic acid ($H_2C_2O_4,2H_2O$) converts peroxide of lead into protoxide, but is without effect on minium. The same may be said of the protonitrate of mercury [$(HgNO_3)_2(H_2O)_3$] and sulphurous acid (H_2SO_3). On the other hand, the protoxide of lead may readily be converted into the peroxide by fusing at a gentle heat a mixture of four parts of the oxide with one part of potassic chlorate ($KClO_3$) and eight parts of potassic nitrate (KNO_3); but minium, which might be considered as the protoxide already partly converted into peroxide, cannot be substituted for the latter in this process for obtaining the peroxide. At a temperature of about 440deg. F., the peroxide of lead is decomposed into oxygen and minium. At a much higher temperature, oxygen is again evolved, and the protoxide of lead remains. In the case of the electrolytic peroxide, dried in the water bath, I have always found that water as well as oxygen is liberated at the above temperature, the residue being minium, with lead sulphate and oxide.

Mr. Tribe's statement as to the quantity of acid absorbed during the discharge of an accumulator certainly does not disprove my contention if I can show by analysis the existence of one of the lower oxides of lead in a discharged peroxide element. For in this case—to use the expression of M. Darrieus—the sulphate of lead formed at this element is not, as in the case of the spongy-lead element, a function of the ampere-hours of discharge. And there is no difficulty in demonstrating the existence of a lower oxide of lead in a discharged peroxide plate. The more dense the current, the sooner the discharged plate is removed from the acid solution, the easier is this demonstration. Indeed, when it is considered that water to the amount of 5·19 grains per ampere-hour is generated within the substance of the peroxide, it is difficult to imagine where the sulphuric acid, to combine with the protoxide simultaneously formed, is to come from. And it cannot be denied that peroxide of lead is reduced—*i.e.*, that lower oxides are formed—in an electrolyte which does not contain a free acid. In this case, can it be supposed that the lower oxide, in presence of a large excess of peroxide, would be PbO rather than Pb_2O_3—the oxide next below PbO_2? Can we suppose that PbO in the nascent condition would not enter into combination with the residual PbO_2 amidst which it would be generated.

In regard to the two observations quoted from Mr. Wade, I may say, in the first place, that when a plate with active material containing about 48 per cent. of PbO_2 is found to be practically "spent," or discharged—since it will no longer give a P.D. higher than 1·85—the hypothesis of the "clogging" and "screening" effect of lead sulphate in mere admixture is insufficient to explain the diminution of E.M.F., though it may account for the increase of resistance. And, in the second place, I may say that I find it difficult to understand how any electro-chemist can suppose that PbO_2 on a cathode plate can be reduced "straight away" to PbO or Pb in presence of a large excess of the peroxide. And I may further say that if in any case where E.M.F. is not constant, but falls from a maximum to zero, the thermal values deduced from an electro-chemical equation (involving, for instance, the conversion of Pb into $PbSO_4$, and of PbO_2 into $PbSO_4$) were equivalent to the *initial* E.M.F., or to the *final* E.M.F. (which would be nil), then I should know that the electro-chemical equation, or the application to it of the thermal data, was wrong.

* *L'Electricien*, May 18, 1895.

ALTERNATING-CURRENT DYNAMO TESTS.*

BY HORACE FIELD PARSHALL, M.I.C.E.

The object of the following investigation was to measure the efficiency of a large alternating-current dynamo at different loads; to obtain definite quantitive results regarding armature reaction and its effect upon the field magnets, and upon the form of the E.M.F. curve; to subdivide and locate the elements of the total losses in the machine, and to establish an economical, accurate, and comprehensive method of testing. The efficiency of large machines has hitherto been only indirectly measured by determining the efficiency of the engine or other prime mover, and comparing this with the combined efficiency of the prime mover and the dynamo. It is generally understood that the efficiency of an alternating-current dynamo under load cannot be predicted from no-load trials, as in the case of continuous-current machines, for, whereas in a continuous-current dynamo the reaction of the armature on the field magnets may be expressed in the same terms as the effect of the field magnets on the armature, as is shown by Drs. John and Edward Hopkinson,† in an alternating-current machine, when the current is in phase with the E.M.F. induced by the magnetism of the field magnets, there is no corresponding armature reaction, as in a continuous-current machine when the brushes are set symmetrically with respect to the polar projections. When, however, the current is displaced in phase from the E.M.F., it reacts on the field magnets, and, in the case of lagging current, tends to diminish the magnetisation of the field; or, in the case of a leading current, such as would occur in a dynamo acting on a system of sensible capacity, it tends to act with the field magnets, such effect being proportional to the angular displacement of the current with respect to E.M.F. This, in a general way, corresponds to the angular lead of the collecting brushes in a commutating dynamo. Owing, however, to the effect of alternating currents and self-induction of the armature coils, currents are set up in the mass of the field magnets, of double the frequency of the generated current. These local currents tend to demagnetise an alternating-current dynamo in the case of lagging current, or to increase the magnetism in the case of a leading current. Further, owing to the mutual induction between the armature and magnet coils and the self-induction of the armature, the current in the field-magnet coils is to some extent reduced. The nature and theory of these phenomena have been set forth by Dr. John Hopkinson and Mr. E. Wilson.‡

The method of test followed was that devised by Dr. John Hopkinson.§ Two similar machines were rigidly connected by a coupling which admitted of the angular position of one armature varied relatively to the other, the power for driving being supplied by shafting through a specially-designed dynamometer. When two alternating-current dynamos are connected in parallel, whether or not current passes between them, the work required to drive them from an independent source depends simply on the

* From the *Proceedings* of the Institution of Civil Engineers.

† *Philosophical Transactions* of the Royal Society, vol. clxxvii., p. 331.

‡ *Ibid*, vol. clxxxvii.

§ *Ibid*, vol. clxxvii., p. 347.

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frictional and other losses in each, the amount of current that passes between them, and, consequently, the load on each, depending on the angular displacement in phase of the one in respect to the other. The coupling was graduated in degrees, so that the phase difference between the machines was known. The amount of phase difference necessary for a given current, and, consequently, a given load, was first determined mathematically by coplanar vectors,

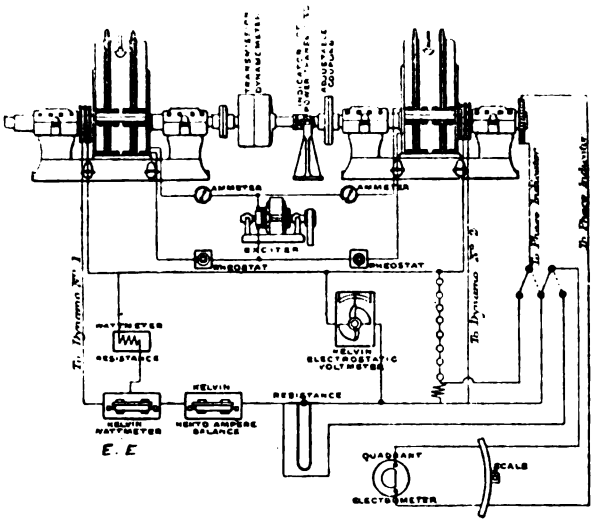


FIG. 1.—Diagram of Connections for the Test.

which have been found generally useful and reliable in this work, and agree with the results obtained. When two machines are rigidly coupled together and are displaced one with respect to the other in phase, one acts as a motor and the other as a dynamo; and to maintain them at a given speed and load it is only necessary to supply from external sources the work lost between the two machines. This being done, the machines can be loaded to any desired amount, and there will be established the same phase relations, reactions, and losses that occur in machines driven under the same load conditions in practice with respect to capacity and inductance. The results of the tests show that when two similar machines are equally excited, the phase of current and E.M.F. obtaining in the circuit corresponds with close approximation to that of an alternating-current dynamo running on a non-inductive load. The range of the tests, however, is varied considerably, so that the efficiency of the machinery has been determined under conditions corresponding both to a highly inductive load and to a load having a very sensible capacity.

A diagram of the connections is shown in Fig. 1. In

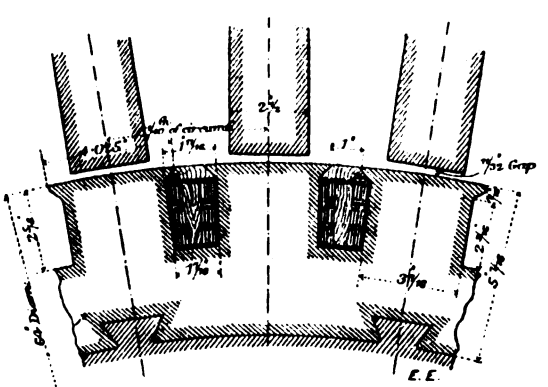


FIG. 2.—Cross-Section through the Armature-Projections and Poles.
Scale, 2in. = 1ft.

the main circuit there were two complete self-contained sets of apparatus for the test, one consisting of an ampere-balance, a watt-balance, and an electrostatic voltmeter; and the other, which may be called the interrupted contact set, consisting of a resistance in series with the main circuit and the shunt resistance across it, an interrupted contact disc on the end of the shaft, and a quadrant electrometer. The first is the more practical, economical, and direct method. The second method is, on the other hand, susceptible of great refinement, and shows the nature of the curves of current and E.M.F. and the effect of the reactions in the armature upon the shape of the curves. It, however, entails great labour in observation, plotting, integrating, obtaining constants, and caculating tables, yet it is advisable that this method should be used for a new type of machine when the general characteristics, common to all, can be obtained, such as the form of the E.M.F. curve, the influence of the reactions upon the form of this curve, depending, in fact, upon the ratio of pole-arc to pitch, the number and shape of the tooth or teeth. After that the more direct method will tell all the properties peculiar to the particular machine under test. In this case both methods were used as a check one upon the other.

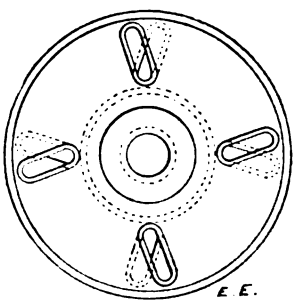
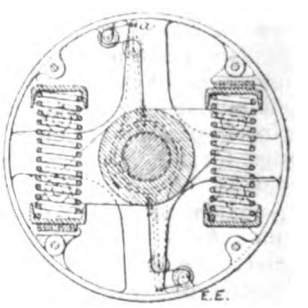


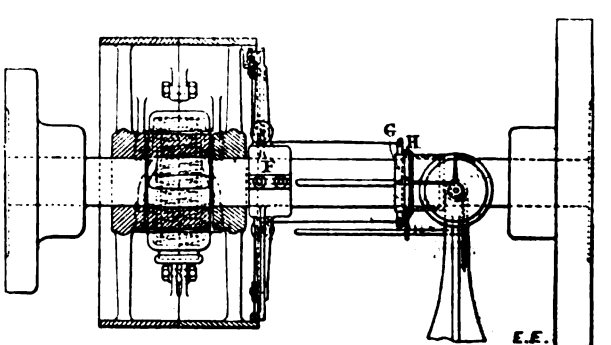
FIG. 3.

The two machines tested were constructed by the General Electric Company of the United States for the British Thomson-Houston Company, to be installed in the generating station of the City of London Electric Lighting Company, Bankside. The output is 385 kw., the speed 300 revolutions per minute, and the potential at full load 2,200 volts. The field-magnet system has 40 poles, and



Cross section.
FIG. 4.—Transmission Dynamometer.

consists of a cast-iron yoke holding magnet cores of laminated sheet iron, the yoke being cast with the magnet cores in position. The ratio of the pole-arc to the pitch is 0·5. The coil consists of 130 turns, and is supported by a brass flange. The coils are arranged in two sets of 20.



Sectional elevation.
FIG. 4A.—Transmission Dynamometer.

The resistance of the two halves of the field in parallel is 1,378 ohms at 20deg. C. The armature consists of a laminated core of iron 0·014in. thick fixed on a cast-iron spider. The armature has 40 T-shaped projections, each carrying a coil of six turns. Its total resistance is 0·1105 ohm at 20deg. C. The general arrangement of the armature projections and the poles is shown in Fig. 2.

The two machines were carefully aligned upon a large surface plate and connected by the adjustable coupling. That part of the coupling fixed to the one machine has four

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slots inclined at an angle to the radial direction, and that fixed to the other machine has corresponding slots inclined by the same amount in the opposite direction. The centre lines of the slots (Fig. 3) are tangents to a circle about 8in. in diameter, having its centre in the axis of the shaft. By this arrangement one armature can be advanced relatively to the other by a distance of 5in. measured on the periphery, which, as the pitch on the periphery of the armature measured 5in., corresponded to a phase variation of 180deg., or one-half of a complete period. If, in addition, the field of one is reversed, a total phase relation of one complete period is obtained. The position of one armature relatively to the other was determined by means of scales

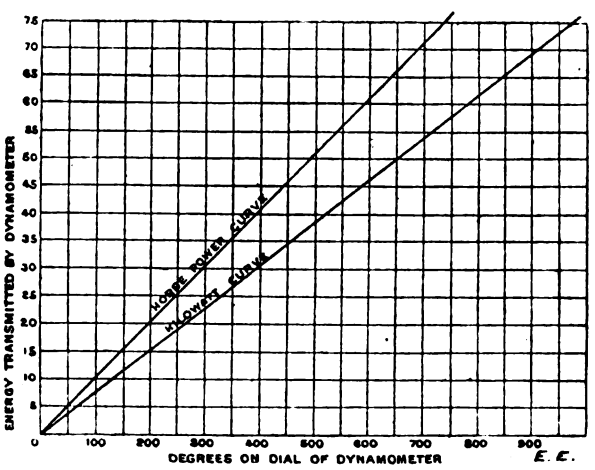

FIG. 5.—Scale of Power Transmitted by the Dynamometer at 300 Revolutions per Minute.

glued on the peripheries of the armatures and fixed to corresponding points, with respect to the armature coils, and readings taken with reference to corresponding marks on the field-magnet poles. The scales were long enough to cover five poles, so that a fair average was arrived at. As a check upon these readings and as a convenient reference in setting, parts of the peripheries of the two sections of the coupling were marked in degrees, starting from a common zero obtained by careful alignment of the two armatures, with respect to the field magnets, and to each other.

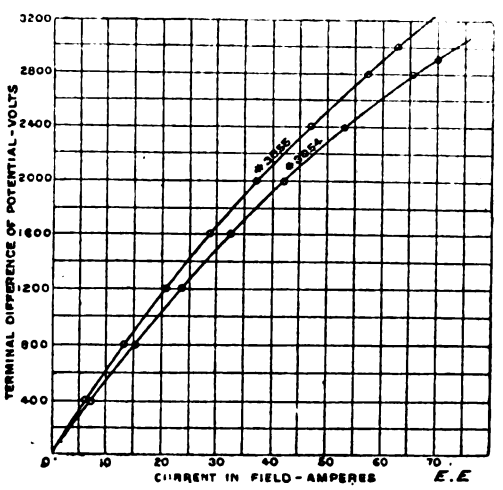

FIG. 6.—Saturation Curves at 300 Revolutions per Minute.

The dynamometer (Figs. 4 and 4A) through which the power was transmitted to the shafting of the two machines coupled together, was designed by the author in consultation with Dr. Hopkinson, and proved thoroughly reliable and very sensitive. It is a combination of a pulley or sheave, free to rotate on the shaft within the limits of compression of the springs. The power is transmitted from the belt to the shaft through these springs acting on an arm of 12in. upon a lever fixed to the shaft. The amount of turning of the pulley, with respect to the shaft, is a measure of the compression of the springs, and therefore of the torque applied to the shaft. To indicate this angular position the shaft has fixed to it within the pulley an auxiliary double lever, to the ends of which are fixed the ends of the two steel wires. These first pass from the end of the lever round a small sheave fixed to the inner periphery of the pulley, and then to a sheave on the lever, which deflects the wire radially along this lever towards the shaft. It then passes round a sheave on the hub of the lever, which deflects the wire parallel to the shaft; then on to a collar which is free to travel lengthwise along the shaft, but not free to rotate relatively to the shaft. Upon this collar is mounted another, free to rotate but not to move longitudinally, with respect to the first collar, and it is thereby constrained to travel backwards and forwards along the shaft with the first collar, according to the angular positions of the pulley and lever or according to the power transmitted. This linear motion along the shaft is converted to a circular motion by attaching wires to the second collar passing around small sheaves mounted on brackets, separate from the machine, the motion being multiplied by means of an

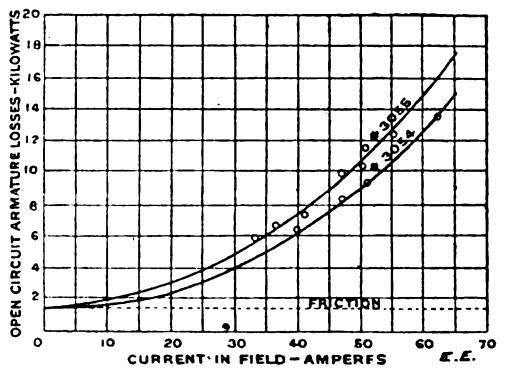

FIG. 7.—Curves of Armature Losses with Field-Currents on Open Circuit at 300 Revolutions per minute.

index and read off on a degree scale. The scale was graduated by clamping a piece of canvas on the pulley, attaching weights to the free end and reading off the corresponding deflections on the degree scale referred to, which, when plotted to correspond with the weights, formed an equivalent to a stress-strain diagram. A power curve was thus deduced for a speed of 300 revolutions per minute. The two curves (Fig. 5) give the activity in horse-power and in kilowatts per degree on the dynamometer dial for 300 revolutions per minute. During the test all readings were taken as nearly as possible at this speed, as the component losses, of which the dynamometer reading is the sum, are functions of different orders of the speed. It was, however, not found possible to adhere strictly to a uniform speed; still, as the more important loss varies with the speed, the error in correcting proportionally to the speed was not great, say, for a difference of 1 per cent. or 2 per

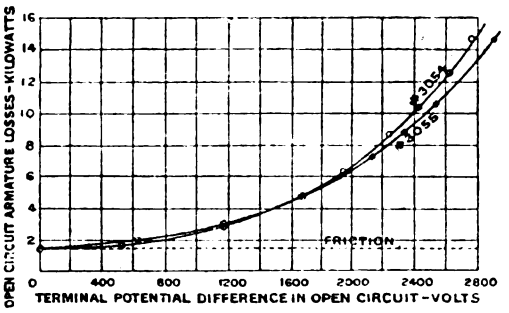

FIG. 8.—Curves of Armature Losses with Terminal Potential Differences at 300 Revolutions per Minute.

cent. Greater weight was given to those readings which were obtained at a speed of 300 revolutions.

The first quantity to be measured was the loss through friction of the bearings and the air resistance of the coupled machines. At a speed of 300 revolutions per minute, the dynamometer read 40deg., which corresponds to a transmitted power of 3,000 watts. This requires care in observing, as the slightest change in speed means a positive or negative inertia factor.

The saturation curves (Fig. 6) were next determined for each machine separately, and the dynamometer readings taken at the same time from these observations give also the curves of armature losses with field current (Fig. 7) and the armature losses with potential difference on open

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circuit (Fig. 8) for a speed of 300 revolutions per minute, corresponding to 100 periods per second. The last two sets include 1,500 watts for friction of the bearings and air resistance, one-half the value obtained in the first observation. This quantity is assumed to be constant, but it is only known when the machine is not excited. The remaining losses consist of hysteresis, eddy-current loss, and losses incidental to the varying reluctance of the magnetic circuit.

The machines were next coupled together electrically in four different relations corresponding to an exchange of power between the machines equal to full load, three-quarter load, half-load, and quarter-load of either machine; and three sets of observations were taken in each position, one with normal excitation on each machine, another with the excitation of generator above and motor below, and the third with the generator below and motor above, the normal excitation. Readings were taken on the wattmeter, ampere-balance, and voltmeter, and instantaneous values were taken of the current and potential difference on the terminals. In each case about 20 observations were made to construct the curves (Figs. 9-12). In one case only were the open-circuit potential differences taken directly throughout, this being sufficient to establish the form of the curve and to locate the two potential differences, and to compare their determined positions with the measurements on the coupling. How near this was made to accord can be seen by reference to Figs 16-18, in which the curves, E_g, E_m, representing the impressed and counter E.M.F.'s of generator and motor, cross the zero line 71deg. or 72deg. apart. The angular positions of the armature differed by 2·01in. on the scales laid on their periphery. The mean difference between the poles was 5·01in., corresponding as nearly as possible to 72deg. difference of phase. The terminal potential difference curve of each machine on open circuit is plotted separately (Fig. 19), so that the characteristic of each may be observed.

In the diagrams (Figs. 9-18) E_g represents the impressed E.M.F. of the generator; E_m the counter E.M.F. of the motor; and "e" represents the effective E.M.F. of both motor and generator. Actually "e" is the curve of instantaneous values of the terminal potential difference on the generator, but the correction for the generator armature resistance on the one hand, and for the motor armature resistance plus the resistance of the connections on the other, are inappreciable, so that the same curve "e" stands for the effective E.M.F. of both machines. The curve marked $\int e\,dt$ is the integral curve of "e"; $\int E_g\,dt$ the integral curve of E_g; and $\int E_m\,dt$ the integral curve of E_m. As shown by Dr. Hopkinson in the papers referred to, were it not for the effect of the current in the armature, the integral curves should cross at the instant that the current is zero, as implied in the equation for $x = 0$:

$$\int E\,dt = \int R\,i\,dt + \int L\frac{di}{dt}\,dt.$$

The difference, therefore, of the two integral curves at the instant when the current is zero, is a measure of that effect of the armature current upon the field which is not

Fig. 9. A, Curves.

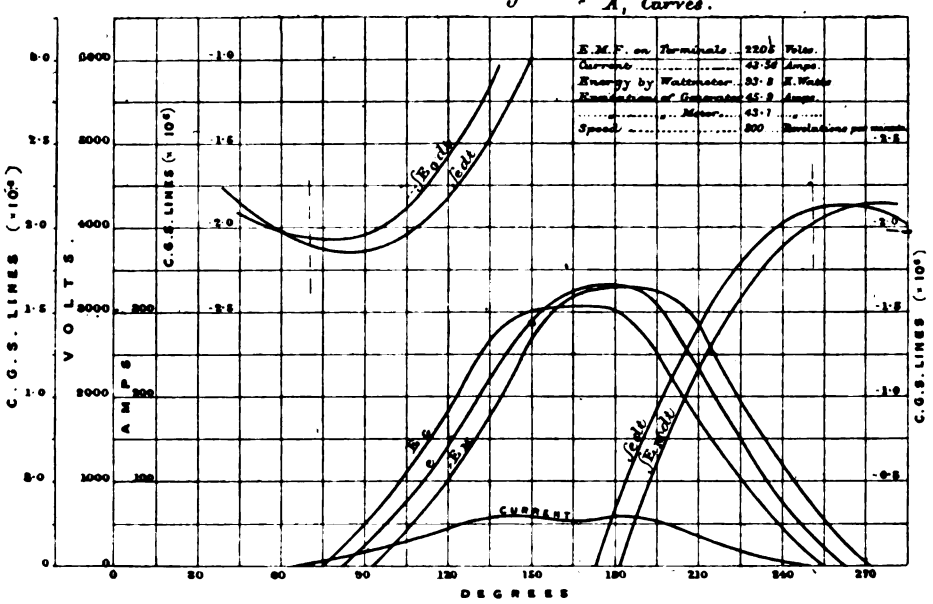
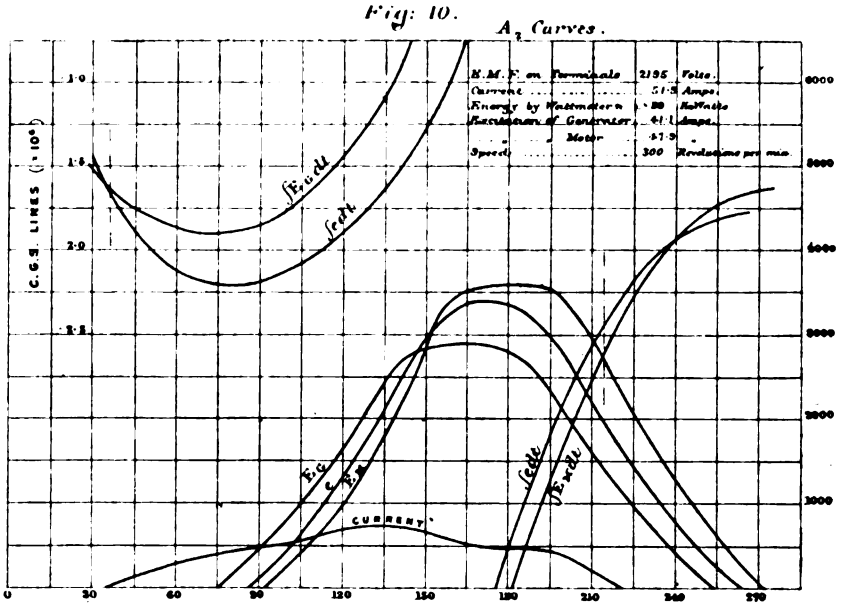


Fig. 10. A, Curves.



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accompanied by a corresponding displacement of current relatively to the E.M.F. The diagrams afford the means of measuring this effect in percentage of the total flux for various effective current values and various phase relations. They show the nature of the effect of the current in diminishing the effective ampere-turns on the field magnets, and to some extent the magnitude of the effect. For instance, in Fig. 16, E_1, the phase relations are nearest those of non-inductive load conditions, the difference between $\int E_g\,dt$ and $\int e\,dt$ is $0{\cdot}15 \times 10^6$, and the maximum flux is $2{\cdot}55 \times 10^6$. The percentage increase in the flux necessary

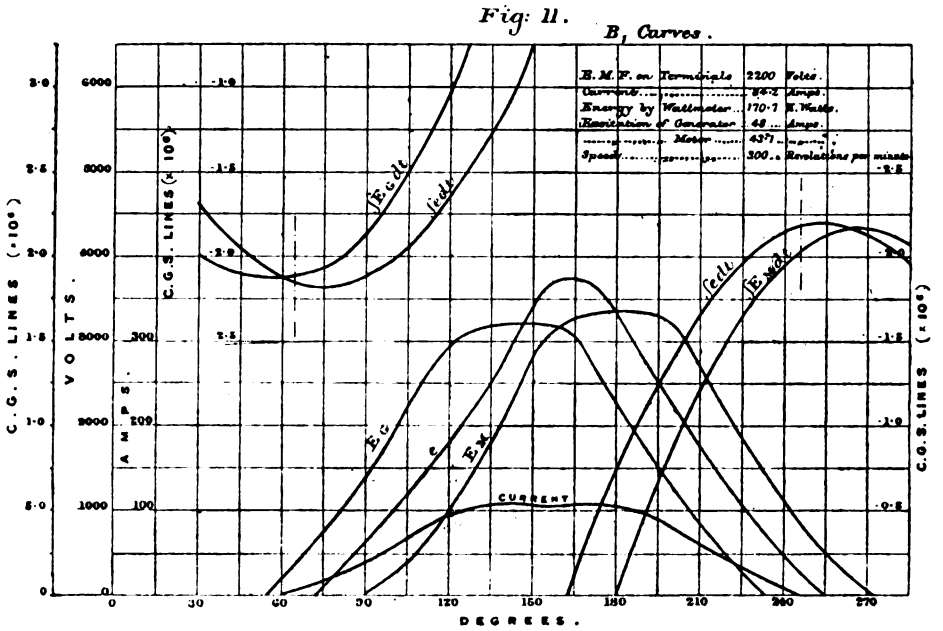
armature and the field structure. The whole action of the current in the armature may be summarised as follows:

1. Reaction in the electromagnetic field accompanied by displacement, expressed by the equation, $E = R\,x + L\frac{d\,x}{d\,t}$.

2. Reaction of current on the field not accompanied by displacement of current, an effect represented by losses through induced current in the field-magnet winding, core, and yoke.

The following is the method of analysing the second

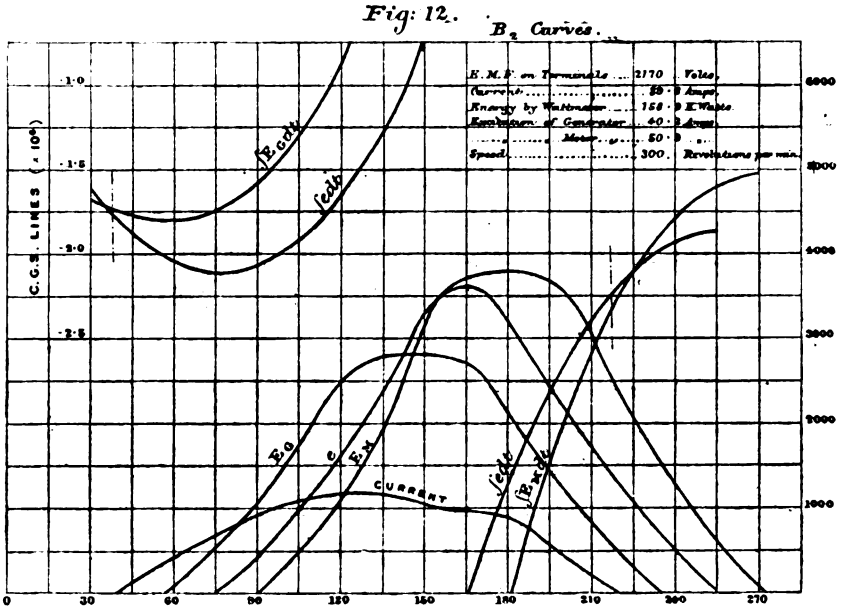
Fig. 11.



to overcome the effect of the current of 177·8 amperes in the armature upon the total magnetising force in the phase relation indicated is approximately 6 per cent. of the maximum value. The E_2 and E_3 curves (Figs. 17 and 18), however, seem to agree that this result is too low, and that the result is nearer 7 per cent., for in these cases the percentage is greater, and at the same time the current is more nearly in phase with the impressed E.M.F. Compar-

effect. It will be sufficient to refer to one set of curves only; thus, take Fig. 16, E_1, the total flux in the armature of the generator necessary to fulfil the conditions 1 and 2 over that necessary to fulfil the conditions in 1 is greater by 6 per cent.; the density is greater, and therefore the increase in hysteresis loss and eddy currents may be calculated. Further, from these two values of the total flux is obtained two impressed E.M.F. values, one of which

Fig. 12.



ing this group with another group—C, say—where the currents in the armature are smaller, the difference is at once apparent. Comparing C, in which the phase relations approximately correspond with group E, it will be seen that the increase necessary in the flux is 3·2 per cent. For this purpose set A is ill-conditioned, as the errors incidental to the plotting are greater than the difference sought for. The difference in the integral curves at the instant when the current is zero, together with the dynamometer readings, form the basis of the analysis of the reaction of the current, in so far as it affects the core losses in the

must fulfil condition 1, and can be verified by a polar diagram, and then by referring to Fig. 8 the corresponding losses are obtained, and the difference gives the increased losses accompanying the increased flux density. A further reference to the saturation curves and the corresponding field current, together with the resistance of the field coils, gives the increased C^2R losses in the field winding. Next, the power absorbed is compared with the open-circuit loss for the corresponding impressed E.M.F. of the generator, the difference giving the losses through induced current in the field-magnet structure, in this instance due to a current of 177·8

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amperes in the armature with a phase difference of 28deg. The loss from increased flux density, hysteresis, and eddy currents is 11 kw., and the loss through induced currents is 10 kw. The magnitude of this quantity is readily understood when it is borne in mind that a current of a certain periodicity in a revolving armature induces currents of twice that period in a stationary field; in fact, the whole effect of the current, as regards the field magnet, may be regarded, for practical purposes, as that of a fixed vector, which when compounded with the field ampere-turns gives

Fig: 13. C_1 *Curves.*

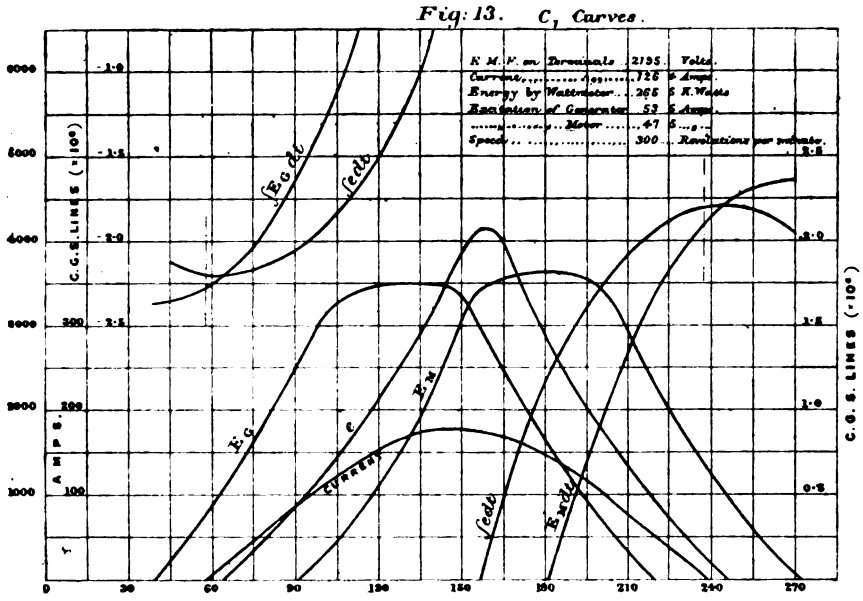


Fig: 14. C_2 *Curves.*

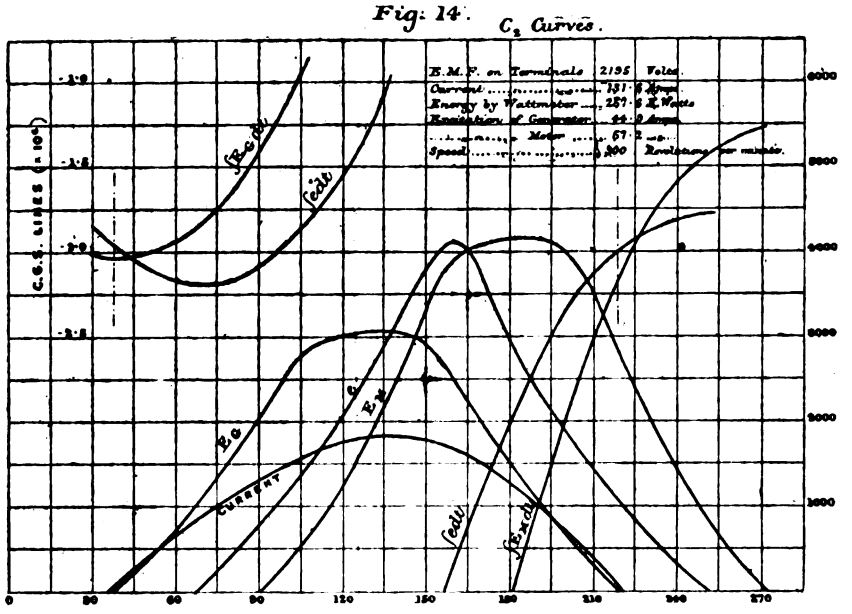
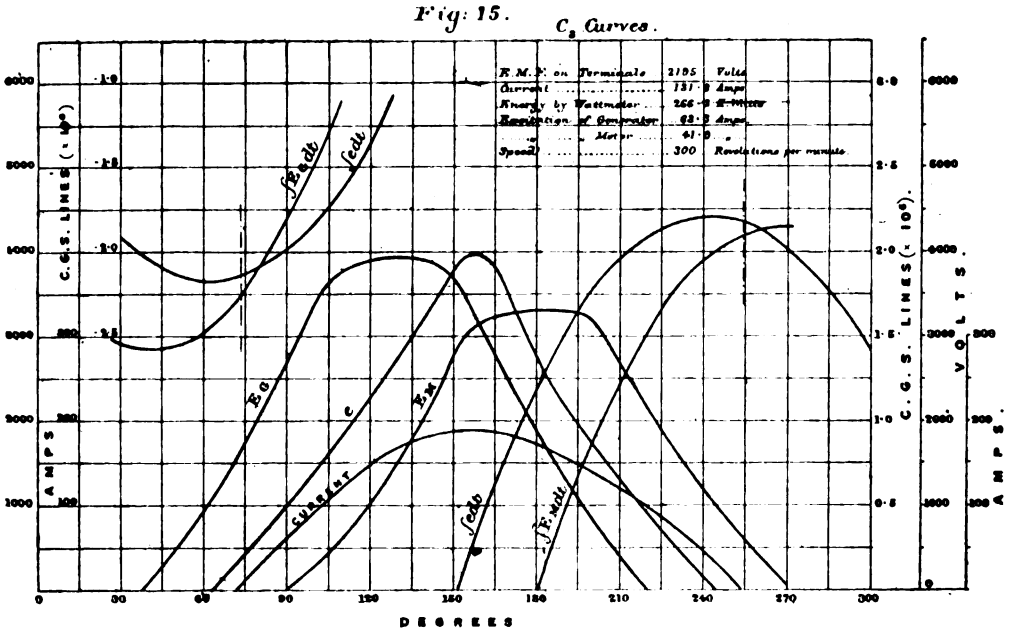


Fig: 15. C_3 *Curves.*



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the effective ampere-turns and a vector of equal magnitude rotating at double periodic turns of the current. The much importance. The following table gives the total loss by induced currents in the field magnets in the coupled

Fig: 16.

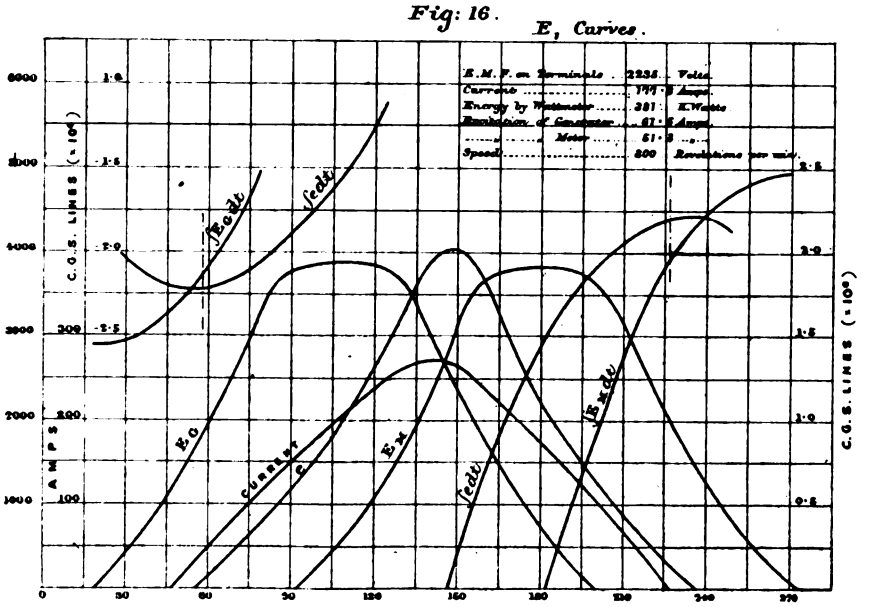


Fig: 17.

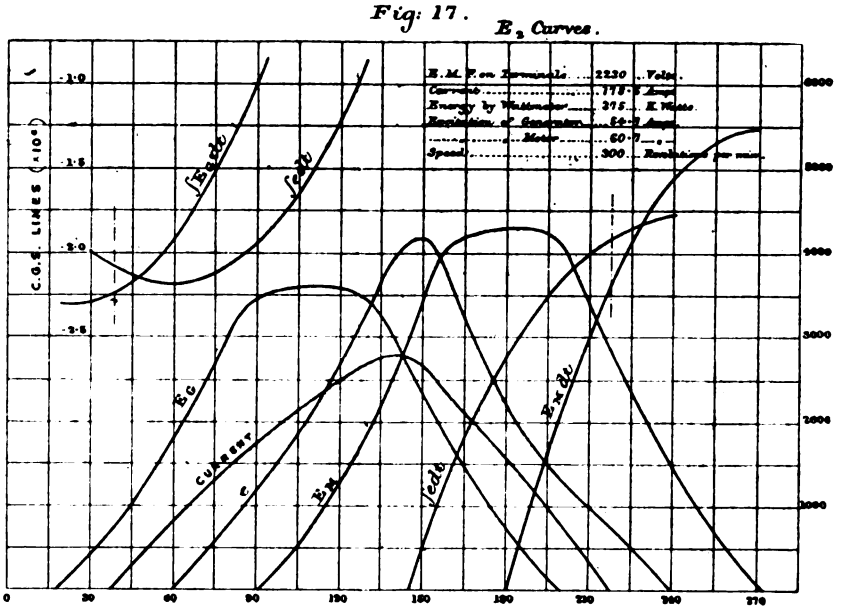
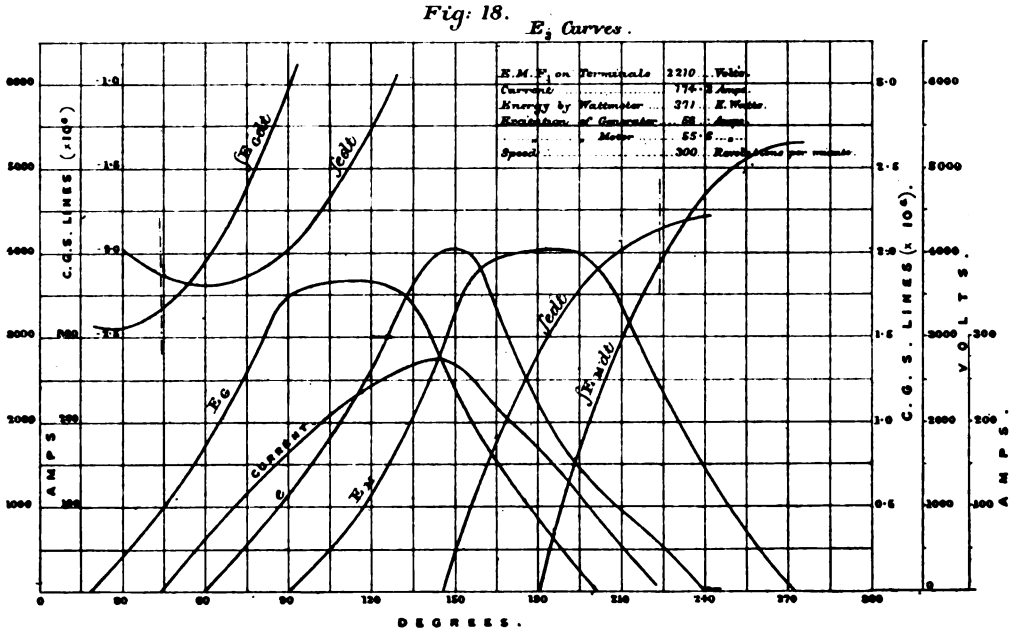


Fig: 18.



amount of compounding in the first case depends upon the phase relation of current and E.M.F.; the effect of the phase relation upon the latter does not seem to be of so generator and motor in different phase relations and for different currents, the result varying approximately as the square of the current.

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Curves.	Current in system. Amperes.	Loss by induced currents in generator and motor. Kilowatts.
E_1	177·8	21
C_1	126·4	10 56
B_1	84·2	5 82

The results of the tests are shown in Table I., and give the losses at about quarter, half, three-quarters, and full load under three conditions of phase relation of current and E.M.F. indicated by the relative values of the energy dissipated in the fields. Those values which correspond to the higher power factor in the table, or to coincidence of current and E.M.F. in the figures, may be taken as corre-

TABLE I.—Generator and Motor Combination Test, Showing Allocation of Losses in the Two Machines (No. 3,054 as Generator and No. 3,055 as Motor).

—	A_1	A_2	A_3	B_1	B_2	B_3	C_1	C_2	C_3	E_1	E_2	E_3
a. Phase difference between armatures ..... degrees	17·7	17·7	17·17	36·2	36·2	36·2	51 9	51·9	51·9	71 6	71·6	71·6
b. Power factor	0·9723	0·6691	0·8910	0·9890	0·8090	0·9659	0·9877	0·8481	0·9877	0·9903	0·9336	0·9613
1. Power given out by generator in kilowatts (by wattmeter)	93·73	89·22	93·03	171·13	159·3	175·82	266·1	258·24	266·97	382·0	376·0	372·0
2. Power given to motor kilowatts	93·5	89·00	92·8	170·7	158·9	175·4	265·5	257·6	266·3	381·0	375·0	371·0
3. Power dissipated in generator armature. kilowatts	0·21	0·298	0·37	0·78	0·89	0 93	1·77	1·91	1·92	3·5	3·52	3·36
4. Power dissipated in motor armature..... kilowatts	0·21	0·298	0 37	0·78	0·89	0 93	1·77	1 91	1·92	3·5	3·52	3·36
5. Power dissipated in generator magnet winding kilowatts	2·93	2·35	3·9	3·2	2·25	4·52	3 98	2·8	5·57	5·25	4 175	4·37
6. Power dissipated in motor magnet winding kilowatts	2·58	3·19	1·81	2·58	3·6	2·11	3·14	4·55	2·44	3·66	5·13	4·3
7. Power dissipated in connections..... kilowatts	0·23	0·22	0 23	0·43	0·40	0·42	1 00	0·64	0·67	1·00	1·00	1·00
8. Power absorbed by combination through belt kilowatts	22 7	21·9	22·6	25·9	26·2	26·35	36·4	37 1	37·25	54·6	54·25	50·75
9. Total electrical power developed in generator = Nos. 1 + 3	93·94	99·52	93·4	171·91	160·19	176·75	267·87	260·15	268·89	385·5	379·52	375·36
10. Half power absorbed by system, less half known power = ½ {No. 8 − (Nos. 3 + 4 + 7)}	10·90	10·49	10 81	11·96	12·01	12·04	16·13	16·32	16·37	23·3	23·11	21·52
11. Total power given to generator = Nos. 5 + 9 + 10...	107·85	102·36	108·12	187·07	174·45	193·31	287·98	279·27	290·83	414·05	406·81	401·25
12. Percentage efficiency of generator = $\frac{\text{No. 1}}{\text{No. 11}}$	87·04	87·25	86·11	91·48	91·32	90·95	92·5	92 5	91·75	92·2	92·4	92·75
13. Percentage loss in generator armature	0·194	0 291	0·340	0·42	0·51	0·48	0·62	0 68	0·66	0·845	0·866	0·837
14. Percentage loss in generator magnet winding ...	2·72	2·29	3·61	1·71	1·29	2 34	1·38	1·00	1·99	1·27	1·028	1·09
15. Percentage sum of all other losses in generator.....	10·05	10·17	9 94	6·39	6·88	6·23	5·5	5·82	5·60	5·695	5·706	5·32
16. Percentage efficiency of generator armature = $\frac{\text{No. 1}}{\text{Nos. 9 + 10}}$	89 52	89·21	89 20	93·07	92·51	93·13	93·7	93·4	93·68	93 4	93·4	93·7
17. Percentage efficiency of motor = $\frac{\text{Nos. 9 + 10 − 8}}{\text{Nos. 2 + 6}}$	85·6	84·83	86·27	91·16	90·00	91·51	92 1	91·31	92·2	92·00	91·4	92·3
18. Percentage loss in motor armature	0·22	0·323	0·39	0·45	0·55	0·52	0·659	0·771	0·714	0·91	0·922	0·896
19. Percentage loss in motor magnet winding	2·68	3·46	1 93	1·49	2·22	1·19	1·176	1·73	0·908	0·952	1·342	1·145
20. Percentage sum of all other losses in motor	11·68	11·39	11·43	6·90	7·23	6·78	6·065	6·19	6·18	6 14	6 34	5·66
21. Percentage efficiency of motor armature = $\frac{\text{Nos. 9 + 10 − 8}}{\text{No. 2}}$	88·0	87·83	87·95	92·54	91·89	92·61	93·2	92·9	93·23	93·00	93·00	93·3

TABLE II.—Losses in Alternator No. 3,054 working on a Non-Inductive Load. Percentages of Total Power.

—	Full load.	Three-quarter load.	Half-load.	Quarter-load.	One-tenth load.	No load.
Total power delivered at terminals ..... kilowatts	385·0	288·75	192·5	96·25	38·5	0
Current ..... amperes	175·0	131·25	87·5	43·75	17 5	0
Potential difference on terminals ..... volts	2,200	2,200	2,200	2 200	2,200	2,200
Friction (all sources) ..... per cent.	0·36	0·48	0·71	1·36	2·94	12·5
Field winding ..... ,,	1 272	1·375	1·66	2·98	6·26	25·9
Hysteresis in armature ..... ,,	1·62	2·015	2·8	4 98	10·37	44·0
Eddy in armature ..... ,,	0·288	0·415	0·544	0·905	1·75	5·85
Variation of magnetic reluctance ..... ,,	0·696	0·767	0·946	1·45	2·64	11 75
Armature winding ..... ,,	0·816	0·608	0·426	0·226	0·196	0
Reaction of current in armature on magnet frame ..... ,,	2·645	2·11	1 66	1·175	0·88	0
	7·697	7·71	8·746	13 076	25·026	100 0
Efficiency of generator ..... ,,	92·31	92·29	91·25	86·93	74·97	0
Total power given to generator ..... kilowatts	417·0	313·0	211·0	110·5	51·1	12·0

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sponding to a non-inductive load. It will be seen that the phase relation of armatures, and consequently impressed and counter E.M.F., remains unaltered under any one letter, such as A, B, etc. The phase relation of the potential difference terminal, D P, and current is altered by varying the field current to an extent indicated by item (*b*). The three conditions are placed under headings such as A_1, A_2, and A_3 for Table I. In item 10, an average value is obtained for both generator and motor by the method of taking half the total number of watts absorbed by the system, less half the known number of watts. This is obviously not always the case, as the

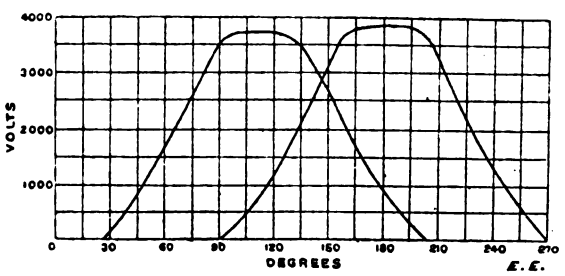
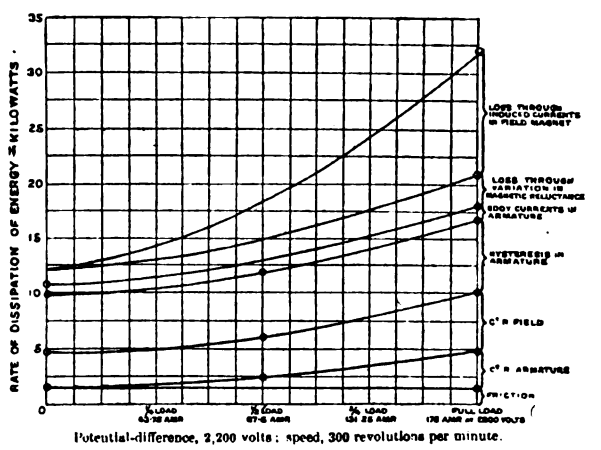


FIG. 19.—Terminal Potential-Difference Curves on Open Circuit Speed, 300 Revolutions per Minute.

impressed E.M.F. of the generator need not be equal to the counter E.M.F. of the motor, neither are they equal in any of these tests.

The result of halving the total losses, other than the armature-winding and field-winding losses, affects the efficiencies of the generator and motor, making the motor efficiency less than the generator efficiency, in spite of the fact that the effect of the current in the field in these cases is such as to diminish the $C^2 R$ losses in the field for the same counter E.M.F. In Table II., which is a summary of this analysis, and also in the curves Fig. 20, this has been done by halving that part of the total loss which is



Potential-difference, 2,200 volts; speed, 300 revolutions per minute.

FIG. 20.—Allocation of Losses in Machine No. 3,054 on Non-Inductive Load.

approximately the same for two equal machines, and apportioning the rest in proportion of the impressed and counter E.M.F. Bearing and wind friction is in this case assumed constant for all loads. Table II. gives the allocation of the losses in alternator No. 3,054 in percentage for full non-inductive load, three-quarter load, half-load, and quarter-load, and one-tenth load. These have been deduced not only from the coupled tests, but in part from direct observation of instantaneous values of current and potential difference on a water rheostat. By means of this table the curves of efficiency can be predicted with fair accuracy for this type of dynamo. The definition of type must cover the shape and number of armature projections, the ratio of the pole-arc to the pitch, and the maximum armature reaction, upon which the items 8 and 10 principally depend.

DIELECTRIC STRENGTH OF OILS.

BY CHARLES PROTEUS STEINMETZ.

In the article by Messrs. Northrup and Pierce, in the *Electrical World* of November 6, some very interesting results are derived on the relative dielectric strength of oil and air, to wit.

1. The ratio of oil strength to air strength depends upon the source of power, being lowest under the stress of alternating currents, highest with the oscillating currents of a high-frequency apparatus, and intermediate with the current of an induction coil.

2. The ratio of oil strength to air strength increases with the striking distance—that is, the voltage—except with heavy oils and alternating currents.

3. In the latter case the strength of oil falls to, or even below, that of air at high voltages.

The first observation seems to be the well-known—though never satisfactorily explained—fact that the disruptive strength of many dielectrics, probably those having a large dielectric hysteresis, depends not only upon the voltage, but also upon the power behind the voltage. The relative disruptive effect in the above tests is in the order of the powerfulness of the source of supply, just the same order that is observed in physiological effects, where, as is well known, the high-frequency coil discharge can hardly be felt, that of the induction coil is quite severe, and that of the transformer dangerous.

I do not believe that the shape of the wave is the cause of the differences. If, as is probable, the alternating current is derived from an iron-clad machine, with the enormous self-induction and considerable capacity of the induction coil used as transformer, the alternating wave probably differs far more from sine shape that the oscillation of the high-frequency apparatus. With the alternating wave, however, the dielectric is continuously exposed to an electrostatic stress, while with an induction coil, and still more with a high-frequency apparatus, short periods of high electrostatic stress are separated by intervals of rest, which are very long compared with the time of activity.

Some years ago I made a number of tests with alternating currents on the dielectric strength of different materials (*Transactions* of American Institute of Electrical Engineers, February, 1893), which gave for air in the range up to 25,000 volts a parabolic law,

$$d = 54\ V + 1{\cdot}2\ V^2,$$

but for paraffine and oils straight lines:

Paraffine paper, $d = 3$ V.
Melted paraffine, $d = 12{\cdot}4$ V.
Boiled linseed oil, $d = 12{\cdot}5$ V.
Crude lubricating oil, $d = 60$ V.

Herefrom it follows immediately that the ratio of oil strength to air strength must increase with the distance—that is, the voltage—as observed in above-mentioned tests.

There remains unexplained, however, the enormous drop of the oil strength to and below that of air in the case of heavy oils with alternating currents. Nothing of this kind was ever observed by me, nor I believe by anybody else, but contrary evidence is quite plentiful. For instance, during the last three years I have had four high-potential oil transformers in frequent use for insulation tests, sometimes for hours at a time, at voltages from 60,000 to 150,000, corresponding to a striking distance of from 7in. to 16in. of air. The total insulation or oil distance from terminal to terminal in these transformers does not exceed about 4in. Thus, if the oil (a transformer oil similar to transil oil) had fallen anywhere near to air in dielectric strength, the transformers would have broken down long ago.

Heavy oils very frequently occlude moisture, and occasionally acids, and I should suggest this property as an explanation of their abnormal behaviour under alternating stress in these tests. A similar effect takes place in condensers. If the dielectric of an electrostatic condenser occludes air, in an alternating circuit the condenser breaks down after a short time at a remarkably low voltage, while on powerless sources of potential difference it is practically as strong as if the air were perfectly excluded.

There can be no doubt in my mind, however, that at high voltages with alternating currents, dry oils have a dielectric strength far superior to that of air.—*Electrical World* (New York).

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

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BOUND VOLUMES.

Vol. XIX. of new series of "The Electrical Engineer" can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.

THE TEACHING OF DONNISON v. BERESFORD.

Some of our contemporaries have used a considerable portion of space in the report of this case, but we venture to assert that in no single instance does the report give, nor can any condensed report give, a true description of what occurred before Mr. Justice Mathew. It was perfectly evident to the onlookers why the jury gave their verdict for the plaintiffs. It may seem funny if we say that in our estimation the verdict was absolutely wrong, yet under the peculiar circumstances of this case it may be held to be right. To comment upon the evidence, though in such cases great latitude is allowed, would involve us in one, if not several libel suits; and much as we would like to speak our minds, and much as we believe it would be for the public good, the necessity of examining closely into personal intentions as well as actions would inevitably lead to legal procedure. Fortunately, there are one or two broad general lessons which we may safely discuss. We have no shred of sympathy for Lord Charles Beresford. If gentlemen of his education and knowledge of the world care to indulge in the most unbusinesslike proceedings, they deserve to pay the piper. His procedure was simply a variation of the old schoolboy method, "Open your mouth and shut your eyes and see what someone sends you." We slightly parody the schoolboy words, as they tend towards vulgarity, if not worse. Lord Charles Beresford would not go to a shipbuilder and ask him to construct a battleship subject only to his (the shipbuilder's) own general specification and supervision; yet this is just what he does when he wants his house lighted electrically. He goes to a firm of wirers, gets from them a specification of the most general character, and agrees to have an installation about which nothing is definitely specified. The tirade about systems, about first-class workmanship, and all that kind of thing in the case, was so much sheer nonsense. The proper course to pursue is to employ a really competent consulting engineer. The consulting engineer should confer with his employer and decide practically upon the position of the lights and the candle-power of the lamps. He should have very definite views as to possible extensions. Then it would be the duty of the consulting engineer to prepare a proper specification and plans, the specification and plans to cover the whole matter, both general and detailed. The contractor ought to have no license to vary the work in any particular, except with the consent and under the instruction of the consulting engineer. We have held and argued for years that the combination of consulting engineer and contractor in one and the same person, is not conducive to good and proper work.

In the case under discussion the plaintiffs were both consultants and contractors. We are given to understand they drew up their own specification, and the evidence was quite clear that they failed to carry out the work in accordance with the express

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terms of the specification. That is the whole crux of the case, so far as we are concerned, and had the case been determined by these facts alone, we cannot conceive of any two opinions in the matter. Unfortunately, the case turned more upon personal matters, and as to the businesslike or unbusinesslike way in which the contractors had been treated; hence the decision in their favour. These matters would have been avoided had there in the first instance been a proper consulting engineer. He would have determined the system to be employed, the size of wires, the number of lamps on any circuit, the fuse arrangements, and, in fact, all the disputed points. There is absolutely no best system for all cases. Each case must be considered, and the most suitable selection made. Here again the necessity of employing a consulting engineer is seen to be paramount. He has no manufacturing ends to serve; he has not to consider new patterns, or the particular run of work in a factory—he simply has to decide what is the best system in the particular case, and to specify it with the required details. The contractor-engineer, on the other hand, may be biassed towards one system because more work is done by his men on that system than on any other. Reverting once more to the case, we are of the opinion that neither party showed very favourably in it, and that is just what would be expected when the safe ways of business methods are left for unsafe ways.

ALTERNATOR TESTING.

The paper by Mr. Horace F. Parshall, M.I.C.E., which, by the courtesy of the Institution of Civil Engineers, we are able to give in our columns this week, is the best contribution to electric technical literature we have seen for some time. The results of tests of two of the 385-kw. alternators now at work in the City of London Company's station at Bankside would in any case be valuable, but in this case the value is much enhanced by the complete details furnished as to the method of testing and the allocation of the losses in the machines. The Hopkinson method of testing two coupled machines was employed, and the measurement only of the power required to drive them, as motor and generator respectively, gives the most accurate test of the actual efficiency of the coupled set. The variation of the angle between the two armatures is the most novel part of the testing gear, and is a feature which enabled the actual working load factor to be varied at will. In this way, practical conditions were obtained. As will be seen, the excitation was also varied considerably in the different readings taken with each position of the coupling. The transmission dynamometer is also worthy of special note, and in this case seems to have given satisfaction. With tests of two direct-current dynamos when coupled as motor and dynamo, we prefer to add the power required to drive the combination electrically, but with alternate currents the phase difference renders the addition of electric power too difficult. The other matter and the diagrams in the paper will repay most careful study.

CORRESPONDENCE.

"One man's word is no man's word
Justice needs that both be heard."

BOOSTERS.

SIR,—In reply to letter in your last issue, I beg to state that if the alternating-current feeder regulators mentioned are mechanically and electrically well constructed, they will give complete satisfaction. They should be connected in series with the inner conductor of the feeder as shown by sketch in answer No. 11.—Yours, etc., JOHN PILLING.

SIR,—On March 23, 1896, Messrs. E. W. Cowan and A. Still read a paper before the Northern Society of Electrical Engineers dealing with the regulation of pressure on alternating-current feeders. This paper was printed fully in your journal at the time, and also in the *Minutes of Proceedings* of both the Northern and London Societies. Messrs. Cowan and Still there fully described the application of regulating transformers to feeders. These instruments are, I believe, working successfully at several electricity supply stations, among which may be mentioned St. Mary's, Islington, and the Metropolitan Electric Supply, Limited.—Yours, etc., A.

REVIEWS.

Electrical Installations. By F. J. WARDEN-STEVENS, A.I.E.E. P. A. Gibert Wood (the *Architect*). Price 2s. 6d.

The book is a reprint and rearrangement of a series of articles which have appeared in the *Architect*. The preface states that the book is intended to fulfil "the requirements of architects, borough surveyors, civil engineers, etc."; and again, "the author's aim has been to place before his readers information and principles which will be of use to them in their professional work." This is a very broad basis on which to write a book of 112 pages, and we hardly see the need for the avoidance of mathematics when the readers are to be of the above classes. Thus, while the author has compiled an interesting book giving general ideas on many subjects connected with electrical installations and special information in certain parts, he would, we are sure, agree with us that the book will not enable the gentlemen in question to dispense with expert advice in electrical matters. The first chapter deals with motive power generally, and touches on water power, steam and gas engines. The author in the latter class describes the advantages of high-speed gas-engines, and gives it as his opinion "that the faster a piston moves immediately after the explosion the greater the economy of the engine." This statement requires considerable modification, and an increase of piston speed with high-speed types of gas-engines is not always found. Also the statement that there is less need for a water-jacket at high speeds is, in our opinion, incorrect. The chapter finishes with a few particulars on boilers and feed-water heaters. The second chapter opens the electrical matter by describing dynamos. Direct-current dynamos only are treated, and the question of sparking at the commutator is the most valuable section of the chapter. Chapter III., on building, is remarkable for its brevity, consisting of three-quarters of a page of matter and a full-page illustration. We do not, however, fancy the use of a wooden building for electrical machinery in any case. The other two chapters of the first section, dealing with the generation of electricity, treat respectively of switch-gear and measuring instruments and storage. The first of these is wanting in illustrations, without which the text is not complete. The treatment of accumulators in the last chapter is more useful, and is concluded by the trite saying that "a battery, like everything else, wears out in time, but it will save many times more during its life than it costs to keep it going."

We then come to the second and larger section, on the distribution of electricity. Here, too, the want of space prevents more than a general reference in most cases. In the chapter on wiring, however, the author gives a series of estimates for completely fitting up an isolated plant

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and wire in a house requiring 100 16-c.p. lamps, with water, gas, or oil, and steam respectively as a motive power. The chapter ends with a few figures as to the working cost. In his total Mr. Warden-Stevens has not included either labour or repair of plant, which makes the totals too low and also misleading. In the chapter on illumination we find a full description of the Holophane globes, and a brief description of the diffusing powers of various coloured surfaces. We should like to see added details as to the corresponding values of light required in rooms where the colour schemes referred to are adopted. After treating of incandescent lamps, the author then gives us a chapter on electric power, which treats particularly of transmission of power in factories. After this comes particulars of special precautions to be observed in factory and theatre lighting. In this part of the book liberal and valuable extracts from the County Council regulations are included. The details as to the relative cost of private and public supplies with varying, size of installations, and their cost of working, are plotted in diagrams. From what we can see, the author has, if anything, favoured the private plant. The book is concluded by chapters on "Testing" and "Notes on Working," which are worthy of close attention. The author has attempted, as we said before, too much in a given space, and, as a consequence, his matter suffers from incompleteness in almost every department.

Steam-Boilers.—Messrs. Yates and Thom, of Blackburn, have forwarded to us their new catalogue of steam-boilers, which we cannot in justice to the firm notice only in the ordinary way. The volume in question was written and arranged by Mr. William H. Fowler, Wh.Sc., M.I.M.E., A.M.I.C.E., member of the Iron and Steel Institute, etc., and contains most valuable information on all matters pertaining to the use and construction of boilers. The volume is not a mere compilation of illustrations, with sizes and price-list of the various Yates and Thom boilers, but a series of explanatory articles are added, which will aid steam users in forming opinions and conclusions respecting the everyday problems that occur in connection with the laying down or modification of steam-raising plant. The arrangement of the matter, and the scope of the information, may be gathered from some of the headings of paragraphs which we give herewith. Thus, the question of "What's the Best Type of Boiler?" and "Points which affect the Choice," are the first two headings. The section dealing with the power of a boiler is an excellent *résumé* of the subject. Thus when the consumption of steam per indicated horse-power hour may vary from 12lb. in a good triple-expansion boiler up to 50lb. in an inefficient non-condensing engine, the absurdity of considering the value of a boiler in horse-power is manifest. The pounds of water evaporated in a given time is the only reliable method of speaking of the power of a boiler. Under the head of "The Size of a Boiler for a Given Power," the author then lays down simple rules for determining how the size of a boiler or battery of boilers should be determined, and recommends in case of difficulty due to indeterminate quantities a reference for advice to Messrs. Yates and Thom. The next division is devoted to "Boiler Efficiency," in which the ratio of grate surface to heating surface is considered. The author then takes up the question of materials to be used in boiler construction, which is followed by a section on "Evaporation Tests," which is worthy of careful reading. The questions of fuel and smoke consumption occupy three sections, which err on the side of brevity. The troubles arising from incrustation and corrosion due to bad water, etc., are carefully considered, and so are the various methods of preventing or checking the first causes. The general part of the list being finished, the boilers themselves are treated. Even in this the catalogue part is not obtrusive, owing to the detailed descriptions given of the boilers themselves and of their numerous fittings and accessories. The steam-pipe arrangements in the Portsmouth electricity station are particularly illustrated. The various types of boilers described are too numerous for individual mention here, and for this we would refer our readers to the volume before us, which should find a place in the books of reference.

FORTHCOMING EVENTS.

The following are some of the announcements for the forthcoming week:

To-Day (Friday).—London Chamber of Commerce, distribution of prizes and certificates at the Mansion House, 3 p.m.—Institute of Electrical Engineers, extra meeting at the rooms of the Chemical Society, Burlington House ("Accumulator Traction on Rails and Ordinary Roads," by Mr. L. Epstein; continuation of discussion). — Civil Engineers, students' meeting, 8 p.m. ("The Elastic Properties of Steel Wire," by Mr. A. D. Keigwin, and "The Elasticity of Portland Cement," by Mr. W. L. Brown).—Crystal Palace Company's School of Practical Engineering, award of certificates at the Crystal Palace, 12 30 p.m.

Monday, December 20.—Imperial Institute, 9 p.m., Mr. Boverton Redwood on "The Petroleum Resources of the British Empire."

THE MANAGEMENT OF BOILERS AND STEAM PLANT, INCLUDING DETAILS OF STEAM PIPES AND FITTINGS.*

BY A. B. MOUNTAIN, BOROUGH ELECTRICAL ENGINEER, HUDDERSFIELD.

During the last few years many exceedingly interesting papers have been read before learned societies upon steam-generating appliances. These papers have, however, in most cases conveyed the manufacturer's experience of his own plant. It is, therefore, the author's intention to place before the society his experience with various types of steam generators. The idea which animates each individual when experimenting with a new form of steam-boiler is, if possible, to utilise more of the heat generated by the fuel consumed. When it is considered that only about 50 per cent. of the units of heat in the fuel are utilised, it may be said that the best results obtained are far from those which may reasonably be expected. It is not necessary to discuss the ancient form of steam-boilers when pressures of 40lb. or 50lb. per square inch were in use. It may certainly be taken that no modern works would be constructed in which the steam pressure would be less than 120lb. per square inch; in most cases it would no doubt be from 150lb. to 200lb. per square inch.

The class of load upon the boiler in a very large measure affects the design. If the works to be constructed will require about the same quantity of steam for a considerable number of consecutive hours, then the heat expended in raising a large body of water to the desired temperature is not such an important matter as it would be if the steam was required for a short time only, as is the case in an electricity works, where the load varies to an extent perhaps unknown to all but those connected with dyeworks; and in this case the boilers are under full steam for about 10 hours per day at regular stated times, and although the quantity of steam required varies considerably, it is usual to signal when a demand is needed, whereas in an electricity works the supply of steam depends upon the demand for energy which is delivered to consumers at a considerable distance from the works, who are quite unable to control the use of their lights, as atmospheric conditions vary so rapidly. It is often necessary, owing to a thunderstorm or sudden fog, to require 20 times the quantity of steam in a very few minutes; this unusual demand must therefore be considered when selecting the type of boiler. Unfortunately, an engineer, when considering what type of boiler to adopt, is forced to look very carefully at the commercial side of the question. He must obtain a boiler which will evaporate the largest quantity of water with the smallest quantity of fuel, and he must not forget that the boiler must evaporate the largest quantity of water per pound of capital invested, and this should be considered in its widest sense; not only the actual cost of the boilers, but the additional cost of buildings, value of extra grounds etc., should be added so that the true commercial value may be ascertained.

The question of maintenance is closely connected with the commercial consideration. One of the most important points, and one which influences the commercial side of the question very largely, is the failure of the boiler from any defects. This not only causes loss due to the cost of repairs, but necessitates holding in reserve another boiler, as the electricity supply cannot be stopped in the same way work of another kind might be; and the length of time required for cleaning is another point which seriously affects the cost of maintenance. It is impossible to consider the type of boiler most suitable for any works without most carefully investigating the water it is proposed to use, and the ultimate effect of this upon the boiler. As an example, assume that the water to be used has in solution a considerable quantity of lime. This would, when heated, throw the lime down in the form of a thick scale; and it would, therefore, be

* Paper read before the Northern Society of Electrical Engineers.

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Type of boiler.	Floor space occupied. Feet.	Water capacity in pounds.	Steam capacity in cubic feet.	Economiser evaporation. From	To	Pounds of water evaporated from and at 212deg. F. per pound of coal consumed.	Heating surface. Feet.	Temperature of gases leaving boiler when working economically.	Price per boiler including setting and fitting without mechanical stokers.	Cost of buildings and ground at £2 per foot.	Price in £ per 100lb. of water economically evaporated.
Water-tube	180	17,500	200	6 500	9,000	11·5	1,827	350	565	360	14·2
Lancashire	360	43.000	200	6,600	7,500	10 0	1,050	600	575	720	19·7
Lancashire with economiser...	410	76,000	260	6,500	9,000	12·0	1,770	250	725	820	23·3
Locomotive	150	22,000	200	6,500	7,500	11·0	1,500	600	675	300	15·0
Dry-back marine	160	25,000	220	6,500	7,500	11·0	1,650	600	645	320	14·5
Marine	150	17,000	180	6,500	7,500	11·0	1,500	600	675	300	15

most unsuitable for feeding direct to a boiler of the water-tube type, as it would be difficult to remove the scale, and it would, therefore, increase very considerably the cost of maintenance and decrease the evaporative power of the boiler. It is, therefore, very desirable to have the water carefully analysed, and ascertain as nearly as possible its effects upon each type of boiler proposed to be employed. For the purpose of comparison it will be advisable to assume some data. Therefore, take the case of an imaginary electricity works for a small town requiring a sufficient quantity of steam ultimately to drive engines having a total of 5,000 i.h.p. Allowing 25lb. of steam per horse-power, the total evaporation of water would require to be at the rate of 125,000lb. per hour. It will now be necessary to decide how many boilers shall be used and the power of each. Therefore, it will be desirable to ascertain what quantity of steam would be required during the daytime, and, taking other towns as an example, it would be safe to estimate that the day load during the summer months would not exceed 200 i.h.p., or 5,000lb. of water per hour. It is clear, therefore, that the boilers must be divided, so that one can run this small load efficiently ; and 6,500lb. may, therefore, be taken as about the evaporation which would be required from each boiler.

The next question is, what kind of water is to be used, it being assumed that the engines to be used are condensing, and that surface condensers will be employed, the water being fed to the boilers from the hot-well. There are three sources of supply usually : the corporation town supply, the canal, and possibly a river or stream. The town supply is clean, but expensive ; the canal water is, as a rule, cheap, fairly clean, and is, in fact, usually rain-water collected, and, therefore, very suitable. The river, supposing one to exist, if situated in Yorkshire or Lancashire, would not of necessity be clean, and it would be necessary to construct a pond, which would require a large capital outlay. Having carefully considered the subject, imagine the canal water was found most suitable and used for condensing purposes, and for making-up the small quantity of feed water required to replace that lost. It would be clear that the water used being condensed would be soft and suitable for any form of boiler which might be adopted.

The next consideration would be the cost of boilers and space to be occupied, and imagine tenders were obtained for the boilers with fittings. The table given above shows approximately the particulars and prices for each type. From the figures it will be observed that the water-tube type is the lowest in price, and it has the great advantage of being a steam generator which may without detriment be forced far beyond its usual limit, and without to any great extent reducing its efficiency. It is particularly safe, and specially suitable for employment where high steam pressure is required. It will be noticed that the evaporation per pound of coal is high, and from tests made by the author he has seen these figures obtained repeatedly, but the boiler must be kept thoroughly clean ; and it is surprising how quickly the evaporative power of the boiler decreases if the cleaning is not carefully done. The fact that the water and steam space is small is a point both for and against the boiler. It requires less fuel to heat up a small amount of water than a larger quantity would require ; and there is practically no limit to the speed with which steam can be raised should another boiler be suddenly needed, but it necessitates careful attention to keep the steam pressure constant. One strong point in favour of the water-tube boiler is its very perfect circulation, which means that practically all the water in the boiler is at very nearly the same temperature. Further, in case of failure in the supply of feed water it is possible to run for a considerable time without doing any serious damage, as the active tubes are directly over the fire and are at the base of the boiler.

The dry-back marine, or economiser type of boiler, occupies very small space, practically no setting, and is being used in several electricity works with very good results. It cannot be so rapidly forced as the water-tube type, and a longer time must be allowed for getting up steam, as the circulation is not so good. Like the water-tube boiler, it must be kept very clean if really good results are to be obtained. It is not so easy to clean or inspect the interior as either the water-tube or Lancashire type, and, in the author's opinion, is not so safe. The marine boiler is being used in some electricity works, and has the advantage of requiring very little setting, occupies small space, and is a rapid steam raiser. It is, however, a type of boiler which requires considerable attention, cleaning, and repairs. The locomotive boiler is also being used in some electricity works. It requires practically no setting, occupies small space, and is a rapid steam raiser. Like the marine boiler, it must be most carefully cleaned, and the cost of maintenance is comparatively high. The Lancashire boiler is used in about three-quarters of the electricity works at present constructed. It, however, occupies a considerable amount of floor space, requires an extensive brickwork setting, and is not very efficient. It is usual, however, to combine with the Lancashire boiler some form of economiser for utilising the heat of the gases after they have left the flues of the boiler. The addition of the economiser considerably increases the cost of the boiler, and practically makes it the most expensive type to adopt, but it undoubtedly has many advantages. It has a large water and steam space ; it requires less attention than any other form of boiler, and can be easily inspected and cleaned. One of its chief disadvantages is the length of time required to raise steam ; although this can be done within two hours, it is usual to allow fully five hours, so that the boiler may be gradually warmed up. Another point against this type of boiler is its bad circulation. It may be practically cold at the bottom for hours after steam has been raised. Further, should the feed water be stopped from any accidental cause, great care must be taken that it does not fall below the top of the furnace, or the results may be very serious, as the furnace top would become heated and possibly collapse.

Having regard to the varying demand for steam in an electricity works, the author is of opinion that the water-tube is the type of boiler specially suitable for adoption at the commencement of an undertaking, and that as the load upon the works increases, Lancashire boilers with economisers should be added, so that the continuous load may be supplied from them, and the water-tube boilers forced during the period of heavy load. In this way it is possible to reduce the number of boilers employed, and consequently make a considerable reduction in the capital outlay. It would, however, be extremely unprofitable to employ Lancashire boilers without utilising in some manner the heat of the gases leaving the flues. Several methods have been devised for utilising this heat. It may be employed for superheating the steam, for heating the feed water, or the gases may be passed through another fire. If it is desired to heat the steam a large number of small tubes are usually arranged at the back of the boiler, through which the hot gases have to pass. The amount of superheating required is regulated by the number of tubes attached to each boiler. The economiser or feed-water heater usually adopted consists of a large number of pipes fixed in the main flue, the cold water being fed into the bottom of the pipes, and passing from the top to the boiler. The hot gases, on their way to the chimney, passing through the tubes heat up the water to a very considerable extent. This apparatus has a further advantage : the water in passing very slowly through the tubes becomes heated, leaving a considerable amount of deposit in the economiser, which would otherwise find its way into the boilers. Many different arrangements have been carried out, but it is advisable, in the author's opinion, to arrange for the gases to pass the tubes as much as possible in parallel and not in series. As an example, the temperature of the gases in the main flue at the back of a Lancashire boiler, when working under economical conditions, is at about 600deg. F., and, after passing through an economiser consisting, say, of 36 tubes in length and eight in width, would be about 250deg. F. If it was necessary to reduce the number of tubes, it would be much better to decrease the length of 36 tubes to 18 than the width of eight to four, as in practice it is found that the first few rows upon which the heated gases impinge are doing the bulk of the work, and that the tubes nearest the chimney are doing very little.

There is, however, an important point often overlooked when considering an economiser or steam superheater and its value,

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and that is the draught of the chimney. It is perfectly clear that if the temperature of the gases at the base of the chimney is lowered from 600deg. to 250deg., the draught of the chimney must also be very considerably reduced. There are many who hold the opinion that the temperature of the gases at the base of the chimney should not be below 400deg. F. In the author's opinion, it is advisable to have a forced draught and let the heated gases be drawn more slowly away, and that the heat utilised in raising the temperature of the feed water is productive of greater economy than if allowed to increase the draught of the chimney.

Having decided to adopt water-tube and Lancashire boilers, it is necessary to arrange the fittings and the question as to whether the boilers should be fired by hand or with mechanical stokers. Closely connected with this is the question as to what kind of fuel is to be used. It may be considered as settled that smoke in any considerable quantity will not be permitted to rise from the chimney top. With water-tube boilers it is difficult to stop smoke, if hand fired, unless a very hard steam coal can be obtained. The flames rising from the fire come into contact with the cool tubes, and are to a great extent extinguished, causing smoke. If coke can be bought at a reasonable price, excellent results may be obtained, and the smoke nuisance entirely removed; but coke has the disadvantage of requiring a very thick fire to stop the air rushing through, and a considerable quantity is usually thrown into the furnace when firing. This cools down the boiler, and reduces for a short time the generation of steam. Then when the charge is being rapidly consumed, the steam is generated at a very rapid rate; if one boiler is used, it therefore requires careful firing to keep a steady steam pressure, but if several boilers are used in combination, it is very easy to fire alternately. If coke cannot be obtained cheaply, and the ordinary bituminous slack has to be used, it is necessary to fix mechanical stokers, otherwise there will be considerable trouble with smoke; and, in the author's opinion, the coking form of stoker is the only form which can be fixed to a water-tube boiler with any certainty of success. The firing of the Lancashire boiler does not require the same care as the water-tube, as the flame from the fire passes over the bridge and helps to ignite any gases which may be passing away unconsumed; and as the flues are connected underneath the boiler, the flame from one fire assists in the combustion of the gases from the other fire. Mechanical stokers have, however, a great advantage over hand firing, in the fact that the class of fuel may be very considerably reduced in quality and consequently in price. It is not necessary to fix the coking form of stoker upon a Lancashire boiler; the sprinkling form of stoker will do equally well, and has certain advantages. It more easily admits of the fire being forced, which in an electricity works is an important point. The heat generated is distributed over the whole length of the bar, whereas in the coking form of stoker the heat is confined to a small portion of the fire, and the damage to the bars is considerable; and the author is of the opinion that the maintenance of the coking stoker is considerably higher than the maintenance of the sprinkling type. There are many other patent furnaces in which it is claimed exceedingly good results may be obtained. In most of these a jet of dry steam is blown through a nozzle or pipe acting as an injector, and increasing the pressure of air underneath the fire. This undoubtedly increases the rate at which the fuel may be consumed, and the steam passing through the fire forms water gas and adds considerably to the heat. If fuel of a very poor quality is to be consumed, a furnace of this type may with advantage be employed, but the author is not sure that there is not a limit to the heat which may be usefully employed in the furnace, and that harm is done to the plates or tubes if this is exceeded. From actual experience he has found damage result from such a furnace when employed in connection with a water-tube boiler.

While considering the firing of boilers, it may be well to notice some of the large number of so-called smoke-consuming devices. These, in many cases, are simply arrangements for admitting a large quantity of air, which only dilutes the smoke and reduces the heat of the furnace gases; and it is well to be very careful before adopting these arrangements. Undoubtedly the results in a furnace in which coke is used can be very much improved by the admission of a secondary supply of air, but this should be supplied to the top as well as the bottom of the fire, and should, if possible, be hot, and so arranged that the air may be admitted in varying quantities. If it is proposed to adopt a furnace of this kind, having a secondary air supply, it is advisable to fix an instrument which will indicate at any moment the condition of the gases leaving the furnace, and consequently show when the air should be admitted and in what quantity. It is no doubt unnecessary to point out that theoretically the gases leaving the furnace should consist of as much carbon dioxide as possible, together with water vapour and nitrogen. This it is, however, impossible to obtain in practice, and it will usually be found that the best results are obtained when about 20 per cent. of carbon dioxide is present, but the author would strongly urge the importance of employing any one of the many methods of recording the condition of the gases leaving the furnace. An excess of air simply reduces the temperature of the gases, and reduces the evaporative results. On the other hand, if there is not enough air, the oxygen required for complete combustion is restricted, and carbon monoxide is allowed to leave the furnace without being converted into carbon dioxide. The use of induced draught instead of forced has lately been tried in connection with marine boilers at some electricity works with apparently satisfactory results. It is, however, questionable whether the draught induced by a fan drawing away the products of combustion at an extremely high temperature, and therefore much expanded, could not be more economically produced by a steam jet. Undoubtedly, the idea of introducing hot air instead of cold is one of the causes of the success obtained with induced draught, and the author has found that this may be readily accomplished, either with the water-tube or Lancashire type of boiler, by forming a division in the walls of the boiler seating, through which the cold air passes on its way to the furnace. This not only heats the air, but keeps the outer wall of the seating cool, and thus prevents wasteful radiation of heat. The subject of coal elevating and conveying machinery, although somewhat outside the scope of this paper, is too interesting to be passed without comment. The first question to decide is, when it will be advisable to put in elevating and feeding machinery. The author is of opinion that it should not be fixed until the work exceeds the power of three men upon the heavy shift, or, in other words, until the wages saved will go a considerable way towards paying the interest upon the capital expended. As to the most suitable arrangements for feeding the fuel to the hoppers of the stokers, this must depend to a very large extent upon the arrangement of the works, and the manner in which the fuel is delivered to the works. Whatever method is adopted, the fuel should be weighed into each hopper in the same manner as the coal in a gasworks is weighed and fed into the retorts; and if ash-elevating arrangements are devised, it is most desirable to know exactly the proportion of ashes per ton of fuel used.

(To be continued.)

INTER-RELATION OF LIGHT AND THOUGHT.

An interesting and possibly important discovery is announced by Mr. Howard Swan, of Arundel-street, Strand, who was until recently connected with this journal, which we mention at present as a matter of priority. After a long course of experiments Mr. Swan has found that a certain faint, slow-moving phosphorescence, to be observed with suitable precautions in the dark room, within the eyeball or optic nerve (hitherto thought to be due to the circulation of the blood) is sensitive to sound vibrations, being thrown into various movements which are subject to laws, some of which he has determined by experiment. Musical sounds produce the strongest effect. When the sound is a definite word, a tendency can be noticed for the phosphorescent film or slow-moving vortex ring to form patterns more or less geometric. The results of the experiments have been shown to various scientific men, and have awakened considerable interest, as the possibility is suggested that the discovery is one of the circulation in the nervous system. The fact that the movements of the phosphorescent rings takes place probably on the inner side of the retina, or within the optic nerve, make the experiment in one sense subjective; but as the movements can be watched much as radiation experiments, by the observer, they are evidently to this extent objective. The variation of apparent luminosity and of speed of movement may possibly be subjected to mathematical treatment, and the fact that the patterns are to some extent under control of the will by the choice of words and sounds, gives a suggested inter-relationship of the vibratory forces with the mental activity of thought, which conceivably may open vast and as yet little explored fields of research.

ELECTRICAL FITTINGS.

We have received from the Edison-Swan United Electric Light Company, Limited, a copy of the sixth section of their catalogue, which deals with fancy fittings, electroliers, brackets, etc., for electric lighting purposes. The company insert a note in the commencement to say that they have artist-designers at the disposal of the trade who will prepare designs to correspond with special architectural features and decorations of a building. The company's new factory at Walsall, near Birmingham, is now busy meeting the demand for these fittings and accessories. We give herewith a few illustrations

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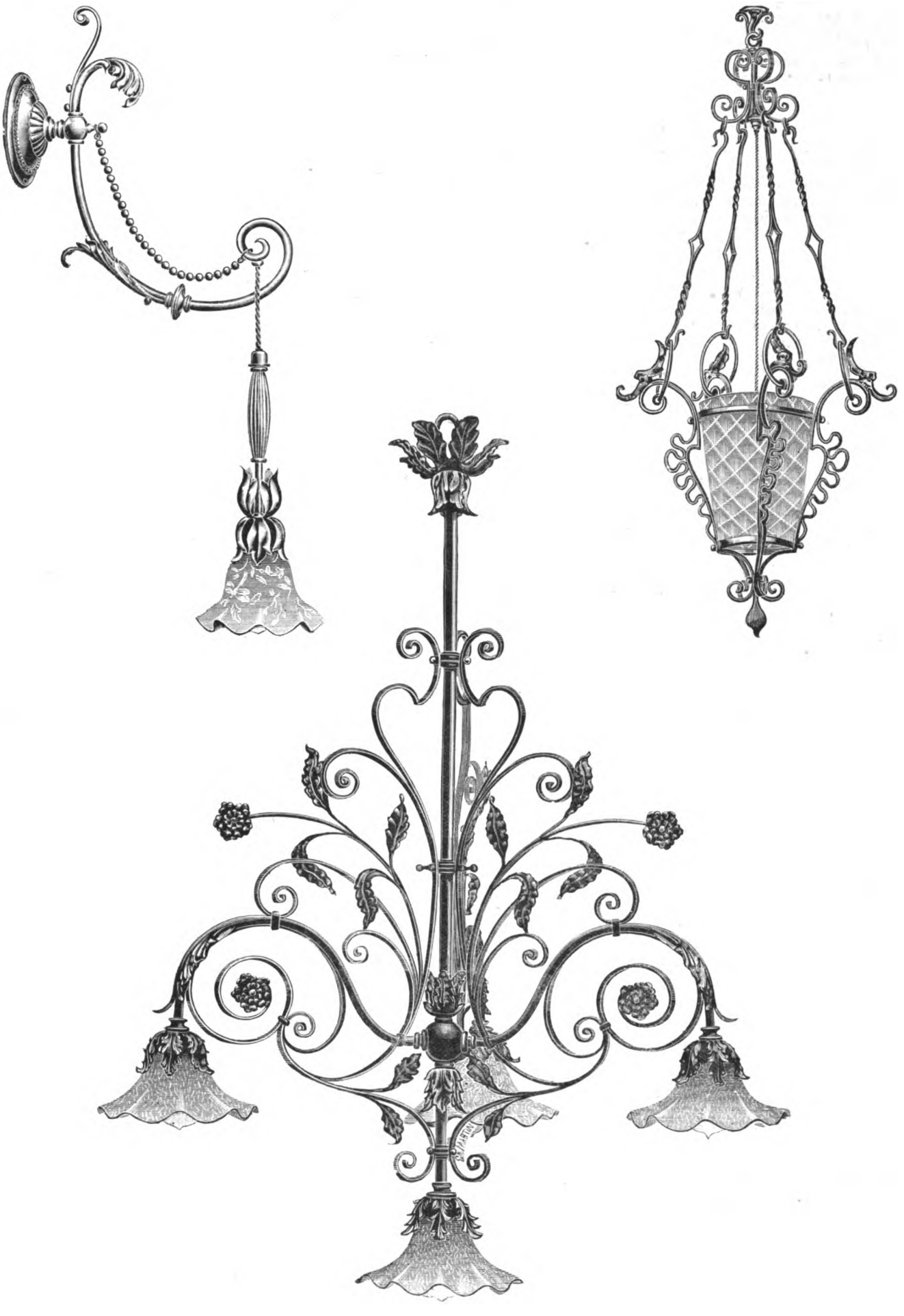
of some new types of fittings, but these types are always being added to, and hence it is difficult to keep the lists up to date. The catalogue now before us gives a good idea of the range of fittings manufactured, as these vary from a simple bracket at 1s. 6d. up to a pair of bronze candelabras at £264. In wrought-iron work we notice several new and very neat designs, while in pendants there are many novelties in this list.



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QUESTIONS AND ANSWERS.

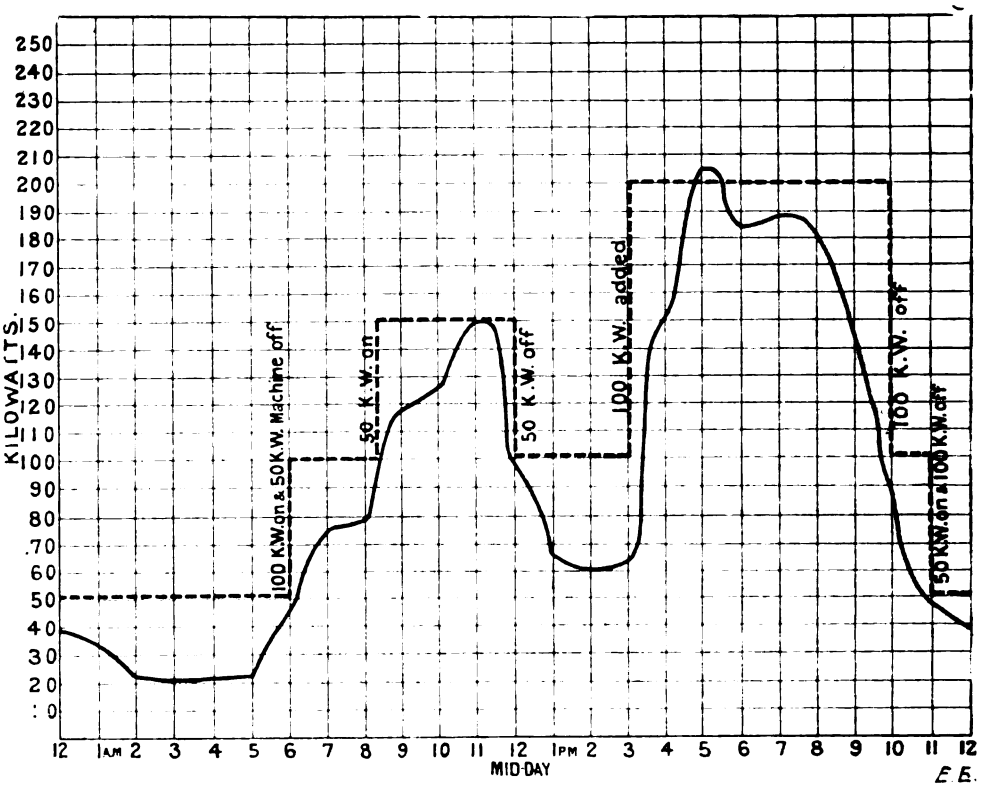
Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We shall also in future give *two shillings and sixpence* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared, and should be written on one side of the paper only. Questions may be sent at any time.

QUESTIONS.

20. Give reasons for and against the use of flywheels with tramway generators.—ARTHUR C. NASH.

21. What are the advantages and disadvantages of mechanical stokers in connection with the boilers in electricity works?—J. POWNALL.

LOAD DIAGRAM (W. WYLD).



N.B.—Recording ammeter and steam gauge charts to be attached. Dotted lines indicate machines running.

ANSWERS.

Question No. 15.—Draw up a form such as you would advise being filled in each day, and present to the chief engineer, to show the results of the day's working.

Best Answer to No. 15 (*awarded* 10*s.*)—

DAILY REPORT AND LOAD DIAGRAMS.

.....day, the.....day of....., 189...

Output.	Calculated.	Metered.
Circuit 1	.....	.....
„ 2	.....	.....
„ 3	.....	.....
„ 4	.....	.....
„ 5	.....	.....
„ 6	.....	.....
Total...	.....	.....

Public Arcs.

From.....to..... = ...hours.....lamps = ...units.

Maximum load = ...kilowatts at .....p.m.

Fuel.	Tons.	Cwt.	Per unit output.
Coal.....	.....	.....	.....lb.
Water.....	gallons		.....lb.

Lbs. of water per lb. of fuel = ...

Oil. Engine.....gallons, cylinder.....gallons.

Report on condition of plant and repairs required:

Remarks:

	From.	To.	Name.
Engineer-in-charge.....	.....	.....	.....
„ „	.....	.....	.....
„ „	.....	.....	.....

Signature.....

—W. WYLD, A.I.E.E.

Answer to No. 15 (*awarded* 2*s.* 6*d.*).—I presume this is for a large station where the "chief" cannot supervise to any extent himself, and also that the form is not to include entries of times of inspections of plant, boilers, etc., as this indicates that a sort of watchman's time-check is required for the assistant, or he will otherwise neglect his work. This is done in several central stations with which I am acquainted, and as much dissatisfaction and bad feeling is caused I would not recommend this. To find out the result of working of a central station, the chief points required are coal, oil, water, and stores, units generated, load factor. I would suggest that the day should be divided into shifts, and the results given for each shift.

FOR SHIFT.

.... 189...

..... Shift.

Boiler-House.

Coal used { for lighting up..... / „ banking ..... / „ running ..... } Stoker .....

Water ... { at...galls. reading... / at... „ „ / at...galls. used..... } Pounds of water evaporated per pound of coal = ...

Height of water in tanks at end of shift—

No. 1 .....

No. 2 .....

Etc. .....

Boilers running ..... { No. 1 from...to... = ... hours. / No. 2, etc. „ ...to... = ... hours. }

Total .... „

Notes.—For reports of defects in plant, conditions of plant, remarks as to quality of coal, smoke, and stores given out, and any special conditions, etc.

Engine-House.

Pounds of water evaporated / Units generated..... } Pounds of water per unit.....

Plant running ..... { No. 1 from ..... to ..... hours / No. 2, etc., „ ..... to ..... hours. }

Total plant-hours ....

Horse-power hours for running plant alone .....

= .....kilowatt-hours.

Units generated..... / „ to mains ..... / „ to battery ..... / „ from battery ..... } Pounds of water per unit generated. .....

Maximum load.....amperes. Load factor.....per cent.

Notes.—For reports of defects in plant, steam-pipes, etc., condition of steam, earths on mains, etc., condition of battery, stores, oil, etc., given out.

(Signed).....

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WHOLE DAY.

..... 189 .....

Boilers.

Coal used..... } pounds of water
Water used—*i.e.*, evaporated... } per pound of coal =

Stokers { Shift 1 .....
„ 2 .....
„ 3 .....

Boilers running { No.....from.....to..... } boiler hours
„ ..... „ ..... „ ..... } total.
„ ..... „ ..... „ ..... } .....

Notes.—

Engine-House.

Units generated ..... } pounds of steam per
Steam used ..... } unit = ...

Plant running { No.....from.....to..... } Total plant-
„ ..... „ ..... „ ..... } hours.
„ ..... „ ..... „ ..... } .....

H.P.-hours for running plant alone..... = kw.-hours....

Units generated..... }
„ to mains ..... } Max. load .....amperes.
„ battery..... } Load factor .....per cent.
„ from battery ..... }

Notes.—

(Signed) .....

It has been assumed that there is a separate book for currents to mains, say, every half-hour, and to battery, etc., with maximum discharge, also currents from machines (approx.) if thought fit. The information asked for also assumes that coal is weighed and water measured on its way to boilers, as this should be done. The notes, etc., can be passed on to fitter, so that defects can be remedied, and there will be no need for verbal complaint and doubts as to whether certain defects were reported, as this often leads to unpleasantness when the "chief" has a bad memory.—W. FENNELL.

Question No. 16.—When counter E.M.F. cells are used to reduce the pressure of supply, in what form is the energy lost?—H. M.

Best Answer to No. 16 (*awarded* 10*s.*).—Counter E.M.F. cells usually consist of lead plates immersed in acidulated water; they are, in fact, unformed Planté cells, and give an effective back E.M.F. of about 2½ volts. The electrical energy is converted (or lost for useful purposes) into chemical energy in the form of hydrogen and oxygen gases evolved at the plates by the decomposition of water. In new cells the oxygen will rapidly attack the plates, but as these become covered with peroxide this action will almost entirely cease, all the gas rising to the surface of the liquid, and no energy will then be expended in chemical action on the plates. A certain amount of energy will be converted into heat by the passage of the current through the cell, this varying directly with the ohmic resistance of the cell. Cells formed of metal plates (such as zinc) in a solution of their sulphates offer practically only an ohmic resistance to the current, and give no back E.M.F.—ADRIAN JONES.

INSTITUTION OF ELECTRICAL ENGINEERS.

At the annual general meeting of the Institution held on the 9th inst., the following report of the Council was presented:

Elections and Transfers.—The total of the additions to the register during the year has been 216, comprising 3 foreign members, 17 members, 120 associates, and 76 students, and 53 candidates have been approved for ballot next month; 24 associates have been transferred to the class of members, and 82 students to the class of associates.

Deaths and Resignations.—The losses sustained by the Institution during the year through death amount to 22—viz, two honorary members (Mr. Jacob Brett, Dr. Von Stephan); two foreign members (Dr. W. P. Brix, G. Verier); six members (John Aylmer, W. S. Graff-Baker, W. H. Blakeney, W. W. Cargill, H. C. Forde, W. Moir); ten associates (J. Auchinachie, E. V. Andersen, L. H. Chase, Paul Dimier, Captain A. B. Hawes, F. Lilley, E. Oldroyd, A. E. Pond, G. H. Thornton, T. B. Webber); and two students (Edward Ray and C. Yatman). Special allusion has previously been made to Mr. Jacob Brett, whose name must always be remembered as that of one of the very earliest pioneers in telegraphy and as one of the founders of submarine telegraphy; to Dr. Von Stephan, who, in his position of Postmaster-General of Germany, did so much for telegraphic science; and to Mr. John Aylmer, one of the most zealous and indefatigable of the Institution's local honorary secretaries. Mr. H. C. Forde was one of the original members, and a former member of Council. His name was very prominently connected with submarine telegraphy, and his death was deeply deplored by all who knew him. Two foreign members, two members, 20 associates, and six students have resigned during the year.

Papers.—In addition to the very interesting inaugural address of the President, the following papers have been read during the year: January 28, "Electrically Interlocking the Block and Mechanical Signals on Railways," by F. T. Hollins (member); February 25, "The Relative Size, Weight, and Price of Dynamo-Electric Machines," by E. Wilson (member); March 11, "On Some Repairs to the South American Company's Cable off Cape Verde in 1893 and 1895," by H. Benest (associate); April 8, "Some Recent Developments in Electric Traction Appliances," by A. K. Baylor; April 22, "The Generation of Electrical Energy for Tramways," by J. S Raworth (member); May 13, "The Disturbance of Submarine Cable Working by Electric Tramways," by A. P. Trotter (member); May 27 'Dynamoes," by W. M. Mordey (member); and November 11, 'Accumulator Traction on Rails and Ordinary Roads," by L. Epstein (member).

Annual Premiums—In respect of papers read during the session 1896 97 the Council make the following awards—viz., the Institution premium, value £10, to Mr. W. M. Mordey (member) for his paper entitled "Dynamoes"; the Paris Electrical Exhibition premium, value £5, to Mr. John Gavey (member) for his paper on "The Telephone Trunk Line System in Great Britain"; the Fahie premium (value £5) to Mr. Benest (associate) for his paper on "Some Repairs to the South American Company's Cable off Cape Verde in 1893 and 1895." They also award an extra premium of £5 to Mr. A. P. Trotter (member) for his paper on "The Disturbance of Submarine Cable Working by Electric Tramways." The students' premium (value £3 3s.) they award to Mr. P. S. Sheardown for his paper entitled "Notes on Electric Tramway Traction" and they further award two extra premiums of £2. 2s. each to Mr. F. Johnston for his paper on "Accumulators" and Messrs. R. M. Sayers and S. S. Grant for their paper on "The Working of Long Submarine Cables." The Council desire to remind members of the increase which they have decided to make in the number and values of the annual premiums, commencing with the session 1897-98—viz., the Institution premium, to be increased from £10 to £25; the Paris Electrical Exhibition premium, from £5 to £10; the Fahie premium, from £5 to £10; two additional premiums for original communications not read but accepted for publication in the *Journal* of the Institution—viz., one of £10 and one of £5; for papers by students read at the students' meetings, one premium of £10 and two premiums of £5 each

The Willans Premium.—Looking to the fact that the award of this premium is, according to the trust, to be made triennially, your Council—by whom the first award is to be made—have considered themselves justified in selecting for such award any one of the papers on the subject specified in the trust deed which have been communicated to the Institution since December, 1894, the date of the trust being January, 1895; and they accordingly award the premium, the value of which they have increased to £25, to Mr. Mark Robinson (member) for his paper entitled "On the Recent Development of the Single-Acting High Speed Engine for Central-Station Work," read May 9, 1895.

Salomons Scholarship.—The Council have awarded a Salomons Scholarship of £50 to Mr. Edward Ernest Tasker, a student of the Technical College, Finsbury.

Students' Class.—The Council are glad to be able to report that the improvement in the merits of the papers read at the students' meetings to which they alluded last year was sustained during the past session. Visits to the following places were arranged for the students by your secretary during the year—viz, the works of the Electric Welding Company, the works of the India Rubber, Gutta Percha, and Telegraph Works Company, the works of Willans and Robinson, the stations of the City and South London Railway, the central electric lighting station, Islington, the electric lighting works of the Great Eastern Railway. The Council have pleasure in acknowledging the facilities thus kindly afforded to the students of visiting works of so much interest to them.

Wiring Rules.—The new wiring rules as finally approved by the Council were issued at the end of July last. The revision of the former rules was carried out by the Technical Committee, comprising the whole of the Council and some other members whose experience was such as to render their advice and assistance of special value. The committee and its sub-committee held many meetings, and obtained both by personal interviews and by correspondence very valuable information and opinions not only from municipal engineers and the engineers of electric lighting and power stations, but from the leading manufacturers of cables and apparatus. The rules consequently are based upon the experience and knowledge of representatives of all classes in the electrical profession and the electrical industry, and can scarcely fail therefore to be of material service to all who are engaged or interested in the employment of electric energy for lighting, heating, or motive power, etc. Although in certain respects somewhat more detailed than the old rules, they are not intended to take the place of specifications drawn up by consulting engineers, or to be regarded as other than an enunciation of the general principles

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which should be observed in the wiring for the supply of electrical energy.

Annual Dinner.—The annual dinner was this year held at the Hotel Cecil on November 24, and the number of members present was larger than usual.

Annual Conversazione.—The conversazione this year was, by permission of the trustees of the British Museum, held in the galleries of the Natural History Museum, South Kensington, and was very numerously attended. Much of the success of the entertainment was due to the temporary installation of the electric light for the occasion by the Kensington and Knightsbridge Electric Lighting Company, who, at the request of the Council, kindly undertook to carry out the work at a minimum of cost to the Institution. Your Council are glad of this opportunity of acknowledging their indebtedness to their colleague, Mr. H. W. Miller, the engineer to the company, for the great amount of trouble taken by him personally in respect of the work, which had to be carried out under considerable difficulties.

Building Fund.—The amount standing to the credit of this account at the date of the last annual general meeting was £3,528. 4s. 2d. This year the Council, in pursuance of the desire unanimously expressed by the members that the fund should be augmented from time to time as far as the finances will permit, have transferred to it from the general fund a further sum of £1,000 out of the surpluses of 1895 and 1896, which sum, together with dividends and income tax recovered, brings the total amount standing to the credit of the fund on September 30 last up to £4,639. 13s. 7d., of which £63. 15s. 11d. remains to be invested.

Annual Accounts and Financial Position.—The statement of accounts and balance-sheet for the year ending September 30, 1897, shows that the financial position of the Institution continues sound and satisfactory, the excess of the receipts over expenditure during the year being £1,080. 11s. A further amount of £185. 1s. 9d. has been invested on account of life compositions, leaving, at the date up to which the accounts were made up, a balance of £131. 6s. 5d., which has since been also invested. The Council have the satisfaction of reporting that the amount already received in respect of subscriptions outstanding on September 30, 1896, exceeds the estimate made in the last annual report—viz., £532. The estimated realisable amount of subscriptions outstanding on September 30, 1897, was £555, and none of this is taken into account in the balance-sheet now presented.

The Secretaryship.—On March 25 last your President announced that Mr. Webb desired to retire in February next from the office of secretary, which he will then have held for a period of 20 years. The applications received in response to the advertisement inserted in the technical journals for a successor to Mr. Webb were 48 in number, and were very carefully considered by a committee specially appointed by the Council, and certain of the candidates whose qualifications appeared to best meet the requirements were personally interviewed by the committee in the first place and subsequently by the Council, who finally selected Mr. Walter George McMillan, F.I.C., F.C.S., late lecturer on metallurgy at Mason College, Birmingham. Although Mr. McMillan will not actually take office until February 12, his engagement commenced on October 1, so that he might have ample time to make himself acquainted with the duties of his office. The Council feel that they would be failing in their duty were they to omit to place on record their high appreciation of Mr. Webb's services to the Institution during the best years of his life. While they respect his single-mindedness, his high personal character, and those qualities which have made every member a friend, they deeply deplore the loss of his services.

The **President** then moved the adoption of the report of the Council and the statement of accounts and balance-sheet for the year ending September 30, 1897, which were carried.

The following resolution, moved by the **President**, seconded by **Major S. Flood Page**, and supported by **Prof. S. P. Thompson (V.P.)**, **Mr. Langdon**, **Prof. Perry**, and **Mr. Mordey**, was unanimously carried: "That in further recognition of his valuable services to the Institution during the past 20 years, a pension of £300 per annum be allowed to Mr. F. H. Webb on his retirement from the office of secretary."

Votes of thanks were unanimously accorded to the Institution of Civil Engineers, the local honorary secretaries, the honorary treasurer (Prof. Ayrton), the honorary auditors (Mr. F. C. Danvers and Mr. A. Stroh), and the honorary solicitors (Messrs. Wilson, Bristow, and Carpmael).

The **President** announced that the scrutineers reported the following gentlemen to have been duly elected as president, council, and officers for the year 1898:

President.—Joseph W. Swan, F.R.S.

Vice-Presidents.—Prof. S. P. Thompson, D.Sc., F.R.S.; Prof. John Perry, D.Sc., F.R.S.; Mr. W. E. Langdon; and Mr. James Swinburne.

Ordinary Members of Council.—Mr. S. L. Brunton; Prof. J. A. Ewing, F.R.S.; Mr. W. P. J. Fawcus; Major R. Hippisley, R.E.; Prof. J. A. Fleming, M.A., F.R.S.; Mr. E. Manville; Mr. John S. Raworth; Mr. Dane Sinclair; Mr. Herbert Taylor; Mr. Charles Henry Wordingham; Mr. Henry Edmunds; Mr. Robert Kaye Gray; Mr. P. V. Luke, C.I.E.; Mr. W. M. Mordey; and Mr. A. A. Campbell Swinton.

Associate Members of Council.—Mr. H. W. Miller; Mr. Sydney Morse; and Mr. Sydney Evershed.

Honorary Auditors.—Mr. Frederick C. Danvers and Mr. E. Garcke.

Honorary Treasurer.—Prof. W. E. Ayrton, F.R.S. (past-president.

Honorary Solicitors.—Messrs. Wilson, Bristows, and Carpmael.

LEGAL INTELLIGENCE.

ELECTRIC RAILWAY SIGNALS.

A petition was presented on the 9th inst. before the Judicial Committee of the Privy Council by Mr. Illius Augustus Timmis, a railway engineer, for the extension of Currie and Timmis's patent, No. 5,718, of 1883, for "improvements in the means of working and interlocking railway signals by electricity."

Mr. Bousfield, Q.C., and Mr. Graham appeared for the petitioner, whilst the Attorney-General and Mr. Sutton represented the Crown.

According to **Mr. Bousfield's** opening statement the patent was originally taken out by the petitioner and another engineer named Currie, and, as a fact, the invention, as well as kindred inventions which were the subjects of patents taken out in 1891, were the petitioner's, and he had found the money for bringing them out and experimenting with them, with the result that he was a loser up to the present time of about £6,000. The invention, which had been patented in most of the countries of Europe, as well as in the Colonies and the United States, was a very important one for the safe, economical, and efficient working of railway signals, and the only reason why the petitioner had not been successful was the difficulty of supplanting an established system and inducing the managers of the old trunk railways to go to the expense of adopting a new system, but the great success obtained by the petitioner's electric system on the Swansea Dock Railway and on the Liverpool Overhead Railway had now removed all doubts, and there was great hopes of success in the future.

The **Petitioner** then gave evidence describing his invention, which consisted in the placing of an electromagnet on or near to each signal-post in a station, the magnet being connected with the source of electricity. When the signalman pulled over his lever and completed his electric circuit the signal-arm was lowered from "danger" to "line clear," and the merit of his system, from an economic point of view, was that when the signal came to "line clear," where it often had to stand for a considerable time, the current of electricity was lowered from five volts to one-tenth of a volt, and kept continuously at that.

Sir Douglas Fox, vice-president of the Institute of Engineers, who was joint-engineer to the Liverpool Overhead Railway, said the system had been very successful at Liverpool. It was less dangerous and costly than the rodding system at railway stations, and could deal with signals at a greater distance.

The **Attorney-General** admitted that the invention was a useful one, and said he did not consider it to be his duty in the interests of the public to offer any opposition to the extension of the patent.

Lord Hobhouse, in giving the judgment of the Court, said their Lordships were of opinion that the petitioner had established the fact that the invention possessed very considerable merit. Their Lordships were, therefore, of opinion that this was a case in which they could properly advise her Majesty to grant an extension of the term of the patent for 10 years.

BARON v. NEW ZEALAND ELECTRICAL SYNDICATE.

In the Queen's Bench Division the hearing of the action brought by Mr. Alfred Inigo Sucklinge Baron, electrical engineer, of Pailton, near Rugby, to recover damages for wrongful dismissal from the New Zealand Electrical Syndicate was finished on the 14th inst. before the Lord Chief Justice and a special jury.

The **Plaintiff** said that he had no idea of coming to England until he was summoned by the Board in September, 1896. He made arrangements, as required, and when he got to England he was in consultation with the Board for several weeks, and there was not a hint made to him that he was not continuing in the service of the company till he received the letter of January 11, 1897, dismissing him.

Having opened the defendants' case, **Mr. Bucknill** called **Mr. Kelman**, who gave his version of what took place between himself and the plaintiff. In his negotiations with the plaintiff the latter insisted that his salary should average £750, and witness understood that that was a definite demand, and not a mere proposal. He was prepared to recommend the continuance of the plaintiff's services at a salary of £600 a year, and told plaintiff so, but he did not consent to the proposal. In cross-examination, witness said he did not insist upon the plaintiff finding room for his son in the service of the syndicate, though he asked if plaintiff could find room for him. He admitted, however, that before the dismissal of plaintiff he wired to New Zealand to ascertain if there was anybody who could take up plaintiff's duties in case of plaintiff's dismissal, and upon receiving a reply to the effect that a Mr. Turnbull would do the work for £350 a year if he were given a junior, Turnbull was appointed to the plaintiff's position at £350 a year, and witness's son as junior at £200 a year, besides which the local directors were given £200 a year, though they were unpaid in the plaintiff's time.

Other witnesses having been called, and counsel having addressed the jury, his **Lordship** summed up.

The jury found that the agreement was a continuing agreement, and that the plaintiff did not put an end to it. They further found that the plaintiff was entitled to six months' salary in lieu of notice at the rate of £500 a year, the commission of 1s. per 8-c.p. lamp, and to 5 per cent. commission on net profits of certain agencies, and also to additional damages of £350 for loss of employment and commission. In regard to the latter item, the learned judge having intimated that he thought the jury had gone beyond their powers in finding it, and that it might raise difficulties, counsel for plaintiff agreed to take the verdict without the last finding.

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His **Lordship** thereupon reserved judgment till counsel on both sides agreed as to the amount for which judgment should be entered.

ALLEGED DEFECTIVE ELECTRIC LIGHTING.

In the Westminster County Court on Tuesday, his Honour Judge Lumley Smith, Q.C., had before him the case of Laing *v.* Wilson, in which the plaintiffs, a firm of electrical engineers, sued the defendant to recover the sum of £13. 4s. 6d. in respect of an electrical installation supplied to his order.

The defendant admitted having given the order for the work, and paid £10 into court, but disputed liability as to the balance on the ground that the work was defective, and that he had to employ another firm to complete the work.

The plaintiffs called several witnesses to prove that the work was well and efficiently done, and that the alleged defects arose out of circumstances over which they had no control.

The **Defendant** said the lights were unsatisfactory from the first, and as the plaintiffs failed to put the matter right, he had to employ another firm to do it.

After hearing the evidence on both sides, his **Honour** said he was of opinion that the work was properly done, and gave judgment for the plaintiffs for the full amount claimed, with costs.

ELECTRICAL ENGINEERS IN DISPUTE.

In the Westminster County Court on Monday, his Honour Judge Lumley Smith, Q.C., had before him the case of Tracey *v.* The London Electrical Omnibus Company, in which the plaintiff, an electrical engineer, sued the defendants to recover the sum of £57. 8s. in respect of work done and material supplied in connection with the new electric omnibuses.

Counsel for the plaintiff said that the action was commenced in the High Court, and out of the sum claimed £33 had been paid on account, but the defendants denied liability as to the balance, on the alleged ground that the work had been overcharged in some cases and was useless in others.

On behalf of the plaintiff's case several witnesses were called to prove that the work was efficiently done and that the charges were very fair and reasonable.

For the defence, **Mr. Ward** was called, and said he was the managing director of the company. He had gone carefully through the whole of the items, and had come to the conclusion that the time charged for labour was very excessive, considering the amount of work which was done.

Several other expert witnesses were called on the same point, but after hearing their evidence, his **Honour**, without further comment, gave judgment for the plaintiff for 50 guineas, and costs.

CLAIM AGAINST THE IMPERIAL TRAMWAYS COMPANY.

Before his Honour Judge Turner, at Stockton County Court, Charles Thos. Sickling, farmer, of Acklam, sued the Imperial Tramways Company, Limited, for £10. 2s. damages and costs sustained by him through the defendants, who are laying down an electric tramway, having taken up a portion of the public highway at Thornaby, and having negligently and improperly directed the defendant's servants to proceed along the highway with the plaintiff's horses and rolley, whereby the rolley was damaged and a load of straw consumed and damaged by fire.

Mr. C. J. Archer appeared for the plaintiff, and Mr. Geo. Barnley (Middlesbrough) for the tramway company.

Mr. Archer contended that it was owing to the narrow state of the road that the accident occurred, and that the tramway company were liable.

Mr. Barnley, for the defence, stated the rails were at the time fixed in their place, and the distance at present from the rails to the kerb was 10ft. 3in. The tramway company excavated 1ft. 2in. on either side of the outer rails, and this left a free pasage of 9ft. 1in. The tramway company, he submitted, were not answerable for the sufficiency or otherwise of the space left for traffic during the construction of the lines. It was the duty of the local authorities to superintend the alterations, and see that there was sufficient roadway. The plaintiff's man was warned before the load collided with the street lamp. It could not pass the load with safety.

Evidence was called, and the **Watchman** stated that he had told the plaintiff's man not to go on, but to wait. The load on the cart was all on one side, and it therefore could not pass the lamp.

His **Honour** held that the tramway company had acted contrary to the law by opening out too much of the road at one time, and gave judgment for the plaintiff for the full amount claimed, with costs.

COMPANIES' MEETINGS AND REPORTS.

RAND CENTRAL ELECTRIC WORKS.

The ordinary general meeting of the shareholders in the Rand Central Electric Works, Limited, was held on the 14th inst. at Winchester House, Old Broad-street, E.C., Sir C. Rivers Wilson, G.C.M.G., C.B. (the chairman of the Company), presiding.

The **Chairman** said that they had now been in existence as a Company for some 2½ years. Referring to the engagement entered into between the Company and the contractors, he said it was originally contemplated that the works should be completed within 18 months, which expired on November 5, 1896, that time being further extended to November 20. It was contemplated that after the completion of the works they should be maintained for three years at the cost of the Company by the contractors, they paying the agreed minimum dividend. Following on the period of maintenance came another period of five years, during which the contractors were to act as the consulting engineers to the Company. For some time prior to November of last year it became evident that it would not be possible for the contractors to complete the work within the specified time, owing to the enormous difficulty and complexity of the work. No blame could be attached to the contractors for this; on the contrary, one could not help feeling a certain amount of admiration for the enterprising manner in which they had entered on the great work. The directors had made up their minds that there would have to be an extension of time. According to the strict wording of the contract, a penalty of £500 per week could be enforced. Instead of doing this, a new agreement had been made with the contractors, by which the period of completion was taken as from January 1, 1897, instead of November 20, 1896, the contractors undertaking from that date to start paying their guaranteed interest. That he considered to be an arrangement of the most beneficial character in the interests of the shareholders. From January 1 last, therefore, the shareholders would be in receipt of their guaranteed interest at the rate of 6 per cent. per annum. The nature of the work which they had contracted to perform was of two characters. It was mainly and principally in connection with the supplying of motive power to the mines, but they had also, with the consent of the Government, entered into an arrangement for supplying lighting power. As a matter of fact, they had already entered into contracts to supply lighting power to the stations on the Netherlands Railway, and to supply a portion of the township of Johannesburg with light. They had also contracts to supply the whole of the mines with power. The works had been in operation ever since July 1 last. They were only working with three engines instead of four, keeping one in reserve, but the three were ample for the supply of the whole of the horse-power they had contracted for. As a matter of fact, the engineer in his certificate had stated that the engines and motors were able to supply about 200 h.p. more than was originally contemplated. Amongst other inconveniences, they were at the outset subjected to certain outrages on the part of malignant persons or Kaffirs, but since they had offered a reward of £100 for the apprehension of any of these offenders they did not hear of so many complaints on that head. Their relations with the Government were of a most satisfactory description, their works having been visited by President Kruger himself, who expressed his admiration of, and satisfaction with, the works. They had carefully and cautiously considered the question of ordering a fifth engine, but as yet they had come to no decision on the subject. The dividends paid would be on the net profits after carrying 10 per cent. to reserve.

The report was adopted.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Bucharest.—Tenders are invited for 20,000 porcelain insulators. Specifications are to be obtained from, and tenders addressed to, the Railway Department, Bucharest, by December 30.

Bucharest.—Tenders are invited for 10,000 insulator brackets. Specifications are to be obtained from, and tenders addressed to, the Railway Department, Bucharest, by December 29.

Bucharest.—Tenders are invited for 22,500 kilogrammes of galvanised iron wire. Specifications are to be obtained from, and tenders addressed to, the Railway Department, Bucharest, Roumania, by December 28.

Salford.—The Town Council invite tenders for the supply of 300 yards of portable tramlines and 12 side-tipping trucks, to carry 20 cubic feet. For particulars apply to the Borough Engineer, Town Hall, Salford.

Reus (Spain).—Tenders are invited for the electric lighting of the town. The deposit is 2,500 pesetas. Specifications are to be obtained from, and tenders addressed to, the Municipality of the town by 2 p.m. on December 31.

Novorossisk (Russia).—Tenders are invited for the construction, etc., of an electric lighting installation for the town. The deposit is 5,000 roubles. Specifications may be obtained from, and tenders addressed to, the Municipal Authorities of the town by March 1 (13).

Catanzaro (Italy).—Tenders are invited for electric tramway or other light railway between the town and the railway station. The deposit required is £400. Specifications are to be obtained from, and tenders addressed to, the Municipal Authorities by December 30.

Novorossisk (Russia).—Tenders are invited for the construction, etc., of an electric tramway. The deposit required is 5,000 roubles. Specifications, etc. (in French), are to be obtained from, and tenders addressed to, the Municipal Authorities, Novorossisk (Russia), by March 1 (13). The time has been extended from November 15.

Utrera (Spain).—Tenders are invited for an electric lighting installation. The provisional deposit required is 8,805 pesetas (about £340) and 17,640 pesetas final. Specifications are to be obtained from, and tenders addressed to, the Municipal Authorities, at Utrera, province of Seville, Spain, by 2 p.m. on December 27.

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Laredo (Spain).—Tenders are invited for an electric lighting installation. The estimated cost is 8,500 pesetas, and the deposit required is 2,125 pesetas (provisional) and 2,125 pesetas (final). Specifications are to be obtained from, and tenders addressed to, the Municipal Authorities, Laredo (Santander), Spain, by 2 p.m. on December 22.

Londonderry.—The Corporation invite tenders for supplying oils for general machinery and for machinery at generating station. Forms of tender and particulars can be had from the City Surveyor and Electrical Engineer on application to them at the Guildhall, Londonderry. Tenders, sealed and endorsed "Tender for Oils," are to be lodged with Sir R. Newman Chambers, town clerk, by 4 p.m. on December 20.

Dundee.—The Gas Commissioners invite tenders for the supply of service fuse boxes, delivered at the electric lighting station, Dudhope-crescent-road. Specifications and forms of tender may be had on application to the Electrical Engineer, Electric Lighting Station, Dudhope-crescent-road, Dundee. Tenders to be sent to Sir T. Thornton, clerk of the Commissioners, Town House, Dundee, by 12 noon on December 20.

Glasgow.—The Corporation invite tenders for the supply of 2,000 tons of steel straight track rails, 200 tons of steel curve rails, and about 120 tons of steel fishplates. Specification, with form of tender and section, can be obtained on application to Mr. John Young, general manager, 88, Renfield-street, Glasgow. Tenders, sealed and marked on cover "Tender for Tramway Rails," to be lodged with Mr. J. D. Marwick, town clerk, City Chambers, Glasgow, by 10 a.m. on December 28.

Dublin.—Tenders are invited by the Dublin United Tramways Company for the supply of general stores and sundries during year ending December 31, 1898. Forms of tender (price 1s. each), conditions, and all information can be obtained, and patterns seen, at the Company's Office, 9, Upper Sackville-street, Dublin, from December 13 to 27. Tenders, sealed, and marked on outside "Tender for Stores," and addressed to the Chairman, to be lodged with Mr. Wm. Anderson, secretary, by January 3.

Worcester.—The City Council invite tenders for the following kinds of coal, delivered at the electricity generating station at Lower Wick, near Worcester, during 12 months ending December 31, 1898: best large Welsh smokeless coal, Welsh nuts, large Staffordshire coal, Staffordshire nuts. Tenders, marked "Tender for Coal," and stating the kinds of coal to be supplied, and price, to be delivered at the office of Mr. Samuel Southall, town clerk, Guildhall, Worcester, by December 18. No special form of tender is required.

Hammersmith.—The Vestry invite tenders for the supply and erection of two 375-h.p. slow-speed vertical engines, and two 300-kw. flywheel alternators, coupled direct to the engines. Copies of the specifications, with general conditions and form of tender, can be obtained at the office of Mr. W. P. Cockburn, vestry clerk, Town Hall, Hammersmith, on payment of a fee of £2. 2s., which sum will be returned on receipt of a bona fide tender. Sealed tenders must be delivered at the Town Hall at or before 5 p.m. on December 22.

Worthing.—The Electric Light Committee of the Town Council invite particulars and conditions under which any person, firm, or company is willing to instal and maintain the electric light in the borough for a term of years, with power to the Corporation to acquire the undertaking upon agreed terms and at stated periods. The provisional order of the Board of Trade, which is in the usual form, may be inspected, and a plan of the town, showing the compulsory area and other particulars, obtained, on application at the Town Clerk's Office, Liverpool-road, Worthing.

Bedford.—The Electric Light Committee are prepared to receive tenders for the supply and erection of the following plant: (Section A) one 420-b.h.p. double-acting compound enclosed engine; (B) one 250-unit alternator, with stationary armature. Specifications, with terms and conditions of tender and contract, may be obtained at the offices of Mr. T. S. Porter, town clerk, Town Hall, Bedford, on payment of a fee of 5s. for each section. Tenders, sealed and marked "Electric Lighting, Section A or B," must be delivered to the Town Clerk by January 10.

Canterbury.—The Corporation are prepared to receive tenders for the provision and erection, complete, of refuse destructors for the city, to be worked in conjunction with the electricity works about to be established. General site plan and arrangements proposed, together with description of works and general conditions of contract, may be obtained on deposit of £1. 1s., returnable on receipt of a bona fide tender, by application to the City Surveyor, 28, St. Margaret's street, Canterbury. Tenders, on printed forms, to be lodged with Mr. Henry Fielding, town clerk, by December 31, at 12 noon.

Guipuzcoa.—The Secretary of State for Foreign Affairs has received a despatch from her Majesty's Consul at Bilbao, reporting that the Provisional Board appointed in connection with the electric tramway which it is proposed to lay from Zumarraga to Zumaya, in the province of Guipuzcoa, invite plans and tender, to be received by February 28, for the construction and equipment of the line. Further particulars of the conditions of the tenders for the above-named tramline and branch, which together measure 30 miles, may be inspected at the Commercial Department of the Foreign Office between 11 and 6.

London, N.W.—Tenders are invited by the Vestry of St. Pancras for the supplying and erecting of arc lamps, posts, and circuits, complete; also feeding and distributing mains. Copies of specification, conditions of contract, and forms of tender to be obtained upon application to the Chief Clerk, Electricity Department (offices, 57, Pratt-street, N.W.), on payment of a deposit of £1, which will be returnable on receipt of a bona fide tender, accompanied by the specification. Tenders to be sent to Mr. C. H. F. Barrett, vestry clerk, Vestry Hall, Pancras-road, London, N.W., endorsed "Tender for Arc Lighting Extensions," by 12 noon on 28th inst.

Leicester.—The Sanitary Committee invite designs and tenders for motor vehicles for the collection of house refuse. The motive power, capacity, and all other particulars are to be described in a full specification, accompanied by drawings and delivered at the office of Mr. E. George Mawbey, C.E., borough engineer and surveyor, Town Hall, Leicester, addressed to the Chairman of the Sanitary Committee, by January 31. The loaded wagons would have to ascend an incline of 1 in 20, turn in a limited space, back and tip over a beam about 14in. high by 12in. in width, and when empty descend a road having a gradient of 1 in 15. The Committee do not bind themselves to accept any proposal, and firms tendering must do so at their own cost, no fees being allowed for the preparation of drawings, etc.

Barking.—The Urban District Council desire tenders for the erection of an electric light station at the rear of the public offices, East-street, Barking Town. Drawings, specification, and conditions may be seen, and bills of quantities (prepared by Mr. G. Lamb, East-street, Barking) and forms of tender obtained, on application to the surveyor to the Council, Mr. C. J. Dawson, F.R.I.B.A., Public Offices, Barking. Contractors will be required to deposit a £10 Bank of England note with their tender, which will be returned on rejection of the tender, or, if accepted, on the contract being signed. The contractor will be required to pay the trade union rate of wages to all men employed on the works, and to observe the recognised hours of labour. Sealed tenders, marked "Electric Light Station," to be sent to Mr. Edwin H. Lister, clerk, Public Offices, Barking, by 5 p.m. on December 21.

Gloucester.—The Electricity Supply Committee are prepared to receive tenders for the supply and erection of the following plant on the low-tension system, for the municipal electricity works: (Section A) boiler-house plant—Lancashire boilers and accessories, mechanical stokers, feed pump, injector, economiser, electric motor; (B) engine-house plant—steam dynamos and accessories; (C) overhead travelling crane; (D) switchboard and instruments; (E) accumulators; (F) mains—insulated cables and trenching; (G) public lamps—arc and incandescent street lamps and lamp-posts; (H) meters—the whole bound up in one specification. Tenderers are at liberty to tender for either section, but not for part of a section. Specification, with terms and condition and forms of tenders, may be obtained at the offices of Mr. Robert Hammond, M.I.E.E., consulting engineer to the Corporation, Ormond House, Great Trinity-lane, London, E.C., on payment of £3. 3s., which sum will be refunded on the return of the specification filled up with a bona fide tender. Duplicate copies of the specification £1. 1s. each, not returnable. Tenders (sealed and marked "Tender for Electricity Works") must be addressed to Mr. Geo. Sheffield Blakeway, town clerk, Guildhall, Gloucester, and be delivered by January 18.

Canterbury.—The Electric Lighting Committee of the Corporation are prepared to receive tenders for the supply and erection of plant as follows: (Section A) boiler-house plant—Lancashire boilers and accessories, mechanical stokers, feed-pump, injector, economiser, electric motor: (B) engine-house plant—steam dynamos and accessories, condensers, oil-filter, steam, exhaust, feed, blow-off, and sundry pipes, valves, feed-water and storage tanks, &c.; (C) overhead travelling crane; (D) switchboard and instruments; (E) accumulators; (F) mains—insulated cables and trenching; (G) public lamps—arc and incandescent street lamps, lamp-posts, and brackets; (H) meters. The whole bound up in one specification, price £2. 2s., returnable on receipt of bona fide tender. Further copies £1. 1s., not returnable. Tenderers are at liberty to tender for any section, but not for part of a section. Specifications, with terms and conditions of tender and contract, may be obtained at the offices of Mr. Robert Hammond, consulting engineer to the Corporation, Ormonde House, Great Trinity-lane, London, E.C., on payment of £2. 2s., which sum will be refunded on the return of the specification, filled up, with a bona fide tender. Tenders, sealed, and marked "Tender for Electricity Works," must be addressed to Mr. Henry Fielding, town clerk, 15, Burgate-street, Canterbury, and delivered by December 20.

Bootle (Lancs.).—Tenders are invited by the Corporation for the supply and erection of (1) Lancashire boilers and Green's economiser; (2) engines, dynamos, switchboard, condensers, condensing and feed-water pumps, balancing transformers, boosters, piping, tanks, crane, meters, wiring of electricity supply works, and alterations and additions to wiring at town hall; (3) secondary batteries and accessories; (4) feeder and distributing mains (solid system), potential leads, network and surface boxes, and service connections; (5) running of the electricity supply works for period not exceeding three years. Specifications, drawings, and form of tender can be obtained at the office of Mr. J. H. Farmer, town clerk, Town Hall, Bootle, on payment of £5. 5s. (or £1. 1s. per section), which will be returned on receipt of a bona fide tender. Any further information can be obtained from the consulting engineer, Mr. Thomas L. Miller, M.I.E.E., 7, Tower-buildings N., Water-street, Liverpool. Contractors may tender for any section or sections, but not for part of a section, and contractor for No. 2 section must also tender for Section No. 5. The contractor whose tender is accepted will be required to enter into a formal agreement under seal, with sufficient and approved securities, for the fulfilment of contract. Sealed tenders, endorsed "Tender for Electric Lighting," and addressed to the Chairman

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of the Watch Committee, must be sent in by 12 noon on January 10.

Madras.—Tenders are invited for the utilisation of water flowing from the Periyár Lake for purposes other than irrigation and not incompatible with the use of the water for drinking. The irrigating season extends over nine to ten months, during which time the discharge is likely to be from 1,100 to about 500 cubic feet a second, according to the demands for irrigation and the available quantity in the lake. Subject to the risk of interruption by accident or drought, supply can be given throughout the irrigation season. No supply can be guaranteed at other times, but, so long as water is available, the Government will be prepared to issue it in such daily quantities as may seem to it advisable with reference to the time which is likely to elapse before the supply is replenished by the setting in of the rains. The fall from the tunnel to the foot of the hills is approximately 900ft., and the distance measured along the course of the stream about 6,800ft. One cubic foot per second falling 900ft. is estimated to produce over 60 effective horse-power. Intending lessees should state the quantity of water required in cubic feet per second and the annual rent offered for each cubic foot per second. No rent will be charged for the first year from the date of the concession; for the second year the charge will be one-fifth, and an additional charge of one fifth will be made every year until the full rent is reached. The whole or part of the concession may be surrendered on a year's notice being given. Lessees will construct at their own expense, on plans to be approved by Government, all the weirs and other works required to divert the water from the river below the tunnel. For further information, application may be made to the Chief Engineer for Irrigation, Madras, by whom tenders will be received up to July 1, 1898.

RESULTS OF TENDERS.

Richmond.—The Main Sewerage Board have accepted the tender of Mr. C. A. Hemmingway, at £80. 5s. 2d., for electric lighting, subject to an alteration in the plan in the position of one of the lamps.

Bolton.—The Council have accepted the tender of Messrs. Robinson and Co. for covering the steam-pipes for the new engine at the electricity works with steel sheets.

Torquay.—The Corporation have accepted the tender of Messrs. Massingham and Co., of Torquay, for fitting up the town hall and bath saloon with electric light.

BUSINESS NOTES.

Wakefield.—The electric lighting of the streets is still delayed on account of the engineering strike.

Stafford.—It is reported that the supply of electric light for November showed an increase of over 21 per cent.

Ramsgate.—It appears that the application for an order to light the district by electricity will be opposed by the Council.

Shoreditch.—The engineer's report recommending extensions in street lighting to cost £6,930 has been adopted by the Vestry.

Bangor.—After a lengthy debate a meeting of the City Council have resolved to alter the constitution of the Lighting Committee.

Maidenhead.—A sum of £15,000 for the cost of central station was inserted in the Corporation's application for a public lighting order.

Battersea.—Prof. Kennedy has been appointed consulting engineer for the Vestry in connection with their electric lighting scheme.

Blairgowrie.—A committee of the Police Committee is considering the question of introducing the electric light into the district.

Appointments Vacant.—Reference to our advertising columns will show various openings for electrical engineers under several corporations.

Ealing.—The Electric Lighting Committee state that 537 additional private lamps had been connected with the mains during the past fortnight.

Removal.—We are informed that Dr. J. Hopkinson will remove his offices by the end of this year to 26, Victoria-street, Westminster, S.W.

Shillelagh.—A meeting has been called for the purpose of adopting a resolution to specify an area for the proposed lighting of the town of Carnew with electricity.

Keswick.—It is expected that the agreement between the Urban District Council and the electric light company will be definitely settled at the next meeting of the Town Council.

Hammersmith.—The Vestry have accepted an offer from a syndicate which will take 24 loads of dust per day for one month for the purpose of experimenting with a destructor.

Norwich.—The routes for the proposed electric tramways has been fixed. An amendment proposing the substitution of wood paving in the place of granite setts has been defeated.

Henstead.—A special meeting of the Rural District Council has been fixed for the 21st inst. to discuss the grant of a provisional order to the Norwich (Extension) Electric Lighting Company.

Electric and General Investment Company, Limited.—The warrants for the interim dividend on the ordinary shares of this Company for the half-year ended November 30 have been posted.

Tadcaster.—The Post Office Department of the Government are about to erect a new wire from Leeds to Seacroft in order to bring Tadcaster into direct connection with the trunk telephone system.

Liverpool.—The Council have carried by 71 to 8 votes a resolution directing the promotion of a Bill which includes provision for the borrowing of £200,000 for the extension of the electric lighting undertaking.

Warwick.—An application from a tramway syndicate for an extension of the present local Tramway Act with a view to the substitution of electric traction for horse power, is under consideration of the Council.

National Telephone Company.—The transfer-books of the 3½ per cent. debenture stock will be closed from 18th to 31st inst., inclusive, for the preparation of the warrants for the half-year's interest due January 1.

Chester.—The Town Council have resolved to apply to the Local Government Board for leave to borrow sums amounting to £2,446 for wiring and fitting (electric lights, etc.) the town hall, public market, and free library.

Coseley.—At the last meeting of the Urban District Council the Clerk reported the receipt of a communication from the Electric Corporation for Power Distribution, Limited, and stated that the matter could not be proceeded with at present.

St. George's (Hanover-square).—A meeting of the Vestry was held on the 16th inst. The agenda contained a motion to the effect that it be referred to the Committee of Works to consider the application of electric or motor traction for the service of the parish.

Bath.—The Electric Lighting Committee has been constituted as follows: The Mayor; Aldermen Jolly, Rubie, Sturges, and Taylor; Councillors Shum, Phillips, Matthews, Knight, Powell, Siccama, Roadhouse, Stone, Moore, Silcock, Isaacs, Bartrum, John, and Tonkin.

New Factory.—We are informed that the Incandescent Electric Lamp Company, Limited, who are the manufacturers of the "Robertson" incandescent electric lamps, have just taken possession of their new building which has been erected at Brook Green.

Bootle.—Lieutenant-Colonel Albert C. Smith, R.E., has held a Local Government Board enquiry at the Bootle Town Hall relative to the application of the Town Council under the Electric Lighting Act, 1882, for sanction to borrow £35,000 for electric lighting purposes.

Swansea.—It is stated that a further conference is to take place this week on the proposed purchase of the tramways by the Corporation, when Mr. Ruck, one of the directors, and Mr. Kincaid, the engineer, will visit Swansea to meet representatives of the Corporation.

Lowestoft.—At a meeting of the General Purposes Committee on the 14th inst. a report was read from Mr. W. C. C. Hawtayne as to the desirability of establishing municipal electricity supply works at Lowestoft, copies of which were directed to be sent to members of the Council.

B'ackburn.—The ladies' sewing class of the Clayton-street Wesleyan Chapel were the promoters of a very successful sale of work, held last week. The object of the sale was to raise £150 towards defraying the cost of the electric light installation, and the beautifying the chapel.

Eccles.—At the last meeting of the Council, in moving the minutes of the Town Hall and Electric Lighting Committee, the Chairman observed that he hoped at the next meeting of the Council to place more reliable information before them in regard to the electric lighting tenders.

Whitehaven.—A motion has been carried by the Town Council authorising an application to the Local Government Board for power to borrow £7,500, and for the extension (if necessary) of the lighting order so as to include the extended district. The erection of two new boilers is contemplated.

North Darley.—At the monthly meeting of the Urban Council a letter was read from a firm of parliamentary agents as to the application to be made in the next session for supplying electrical energy for the public, and embracing a distance of 26 miles from Warsop, and so shut out the district councils.

Bury.—A special resolution is to be passed at the next meeting of the Council authorising an application to the Local Government Board for permission to borrow a sum not exceeding £20,000 for the purposes of the necessary works in connection with the provisional electric lighting order obtained by the Corporation.

Commissioners of Sewers.—The Commissioners have resolved to prosecute an appeal by the Railway Commissioners from the judgment of the judge of the City of London Court in the dispute between the Commission and the Postmaster-General as to the use of underground tubes by the National Telephone Company.

Horsham.—In moving the adoption of the Lighting Committee's report at the Council meeting, Mr. J. Hicks remarked that many complaints had been made as to the lighting of the town. He suggested that it might be well for the Council to consider the advisability of applying for a provisional order to light the town by electricity.

Buxton.—A meeting of owners and ratepayers was held last week, at which the following resolution was carried: "That this meeting does not approve of the Town Council laying down their own installation for the electric light in Buxton, and recommends them to make the best terms possible with a thoroughly reliable company for that purpose."

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H.M. Yacht "Victoria and Albert."—The Chloride Electrical Storage Syndicate, Limited, inform us that they have received instructions to supply a complete set of cells for her Majesty's yacht "Victoria and Albert." This battery is exactly similar to that supplied some time ago to the Prince of Wales's yacht "Osborne," which has given complete satisfaction.

Lamp Contract.—We are informed that the Edison and Swan United Electric Light Company, Limited, have secured the contracts for the supply of incandescent lamps to the National Telephone Company, the Great Western Railway Company, and the contract for the whole of the electrical supplies, including lamps, to the West Sussex County Asylum, Chichester.

South London Electric Company.—We hear that this Company will be ready to supply its customers by Christmas. The wiring is being done by the National Electric Free Wiring Company. The machinery will not be in working order, but it appears that arrangements are being made with the London Electric Company to supply the current in the meanwhile.

Devonport.—At a meeting of the Mercantile Association, the Town Clerk said, with regard to the lighting of the town by electricity, that the Electric Lighting Committee were considering the appointment of an electrical engineer for the borough. The provision of works was also under consideration, and power sufficient to apply to the trams, if necessary, would be provided.

Camberwell.—At a meeting of the Vestry on the 15th inst. notice was received from the County of London and Brush Provincial Electric Lighting Company, Limited, stating that after the expiration of one month the company will, in exercise of the powers conferred by the Camberwell Electric Lighting Order, 1896, commence the execution of works for electric lighting in different parts of the parish.

Stirling.—The Council on the 13th inst. refused an application by a London company for the transfer of Stirling provisional order. It was remitted to the Lighting Committee to obtain a full report from Prof. Kennedy as to the utilisation of water pressure at Touch or elsewhere for electric lighting. A special committee was appointed to consider and watch over the Bill promoted by Stirling Gaslight Company.

Belfast.—The engineer has reported to the Electric Committee the results of his tests at the contractor's works of 8½ miles of cable and the first steam dynamo and boiler, all part of the plant ordered for the new installation. The question of the alteration of the system of charging for current to that known as "Wright's system" has been considered, and the question is to come before the next meeting of committee.

Islington.—An ordinary meeting of the Vestry will be held on the 17th inst., for which the following notice of motion has been tabled: "That it be an instruction to the Electric Lighting Committee to bring up as soon as possible an estimate of the cost of the extension of the electric light from the Holloway-road at Highbury-corner along Canonbury-road and New North-road so as to join the system already existing in Shoreditch."

Whitechapel.—At the meeting of the District Board a letter was received from the Municipal Electric Supply Company offering to supply electric light, and, on exceptionally favourable terms, for the municipal acquisition of the undertaking later on. The company take all the risk, and would be prepared to carry out electric lighting with or without dust destruction. The letter was referred to the special Electric Light Committee.

Glasgow.—The Watching and Lighting Committee have agreed to recommend that the Tramways Committee should, in erecting their poles on the Springburn route for electric traction purposes, make provision for these poles being used for the electric lighting of the streets on that route. A motion that the electric lighting of the route should be carried out simultaneously with the initiation of electric traction has been referred to the joint committees.

Rothesay.—At a meeting of the Council a motion to apply to the Board of Trade for power to adopt the electric light was unanimously adopted by the Council, and a report on the proposed installation by Mr. C. F. Fulton, electrical engineer, Glasgow, was read. Alternative schemes were submitted, and, after some discussion, it was agreed that in the event of hotelkeepers and others taking supplies, a scheme will be adopted which will cost £6 600.

Llandudno.—At a recent meeting of the Town Council the Chairman of the Electric Lighting Committee, in moving the minutes, which approved of plans relating to the provisional order to construct tramways in Llandudno, justified the action of the majority of the Council in relation to the recent agitation for a light railway. He held that the Council should secure the powers, but should never go in for working the tramways until all efforts to secure their working by a company had failed.

New Firm.—Mr. Gifkins, formerly chief engineer and head draughtsman to Messrs. Drake and Gorham, and Mr. Hill, late general manager of the Jandus arc lamp, D.P. battery, country and town house lighting, and other departments, have opened business under the style of Hill, Gifkins, and Co., electrical, mechanical, and hydraulic engineers, at 68, Victoria-street, Westminster, S.W. We understand that the firm have already been entrusted with several important engineering contracts.

Huddersfield.—The Town Council decided at a recent meeting to give three months' notice to the National Telephone Company, requiring them to entirely remove telephone poles, wires, etc., erected by them at Longwood, under an agrement dated April 1, 1897. The minutes of the General Purposes Committee, showing that approval had been given to a recommendation of the Electric Lighting Committee to municipalise the telephone system at Huddersfield, were adopted. Mr. Kenneth F. Campbell, of Stockton-on-Tees, was appointed borough surveyor and engineer at a salary of £500 a year.

Personal.—Mr. Reginald P. Wilson has been appointed to act as consulting engineer to the Dartford Urban District Council.—Mr J. K. Woodruffe Gardam, A.I.E.E., who recently had charge of the temporary electric lighting plant connected with the recent bazaar at Richmond, N.S.W., rendered himself so popular during his stay in that town that a "send-off" was tendered to him by the School of Arts Committee. Since his arrival in the colony Mr. Gardam has been connected with the firm of Edge and Edge, and in that firm's name has reported on the lighting of the business portion of Richmond by electricity.

County of London and Brush Provincial Electric Lighting Company, Limited.—A circular has been issued stating that the directors of this Company have resolved to make a further issue of 10,000 ordinary shares of £10 each, being balance of the authorised ordinary share capital of the Company. They have decided to allot the 10,000 shares *pro rata* to the holders of the existing 30,000 fully-paid ordinary shares who were registered in the books of the Company on November 29, or to their nominees. Holders of certificates for thirds of a share must either sell them or buy other certificates to make up whole shares.

Coatbridge.—The Council have formally decided to oppose the scheme of the British Electric Traction Company, who are applying for a provisional order to lay a light railway through Airdrie and Coatbridge. The engineer of that company has had a meeting with the Council and explained their proposals. The other company with which both burghs are in negotiation cannot now apply to Parliament for power this session. It was agreed at the last meeting to continue negotiations with the British Electric Traction Company, with a view to ascertaining how far their scheme will suit the burghs before finally deciding to oppose their application.

Sheffield.—During the debate on the tramways at the City Council meeting it was proposed as an amendment to the recommendations of the Tramways Committee that the tender of the British Thomson-Houston Company, Limited, be accepted for the supply of the whole of the general plant and electrical equipment in connection with the Nether Edge to Tinsley section, for the sum of £41,185. 13s., and that a sub-committee be appointed to settle the terms of the contract. It was also moved that these matters be referred back to the committee for further consideration. The amendment was negatived. Several amendments advocating the wood pavement of the lines shared the same fate.

Rotherhithe.—An adjourned general meeting of the Vestry was held on the 14th inst. Notices were received of the intention of the County of London and Brush Provincial Electric Lighting Company, Limited, to apply to the Board of Trade, on or before December 21, under the provisions of the Electric Lighting Acts, 1882 and 1888, for a provisional order in respect to the parishes of Bermondsey and Rotherhithe, and the districts of Greenwich and Lewisham, and plan showing electric lines to be laid down in the following streets in the parish within a period of two years from the commencement of the order: Union-road, Albion-street, and parts of Rotherhithe-street, Lower-road, and Swan-lane.

Bo'ness.—The Bo'ness Harbour Commissioners have lately been considering as to having Bo'ness Harbour and Docks lighted with the electric light, and at their last meeting it was remitted to the engineers, Messrs. Thomas Meek and Son, Edinburgh, along with Mr. Carlow, North British Railway director, and a member of the Board, to consider as to having the proposal carried out The engineers have now purchased the two engines, dynamos, and other electrical plant which was recently in use at the Free Library, Edinburgh, for the purpose of lighting Bo'ness docks. Offers for fitting up an installation of the electric light at the docks are now being considered, and the work, it is expected, will be proceeded with at once.

Dudley.—In moving the adoption of the last report of the Railway, Tramway, and Electric Lighting Committee at the last meeting of the Council, the Chairman stated that the British Electric Traction Company now asked whether the Corporation would meet them and state what proposals they were prepared to make. That reopened the negotiations, and they would approach the company in no spirit of hostility, but from the standpoint of what was best for the town When they had collected the best information they could get, and had satisfied themselves on all points, then, with the approval of the Council, the committee would be prepared to go on. He hoped the Council would bear with them in the difficult negotiations they had in hand.

Leith—The tramway company asked the consent of the Town Council last January to cable the tramway from Pilrig to the foot of Leith Walk, but to that letter they have not yet received an answer. The Leith Town Council are speaking about introducing electric cars along with their electric light. It appears, however, that they cannot do this unless they first purchase the tramway lines. The directors of the street company have, it is understood, made up their minds that they will not introduce electric cars on the Leith lines. They are quite willing to cable to the foot of Leith Walk, which is all they bargained for; but the Leith Council, or the majority of that body, are believed to object to cabling, in case the street company should take cable power from Edinburgh.

National Cycle Show.—The National Cycle Show, which was held at the Crystal Palace last week, offered barely anything

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interesting from an electrical point of view. Motor carriages were excluded on account of want of space, and the various exhibitors of tyres, although they had much to say in regard to the steadily increasing demand for motor tyres, had few samples to show. The Fleuss Tubeless Company showed a motorcar tyre which can be taken off by hand, and they also intend to bring a new solid carriage tyre into the market. The Double Arch Tyre Company have lately patented a tyre composed of two steel rims with a filling of two rubber pieces divided by an empty space in the middle; and the New Fleetwood Works, Coventry, exhibited the Woodstock tyre, which is easily detached or replaced.

Edinburgh.—A representation by the electrical engineer as to further provision for store accommodation was agreed to by the Town Council at its last meeting. Remits were made to the Lord Provost's Committee to conside and report whether any, and if so, what action should be taken to secure the removal of the anomaly of the Lord Dean of Guild and Convener of Trades sitting and voting in virtue of their respective offices as constituent members of Council; and to the Electric Lighting Committee to procure plans for an electric lighting station in M'Donald-road, and report. Permission was also granted to the Electric Lighting Committee to lease two pieces of ground close to the central electric lighting station for the provision of further store accommodation.

Plymouth.—At the last meeting of the Town Council it was stated that by eliminating the merely ornamental part of the design a saving of £3,000 could be effected in the cost of the building of the electric lighting station. According to the *Western Mercury*, the Chairman of the committee declined to give the amount of the tenders which were so much in excess of the estimates as to render this economy necessary. The information ought to be interesting, for the engineer's original estimate of the cost of the buildings, foundations, chimney, railway siding, and wharf was only £7,000, while the tenders were for the buildings alone, without the wharf or the siding. It was resolved, "That it be referred to the chairman, the borough surveyor, and the electrical engineer to endeavour to devise a scheme which will materially reduce the cost of the works." The committee was empowered to accept a tender.

Bristol.—The Electrical Committee's report in favour of the borrowing of £23,000 for the purpose of extending the street-lighting by erecting 200 lamps has been adopted by the Town Council. At a meeting in connection with the Stoke's-croft and North-street Ratepayers' Association on the 13th inst., the following resolutions were passed: "(1) That before sanctioning any further application for tramway extension, it should be made a condition that the supply of electric power should be obtained from the Corporation; (2) that in the event of electric traction being adopted, the overhead wire system should not be permitted in Stoke's-croft and North-street; (3) that this association objects to the proposed piecemeal widening of Stoke's-croft, as in any alteration the condition of the entire street must be taken into consideration, and that we call upon the Council to maintain the statutory distance in this and other business streets affected by the tramway company's proposal."

Barrow.—At the last meeting of the Electric Lighting Committee of the City Council, the Borough Engineer submitted a print of specification for the proposed electric light station, with the plans and estimate. The Borough Engineer laid before the committee particulars which he had received of the Thwaite-Gardner blast furnace power system, by which it is proposed to utilise the waste heat from one or more blast furnaces at the steel-works, for providing a supply of electricity to the town for light and power purposes. It was resolved that the particulars be laid on the table. The committee considered the electric lighting of Furness Abbey Hotel, and it was resolved to recommend the Council to lay the necessary main to the Furness Abbey Hotel, on condition that the Furness Railway Company guarantee a minimum return equal to 10 per cent. per annum on the cost of the proportion of the proposed main from the tram terminus in Abbey-road to the hotel. At the meeting of the Council this report was agreed to.

Hull.—At the last meeting of the City Council, attention was drawn to that part of the Works Committee's minutes relating to the establishment of a generating station for the provision of motive power for the trams. The city engineer and electrical engineer had submitted schedule of and draft report upon the tenders received. They stated that they had gone carefully into the money value of the respective advantages and disadvantages of the two sites, and estimated that apart from first cost and apart from some advantage as regards simplicity in favour of the central site, the items on each side practically balanced each other. They were therefore of opinion that the choice of the station site should be governed almost entirely by first cost, and that unless an exorbitant price had to be paid for land the advantages were in favour of a central site near the docks. Upon this it was carried unanimously that the Council be recommended to authorise the Works Committee to acquire a suitable site for a power station in a central position. The minutes were adopted after considerable discussion.

Taunton.—At the Town Council on the 14th inst. the Mayor said that with regard to the light railway and tramway scheme, which the Light Railway Commissioners had recently refused to sanction on the ground that they had no jurisdiction, the President of the Board of Trade had consented to receive a deputation of which he (the Mayor) was a member, and he told them that he could not alter the decision of the Commissioners or set aside the law on the point; he, however, said that, in the interest of the country generally, and by way of settling the question once and for all, if the Taunton Corporation would put in a memorial asking that the decision of the Commissioners might be reconsidered, he would submit it to the law officers of the Crown and get their opinion as to the jurisdiction of the Light Railway Commissioners. If the law officers of the Crown ruled that the Commissioners had no jurisdiction over such an application as the one from Taunton, that would end all light railways as far as Taunton was concerned; but if, on the other hand, they decided otherwise, another enquiry with reference to the scheme would be held.

Grimsby.—The Borough Surveyor at the last meeting of the Town Council stated that he had received a reply from the Tramways Company. The general engineer had been down in connection with this matter, and had admitted that the line required reconstructing from one end to the other, but the company wished the committee to understand that, on account of the recent strikes in the trade, no one was able to deliver the rails yet, and it was asked that the company should be given until March 1 next. From that time they would undertake the work of reconstruction, and in the meantime they would do what was necessary to keep the line temporarily in a decent condition. In addition to this, the company had taken into account the fact that the Corporation had been considering the question of establishing an electric supply station, and they asked whether the Corporation would be prepared to come to terms for the supply of power; if so, the company was prepared to put down heavier rails for the purpose of carrying a motor, and to meet all the requirements of the Board of Trade. It having been decided that the tramway company must do something at once, the matter was dropped.

Acton.—At the last meeting of the Council the following resolution was carried: "(1) That in consequence of the opinions expressed by the ratepayers of Acton, in reply to the enquiry of the District Council, it is hereby resolved that electric lighting be introduced in Acton under the provisional order already obtained. (2) That an electric lighting committee, to consist of all the members of the Council, be appointed, with instructions to take expert advice as to the best system of electric lighting to be adopted in Acton, and to put into force the Acton Electric Lighting Order 1891." It was subsequently agreed that a special meeting of the Council in committee should be held to take steps to carry out the decision. A letter was received from the managing director of the London United Tramways giving formal notice of the company's new scheme for the extension of its system, and asking for the assent of the Council so far as the Acton district was affected. It was agreed to give formal notice of dissent to the scheme, so that the Council might have a *locus standi* in the matter if, upon further consideration, it wished to take action. The Council have under consideration the lighting of Bedford-park by electricity.

Dublin.—At the enquiry reported in our last issue, Mr. Macinerney, Q.C., who appeared for the Corporation, said the application was for a loan of £20,000. Mains had been laid down in certain streets within two years as originally prescribed, and everything went on all right until last year, when several breakdowns occurred, and those who were skilled in the matter came to the conclusion that those occurrences were due to the wearing out of the rubber used in insulating the cables. The town clerk wrote to the Local Government Board for an additional loan, but their answer was that they could not sanction a fresh loan for the renewal or replacing of works executed under former loans which were still current, and that they could only grant a fresh loan for works that were altogether new. Mr. Campbell wrote saying that the work proposed to be done would be all new. The total amount spent on the existing cables was £3,300, and these cables would be available to the extent of about £2,000. No portion of the loan now sought would be expended on anything but what was new, and taking into account the loans already granted, which had not all been taken up, and also the proposed loan, there would still be a borrowing power of £31,000.

Kensington.—The meeting of the Vestry on the 15th inst. had under consideration a report of the Law and Parliamentary Committee on parliamentary schemes, 1897, consisting of a Bill of the Great Western Railway (General Powers), and one for Metropolitan Electric Supply. The report states that the committee have had before them the parliamentary notices and plans of the above-mentioned schemes, together with the report of the Vestry's surveyor thereon, and they propose to place themselves in communication with the promoters with a view to obtaining an assurance on the several matters which affect the interests of the Vestry, and they will report further when the Bills are introduced. The question of acquiring a piece of land suitable for a depôt, or at least four acres of that property, at £1,500 per acre, was also set down for consideration. Notices and plans having been received from the House-to-House Electric Light Supply Company relative to extensions of their mains in Redcliffe-gardens and Pembroke-gardens, permission was given for the works being proceeded with, subject to the usual conditions—viz., that the plans be approved by the Vestry's surveyor and lighting engineer, and that the works be carried out under their supervision and to their satisfaction.

Perthshire.—A series of extensive improvements were recently carried out at Strathallan Castle, Perthshire, by Mr. Græme A. Whitelaw, ex-M.P., who some time ago obtained a lease of 20 years of the castle and shootings from the agents of Viscount Strathallan. According to the *Glasgow Herald*, Strathallan Castle is now one of the very few mansions in the county where the new illuminant is used. The motive power for generating the electric current is obtained from the River Machany. The lade which supplies the existing meal mill is utilised, and by taking from an extension of the present mill pond a pipe to the old scutching mill on the banks of

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the river a head of some 20ft. is obtained. The old waterwheel has been removed, and in its place a turbine giving some 10 h.p. to 12 h.p. has been substituted, which drives the dynamo. The electric current is conveyed to the castle by means of overhead wires on poles, the distance being some three-quarters of a mile. In an outbuilding close to the castle an electric accumulator, or storage battery, is provided, which is capable of lighting 150 lamps for nine or ten hours. This is charged during the daytime, and supplies current for lighting the castle when the turbine and dynamo have stopped running. The whole of the work, including the water power, has been carried out by a Glasgow firm.

Bournemouth and Poole Electricity Supply Company, Limited.—This Company has been formed to acquire the interests of the County of London and Brush Provincial Electric Lighting Company, Limited, in the Bournemouth and District Electric Supply Company, Limited, for £115,000. The capital of the Bournemouth and District Company consists of £50,000, in 10,000 ordinary shares of £5 each, whereof 5 725 have been issued and fully paid up. There are also loans outstanding as at November 25, 1897, amounting to £63,891. Of such issued shares 5,704 are held by the County Company, which company has also advanced the whole of the before-mentioned loans. The Bournemouth and District Company state that the equivalent number of 8 c.p. lamps connected was 8,988 in 1892 and 23 203 in 1896. The equivalent of 25,837 8-c.p. lamps were applied for at November 30, 1897, being an increase of 2,634 lamps since the beginning of the present year. The directors are: the Right Hon. Lord Rathmore (chairman), Messrs. F. W. Reynolds and F. E. Savory (directors of the County of London and Brush Provincial Electric Lighting Company, Limited), and Messrs. J. Atkinson Hosker, Aymor H. Sanderson (vice-chairman), and R P. Sellon, M.I.E.E. (directors of the Bournemouth and District Electricity Supply Company, Limited).

New Catalogue.—The General Electric Company, of 69, 71, and 88, Queen Victoria-street, have sent us their new catalogue of electro-medical supplies. The list of headings in this catalogue, which represent the various class of goods listed, show us that the average electrical engineer could not pass an examination on the ubject. These headings run as follows: Faradisation, galvanisation, magneto machines, galvano-cautery, batteries, Röntgen ray apparatus, electrodes, rheophores, rheostats, galvanometers, and accessories. We have accordingly looked the matter up, and find that faradisation is produced by faradaic coils, which are not very different from what is known as induction coils. On the other hand, "galvanisation" consists in the application of direct currents to the patient. These two definitions being safely acquired, we turn with pleasure to the details of the catalogue. These details show practically every form of instrument in which electricity plays a part used by the medical man. The catalogue is interspersed with notes of advice, which make it of special value to the medical man. The illustrations are, as is always the case with the General Electrical Company's lists, both numerous and clear. Electric cautery apparatus is most fully described, and this is another instance in which the resistance of a wire, so much in the way of the electrical engineer, is of great service to another profession.

Sydney (N.S.W.).—The *Building, Engineering, and Mining Journal* says that the telephone connection between Sydney and Newcastle is rapidly approaching completion. The rate for use of this line will probably be 4s. for five minutes' conversation. The Brush Electrical Engineering Company are carrying on some extensive additions to the electric lighting plant at Messrs. Geddes Bird and Co.'s stores, Darling Harbour, under the supervision of Wildridge and Sinclair, C.E. A number of incandescent lights will be installed in the cold storage room. Mr. A. C. F. Webb, C.E E for the North Shore Ferry Company (N.S.W.), reports that the dynamo and engines for the ss. "Kangaroo" will probably be landed in Sydney next week. Messrs. Crompton and Co. have the contract in hand for this and two more of the ferry boats. Mr. Webb has received instructions to prepare plans and specifications for the installation of electric lighting plant and erection of lights at the new refrigerating stores, Darling Harbour, for the N S.W. Fresh Food and Ice Company. The contract for the erection of the first section of the building, at a cost of £17,944, was recently secured by Mr. W. Wilson, of Station-street, Newton, plans having been prepared by Mr. Coxon, C.E., 63, Pitt-street, Sydney. Messrs. Hamilton and Rutledge are installing electric light at the building for the Civil Service Co-operative Stores in Pitt-street Sydney. Most of the wiring is in iron tubing, with distributing boards on each floor, the main switchboard being of polished marble, as are also the distributors. Provision has been made for one arc and 235 incandescent lamps. The columns and pendants for the clusters of lights are being specially constructed by Messrs. J. Castle and Sons, of George-street, Sydney. The contract for the supply of current has been secured by Mr. George Adams. Mr. A. C. F. Webb, M.I.E.E., is the consulting engineer.

Ipswich.—At the last meeting of the Board of Guardians the Erection Committee reported that they had come to the conclusion that it would be advisable that the new workhouse should be lighted by electricity instead of gas the necessary plant for generating being purchased and worked by the Guardians. Messrs. Taylor and Field, electrical engineers, of London, prepared an estimate showing that, taking into account the initial cost of lighting by electricity and lighting by gas respectively, and the annual charges in respect thereof, there would be a slight saving in lighting by electricity. Another electrical engineer in London also showed a slight saving in electric lighting. Having been informed that in the Paddington Infirmary electric lighting had been substituted for gas, the committee sent a deputation there to examine and report upon it. This deputation found that the authorities at Paddington were very well satisfied with the alteration, and considered that a saving had been effected thereby. The committee then instructed Mr. A. B. Chapman, of Ipswich, to go into the question on their behalf and report upon it. Taking into account the interest of 3 per cent. upon the additional outlay to light the house by electricity over lighting by gas, it would seem, from Mr. Chapman's report, that lighting by electricity would, if the lights were used for the same number of hours yearly in each case, be slightly more than lighting by gas. It was to be borne in mind, however, that experience has shown that, owing to the ease with which electric lighting can be put out, electric lights are not used as many hours per annum as gas lights. There are also other advantages connected with lighting by electricity. The Chairman suggested whether, considering the importance of the question of lighting, it would not be advisable to adjourn the consideration of that part of the report until members of the Board had had an opportunity of looking further into the matter. This was agreed to on the understanding that an estimate should be obtained from the gas company as to the cost of providing a similar number of gas lights.

Newcastle-on-Tyne.—The erection of a complete electric installation, comprising electric and motive power for the dry docks at Cargo Fleet, was completed last week. Messrs. Ernest Scott and Mountain, Newcastle-upon-Tyne, were the contractors, and Mr. J. G. W. Aldridge, London, the electrician. A trial took place on Friday night last under the superintendence of Mr. Aldridge and Mr. Mountain, which proved to be a complete success. It was demonstrated that with the 10 powerful arc lamps the docking and undocking of ships could be undertaken at night with comparative ease and safety as well as in the daytime. The following is a short description of the electric lighting and power plant: two vertical double-cylinder, double-acting, high-speed engines, each engine capable of giving 30 effective horse-power with steam pressure of 35lb. per square inch when running at a speed of 300 revolutions per minute, and fitted with cylinders 10in. diameter by 8in. stroke The engines are complete with continuous lubricating gear, and the speed of each engine is controlled by centrifugal governors, driven by belt from the crankshaft. The engines drive by belt on to two "Tyne" dynamos, each dynamo being capable of feeding an equivalent of 300 16 c.p. lamps, the machines being constructed to give an output of 175 amperes at an E M.F. of 105 volts when running at a speed of 900 revolutions per minute. The dock is lighted up by 10 arc lamps of 3,000 nominal candle-power each, each lamp burning with a current of 15 amperes for 16 hours without recarboning. The workshops are also lighted by four arc lamps of 1,000 c.p. The arc lamps are run in pairs, each pair being controlled by a switch and adjustable resistance, and the lamps are suspended from poles fitted with suitable head-gear, and counter balance weights. The workshops and offices are further lighted by 47 incandescent lamps—there being four 8-c.p. lamps, 35 16 c.p. lamps, and eight 32-c.p. lamps. Twenty-four 32-c.p. incandescent lamps are supplied for lighting inside vessels and under ships' bottoms; each of these lamps is fitted into a watertight portable lamp, with 100ft. of armoured flexible cable to each. From the distributing boxes, electric motors will be driven for drilling and other purposes in the repairs of vessels of all classes. This installation is of somewhat novel description as the electrical energy is to be utilised for arc and incandescent lighting, and also motor-driving.

Blackpool.—The Blackpool people are noted for their pushfulness, and the local papers are not in any way sparing of their criticism when any undertaking of the Corporation does not come up to their expectations. Thus, the *Blackpool Herald* publishes, in its issue of the 14th inst., a comparison of detailed working costs of the electric lighting plant in the Winter Gardens and the same costs in the Corporation's electricity works. The figures are as follow: The period of working to which the particulars of the Winter Gardens' plant relate is the four months from June 1 to September 30, 1897. The details are as follow: Capacity of dynamos, 360 kw.; maximum load, 324 kw.; number of lamps connected, equal to 8 c.p. each, 21.000. The electricity supplied during the four months was 84,170 units, compared with the production of 429,669 units by the Corporation during one year. The company's electrical engineer points out in his report that had this been supplied to the Winter Gardens Company by the Corporation, it would have cost the former 5d. per unit. The capital expended by the company upon electric lighting plant is put down at £12,000, and the revenue from the supply of current to the company is stated to have been £1,730, besides £49 from the company's tenants, making the total income £1,752. The total cost of production was £440, and allowing £280 for interest and depreciation, at the rate of 7 per centum per annum upon the capital outlay of £12,000, there remained a net surplus of £1,032 after covering all charges. But it is in the analyses of the cost of generation and distributing that the most striking comparison is made. For instance, for coal and other fuel, cartage, etc., the Winter Gardens spent £178, or at the rate of ·51d. per unit, while the Corporation average is 1·21d. The other items of cost were: oil, waste, water, and engine-room stores—Winter Gardens, £19, averaging ·05d. per unit; Corporation, ·40d. Wages of workmen — Winter Gardens, £105, averaging ·30d.; Corporation, ·68d. Repairs and maintenance — Winter Gardens, £15, averaging ·04d.; Corporation, ·48d. Total works' costs — Winter Gardens, £317, averaging ·90d.; Corporation, 2·77d. The respective general costs were: rents, rates, taxes, etc., £25—0·7d. per

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unit; Corporation, 0·11d. Management, salaries of engineers, clerical staff, stationery, printing, and general establishment charges: winter gardens, £98, averaging ·27d.; Corporation, ·53d. The total comparative costs for the two departments are: Winter Gardens, 1·24; Corporation, 3·41. Of course, the editor adds, it is only fair to observe that the period under notice must necessarily be regarded as exceptional, inasmuch as it includes the "season," during which the various departments of the gardens were all in full swing, and the demand for electricity far greater than it will be at any other period of the year. Still, the figures go to prove that a private installation can be very efficiently and economically worked, and if the Winter Gardens Company can show good results, surely it is not too much to anticipate a similarly satisfactory return from the Corporation's electrical undertaking? This closes the editor's remarks, which show again conclusively the well-known fact that any place of public amusement where a regular and heavy load obtains can generate its own electricity at a cheaper rate than a public supply station. This fact may be clearly borne in mind, and we must again reiterate our disapproval of statistics like the above being used to the prejudice of the central-station men. In several ways the Blackpool Corporation station is handicapped, and the exclusively summer season of the place is the chief of these. In spite of this, and of their somewhat excessive capital expenditure, the town engineer would effect an enormous reduction of this total cost per unit if he could get a load factor like that found in the Winter Gardens —Mr. R. Quin, the Corporation electrical engineer, has sent in to the Electric Lighting Committee a report replying to the statements made at the recent meeting at the Empire. Mr. Quin remarks it is scarcely necessary to reply to the statements made and the strictures passed at the recent "town's meeting" concerning electrical affairs, as such statements carry with them their own condemnation by reason of their wildness and inaccuracy; nevertheless, he has deemed it expedient to furnish the committee with a few particulars combating the allegations. As these details are chiefly to point out inaccurate statements to some ratepayers as to the charges in other towns, we do not reprint them, but Mr. Quin's figures for seaside towns are worthy of reproduction. Thus, among 11 seaside towns, the average price obtained per unit is least at Brighton—viz., 4·69d.—Portsmouth following with 4·97d., Blackpool being third with 5 5d. The same order appertains respecting the percentage of gross profits upon the capital outlay. Blackpool figures, therefore, both as regards the sale price and the percentage of profit, come out better than the undertaking of any company trading as suppliers of electricity in seaside resorts. Although these figures show very well in comparison with other towns similarly situated, he certainly hoped for better things to come. One thing is certain, if the same rate of consumption continues, the average price obtained per unit at Blackpool will be less than the average price—viz., 5·5d.—last year. As regards the traction question, Mr. Quin quotes a report of Mr. Hesketh, dated November, 1893, to show that his predecessor was of the opinion that "under the peculiar circumstances then holding in Blackpool—viz., the troubles of sand and water, and the projected widening of the promenade—the overhead system is the most feasible and reasonable to adopt, both on account of its cheap first cost and also its efficiency."

TRAFFIC RECEIPTS.

Bristol Tramways.—The traffic returns for the week ending December 10 were £2,256. 6s. 1d., compared with £1,876. 17s. 3d. for the corresponding period of last year, being an increase of £379. 8s. 10d.

Dover Tramways.—The traffic receipts for the week ending December 11 were £81. 15s. 8d. The total receipts up to the same date were £1,583. 5s. 9d. The mileage open at present is only two miles.

Birmingham Tramways.—The traffic receipts for the week ending December 11 were £3,426. 18s. 10d., as compared with £3,010. 1s. 10d. in the corresponding week in 1896, being an increase of £426. 17s. 0d.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended December 12 amounted to £1,296, as compared with £1,098 in the corresponding week of the previous year, being an increase of £198.

City and South London Railway.—The returns for the week ended December 12 were £1,101, compared with £1,075 for the corresponding period of last year, being an increase of £26. The total receipts for the half-year 1897 amounted to £22,981, compared with £23,022 for the corresponding period last year, being a decrease of £41.

South Staffordshire Tramways.—The traffic returns for the week ending December 10 were £550. 9s. 3d., as compared with £551. 17s. 8d. in the corresponding week of the previous year. The aggregate receipts so far this year were £30,976. 1s. 4d., as compared with £30,046. 3s. 6d. in the corresponding period in 1896.

S.D. Tramways, Dublin.—The traffic receipts for the week ending December 10 were £382. 14s. 3d., as compared with £446. 19s. 4d. in the corresponding week in the previous year, being a decrease of £64. 5s. 1d. The number of passengers carried was 67,082 in 1897 and 69,604 in 1896. The aggregate returns up to date are £14,669. 1s. 5d., as compared with £15,439. 8s. 1d. last year, being a decrease of £770. 6s. 8d. The mileage open is the same as last year—viz., eight miles.

PROVISIONAL PATENTS, 1897.

DECEMBER 6.

28746. A simplified automatic generator for supplying the electric light for cycles and other vehicles. William Doherty, 9, Venus-street, Liverpool.

28751. Improvements in or relating to electric bells. Charles Turnbull, jun., Hylton Lodge, North Shields.

28765. Electric fire-alarm. Henry Patchett, 16, Beatrice-terrace, Bolton-road, Bury.

28784. An electrical apparatus for communicating between railway carriages and the guard's van or engine. Ernest Palmer Dix, 17, Folkestone-road, Walthamstow, London.

28795. A new or improved compound or material for electrical insulating purposes. Hawthorn John Brown, Otto Robert Heinrich Schmidt, and Alexander Mackenzie, 27, Southampton-buildings, Chancery-lane, London.

28799. Improvements in electric current meters. Paul Eibeg, 18, Buckingham street, Strand, London. (Complete specification.)

28800. Improved electric meter. Albert Peloux, 23, Southampton-buildings, Chancery-lane, London.

28809. Improvements in or relating to electric arc lamps. Charles Oliver, 31, Southampton-buildings, Chancery-lane, London.

28823. Improvements in covers, caps, and lids of gas, sewer, telephone, and electrical supply shafts and holes, gullies, and the like. John Price and Joseph Johnson, 11, Burlington-chambers, New-street, Birmingham.

DECEMBER 7.

28839. Improvements in trolleys used on overhead wires for electric traction. William Wood, 2, John-street, Bristol.

28853. Improvements in electrical magazine fuse blocks. William George Heys, 70, Market-street, Manchester. (William Ehrhardt, William B. Thom, and George A. Connor, United States.) (Complete specification.)

28859. Improvements in resistance and contact apparatus for electric currents. Henry Lyon, 121, West George-street, Glasgow.

28882. Improvements in electric valve-controlling devices. George Barker, 77, Colmore-row, Birmingham. (George Joseph Schoeffel, United States.) (Complete specification.)

28895. Improvements in insulating supports for the third rail or electric conductor of electric railways. Albert Anderson, 11, Southampton-buildings, Chancery-lane, London. (Complete specification)

28921. Improvements in transformers and apparatus connected therewith for alternating-current systems of electrical distribution. Eustace Oxley, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

28923. Improvements in means for electrically controlling the opening and closing of a plurality of escape orifices for fluids. Fernand Victor Beauvois, 18, Buckingham-street, Strand, London.

28926. An improved electric switch. Frederick Augustus Gilbert, 55, Chancery-lane, London. (Complete specification)

28940. Improvements in magnetic telegraphy. Oliver Joseph Lodge, 6, Lord street, Liverpool.

28943. Improvements in or connected with electric driving gear. Erich Correns, and the firm of C. Wilh, Kayser, and Co, 6, Lord-street, Liverpool. (Complete specification.)

28952. Improvements in insulated electric conductors and apparatus for making the same. James Draper Bishop, 24, Southampton buildings, Chancery-lane, London. Date applied for under Patents, etc., Act, 1883, Sec. 103, June 7, 1897, being date of application in United States.)

28956. Improvements in electric cables. John Hall Kelman, 1, Queen Victoria-street, London. (Complete specification.)

28960. Improvements in pushes for electric bells and the like. Isaac Hardy Parsons, Alwyn Walter Staveley, and Isaac Hardy Parsons, trading as Gent and Co., 4, South-street, Finsbury, London.

28965. Improvements in controllers for motors and brakes of electric cars. Adolphe Grossman, 40, Chancery-lane, London. (Complete specification.)

DECEMBER 8.

29009. Improvements in or relating to electric furnaces for the production of calcium carbide and other substances. Joseph Bastick and William Arthur Thornton, 50, Wellington-street, Leeds.

29010. Improvements in or relating to means or apparatus for conveying the boxes to and from electric furnaces. Joseph Bastick and William Arthur Thornton, 50, Wellington-street, Leeds.

29011. Improvements in or relating to electric furnaces for the production of calcium carbide and other substances. Joseph Bastick and William Arthur Thornton, 50, Wellington-street, Leeds.

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28994. Regulating electric motors for working hoists or the like. William Harding Scott, Gothic Works, Norwich.

29024. Improvements in electric lighting. John Webster and Walter Reynolds, jun., 8, Quality-court, Chancery-lane, London. (Complete specification.)

29048. Improvements in effecting electrolytic deposits of iron. Francis Edward Elmore and Alexander Stanley Elmore, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (John Oliver Surtees Elmore, India.)

29055. Improvements in or relating to alternate-current meters. Clarence Paul Feldmann and Helios Elektricitäts Aktiengesellschaft, 322, High Holborn, London. (Complete specification.)

29062. Improvements in apparatus for the manufacture of electric cables. Willoughby Statham Smith and William Puddicombe Granville, 24, Southampton-buildings, Chancery-lane, London.

29069. Improvements in syntonic telegraphy. Oliver Joseph Lodge and Alexander Muirhead, 323, High Holborn, London.

DECEMBER 9.

29090. New process or system of sewage and foul water purification by electrical action. Abraham Buckley Ogden, Manchester Corporation Sewage Works, Davyhulme, Manchester.

29116. Improvements in the distribution and regulation of electric energy and in conductors connected therewith. Sydney William Baynes, 25, St. George's-square, Regents Park, London.

29155. Improvements in electric lamp holders. Edward Lionel Joseph, 65, Chancery-lane, London. (Complete specification.)

29163. Improvements in the construction of dynamo-electric machines. Edward Belden Merrill, Picton, Ontario, Canada.

29177. Improvements in and connected with underground electric conduits. Jacob Atherton, 70, Palace-chambers, Westminster, London.

29180. An improved electrical accumulator. Paul Brandt, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

DECEMBER 10.

29222. An improved terminal for use in electric switches, cut-outs, ceiling roses, wall plugs, and the like accessories. Samuel Edward Foster, 21, Bull-street, Harborne, Birmingham.

29229. Improvements in inner globes for electric arc lights. Alfred Horswill Gibbings and Carl Adolf Louis Prusmann, 2, Market-street, Bradford.

29235. Improvements in electrical switches. James Moores and Henry Oliver Farrell, 15, Hanging-ditch, Manchester.

29244. Improvements in apparatus for freeing, lighting, and extinguishing gas-burners at a distance by means of electricity. Paul Guyenot, 60, Queen Victoria-street, London. (Complete specification.)

29251. Improvements in and connected with connections for storage cells. Edward John Wade and the Electric Motive Power Company, Limited, 16, Elm-street, Gray's-inn-road, London.

29257. Improvements in or relating to electric signalling, particularly on railways. Wilfrid Swanwick Boult and Cedric Randal Boult, 111, Hatton-garden, London.

29273. Improvements in plates or electrodes for electric accumulators. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Carl Francke, Germany.) (Complete specification.)

29306. Improvements in apparatus employed in wireless telegraphy. Guglielmo Marconi, 24, Southampton-buildings, Chancery-lane, London.

DECEMBER 11.

29318. Improvements in and connected with the control and regulation of electrically-propelled vehicles. Edward John Wade and the Electric Motive Power Company, Limited, 16, Elm-street, Gray's-inn-road, London.

29322. An improved method of exhausting incandescent electric lamps and apparatus to be used therefor and for similar purposes. Hiram Stevens Maxim, 45, Southampton-buildings, Chancery-lane, London.

29328. Improvements applicable to hoists worked by means of electricity. Claud Hamilton, 121, West George-street, Glasgow.

29361. Improvements in or relating to electric gas-lighting and controlling devices. John Henry Kerridge, 111, Hatton-garden, London.

29379. Uninterchangeable incandescent lamps. William Humphrey Wheatley, 40, Chancery-lane, London. (The Allgemeine Elektricitäts-Gesellschaft, Germany.) (Complete specification.)

29390. Improvements in electrical apparatus for transmitting and receiving predetermined messages. Siemens Bros. and Co., Limited, and Charles Holden, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

29377. Improvements in or relating to the propulsion of railway trains and the like by electricity. Emil Kaselowsky, 322, High Holborn, London.

SPECIFICATIONS PUBLISHED.

1897.

490. Electric deposition of metal on pipes, tubes, and other articles. Wright.

991. Automatic apparatus for producing X-rays and showing their effect on a prepared plate or screen. Dowsing.

2445. Thermometric electrical circuit closer Zeal.

2534. Systems of electric traction. Belfield. (Westinghouse.)

3113. Electrical accumulators. Von Berks and Renger.

4242. Means for connecting or continuing electric circuits through electroliers, brackets for electric lamps, and the like. Clarke.

4824. Rail bonds for electric railways. Daniels.

7189. Means for supplying current to electrical cars. Ott and Silbermann.

11337. Incandescent electric lamps. Boult. (Worringen.) (Amended.)

17596. Trolleys or sliding contacts for electric cars. Wise. (Krotz, Allen, and Kelly.)

18113. Winding apparatus for field telephone wires or the like. Boije.

19479. Magnetic means for resisting end-thrust in shafts or spindles in electric meters and other apparatus. Stanley and Darlington.

19638. Electrical storage batteries and plates therefor. Kennedy.

19846. Manufacture of plates for electric accumulators. Guelzow.

21704. Secondary electric batteries or accumulators. Hart.

22206. Machine for making storage battery plugs. Potter.

22218. Electric measuring instruments. The British Thomson-Houston Company, Limited. (Thomson.)

22800. Electrical apparatus for use in dental surgery and other electro-surgical treatments. Dow.

23792. Electric propulsion of vehicles. Schneider.

24130. Mountings for the contact shoes of surface contact railways. The British Thomson-Houston Company, Limited. (Potter.)

24150. Electrodes for storage batteries. Lloyd.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	11½
Brush Company, Ordinary	3	1½-2
—— Non. Cum., 6 per cent. Pref.	2	2½-2⅝
—— 4½ per cent. Debenture Stock	100	103-112
—— 4½ per cent. 2nd Debenture Stock	100	103-105
Callender's Cable Company, Debentures	100	108-113
—— Ordinary	5	7-8
Central London Railway, Ordinary	10	9½-10
——	6	5½-6
Charing Cross and Strand	5	12½-13½
Chelsea Electricity Company	5	10½-11
—— 4½ per cent. Debentures	100	113-116
City of London, Ordinary	10	26½-27½
—— 6 per cent. Cumulative Pref.	10	17-18
—— 5 per cent. Debenture Stock	100	131-136
City and South London Railway, Consolidated Ordinary	100	66-68
—— 4 per cent. Debenture Stock	100	138-140
—— 5 per cent. Pref. Shares	10	15½-16
County of London and Brush Provincial Co., Ordinary	10	13½-13⅝
—— 6 per cent. Cum. Pref.	10	15½-16
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2 2½
—— 5 per cent. Debentures	—	89-94
Edison and Swan United Ordinary	3	2⅞-3⅛
—— 5 per cent. Debentures	5	4½-5½
Electric Construction, Limited	2	2½-2⅞
—— 7 per cent. Cumulative Pref.	2	3½-3⅝
Elmore's Copper Depositing	1	⅛-¼
Elmore's Wire Company	2	⅛-¼
W. T. Henley's Telegraph Works, Ordinary	10	20-21
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	9-10
—— 7 per cent. Preference	5	11-11½
India Rubber and Gutta Percha Works	10	23-24
—— 4½ per cent. Debentures	100	103-107
Kensington and Knightsbridge Ordinary	5	14½-15½
—— 6 per cent. Pref.	5	8½-8⅝
London Electric Supply, Ordinary	5	2½-2⅝
Metropolitan Electric Supply	10	18½-19½
—— 4½ per cent. First Mortgage Debenture Stock	100	119-123
National Telephone, Ordinary	5	6½-6⅝
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	14-16
—— 5 per cent. Non. Cum. Third Pref.	5	6-6½
—— 3½ per cent. Deb. Stock	100	104-109
Notting Hill Company	10	17½-18½
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8-8½
—— £4½ shares	4½	7-7½
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	105-107
South London Electric Supply, Ordinary	2	2⅛-2
St. James's and Pall Mall, Ordinary	5	17-18
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	36-39
—— 5 per cent. Bonds	100	103-105
Waterloo and City Railway, Ordinary	3	12½-13
Westminster Electric Supply, Ordinary	5	16-17
Yorkshire House-to-House	5	8-8½

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NOTES.

Derbyshire Metallurgical and Engineering Association.—Last Friday evening the first of a series of science lectures under the auspices of this association was given at Derby by the Rev. Stanley A. Pelly, M.A., vicar of Swanwick, upon "Crystals."

Exhibitions. — The exhibition which has been announced to be held next year in Sydney has been postponed, and will not be held until after the Paris exhibition of 1900. It is proposed by the Electrical Association of St. Petersburg to hold an industrial exhibition in 1899.

Rumours of Amalgamation.—Rumours are current in New York of an amalgamation of all the principal electrical concerns, including the General Electric Westinghouse, the Walker Company, and the Fort Wayne Company; but as far as we are able to learn, it will remain a rumour, and nothing more.

Electric Turntables.—The Baltimore and Ohio South-Western Railway have made estimates for a period of several months, showing that the cost of turning a locomotive by an electrical device attached to the turntable is less than a farthing for each time the table is used, while if turned by hand the estimated cost is about sixpence.

Balloons.—Thursday evening of last week at the Society of Arts was devoted entirely to information relating to balloons of all sorts and conditions. The occasion was a general meeting of the Aeronautical Society of Great Britain. Mr. Bruce was there, and explained all about his system of signalling by means of a little goldbeater's skin balloon containing electric lights, which we have previously referred to.

The Railway Agitation.—The answer of the London and North-Western Railway Company to the Lancashire and Cheshire railwaymen's delegates' proposed programme of concessions was received on Tuesday. The company states that, in view of the recent improvements, nothing further can be done at present. The other railway companies have already replied, and the whole of the replies will now be submitted to branch meetings of railway workers.

Institution of Engineers and Shipbuilders in Scotland.—We have received a copy of the *Transactions* of the forty-first session, 1897-98, vol. xli., Part II. (issued December, 1897), which contains the report of the second general meeting, November 23, 1897; the adjourned discussion on Mr. Hermann Kühne's paper on "The Proell-Corliss Engine and the Proell Valve Diagram"; the discussion on Mr. F. J. Rowan's paper on "Water-Tube Boilers"; and Mr. Robert Caird's paper on "A Graphic Log."

Electric Cabs in Leeds.—The attempt to introduce the electric cab into Yorkshire has succeeded in so far that the Hackney Carriages Committee of the Leeds Corporation have given permission for one of these vehicles to be tried in the Leeds streets. The chairman is empowered to inspect and pass the new cab if he thinks proper, and the idea is that it shall be run experimentally between now and the next meeting of the committee three weeks hence, when the whole question will be taken further into consideration.

Electric Traction.—The last of the course of six lectures on "Electric Traction," which have been given at the City and Guilds Technical College, Finsbury, was delivered on Thursday in last week by Mr. Philip Dawson, who stated that if any of the students wished to put any questions to him in writing he should be very happy to answer them. The lectures have been attended throughout by a very large number of students, and they have been very much appreciated. A course of three lectures on "Motors" is announced for the New Year.

Depression in the Chemical Trade.—The outlook in this industry is still very gloomy and depressing. The salt-cake makers, bleach workers, and other employés at the chemical works of Bowman, Thompson, and Co., Limited, Bostock, near Northwich, have received notice that after January 1 a reduction of 10 per cent. will be made in wages. Several branches have refused to accept the reduction, and claim that they are now receiving less than employés at Widnes and Runcorn. Many men at other works in Northwich district are under notice.

Lighting the Ocean.—The possibility of lighting the ocean track between New York and European ports has been more than once discussed. An Italian named Carrello and a French engineer named Lemieur have brought forward another scheme to do this by means of floating lighthouses which are to be anchored at a distance of 50 miles apart. The initial cost is stated to be from 15 to 20 million pounds, and the maintenance between £400,000 and £750,000 per year. The scheme is sure to meet with as much success as it deserves, even on the rough estimate!

Novelties in Advertising.—The *Electrical Review* of New York says that the Central Electric Company of Chicago is sending out handbills offering £20 reward for the conviction of any man who can offer a better line of electrical supplies than several of their well-known salesmen. The handbills contain portraits of these men, with a description following. They are all described as being about as tall as three-fifths of a length of interior conduit, and weighing about the same as an 80-light transformer. If, as we are told, we are to follow America's lead, this is what we shall have to come to.

A Long Train.—There has been a good deal of talk lately about the length to which electric trains are attaining. What is claimed to be the longest and heaviest electric train yet run is that on the Akron, Bedford, and Cleve land Railway, Ohio. The line is about 25 miles long, and, from the *Pittsburg Post*, we learn that the train, which was an excursion train, was composed of 11 passenger coaches, each carrying 125 passengers; and the whole weight was pulled around a curve up a 4 per cent. grade by a single electric locomotive, which was equipped with four 50-h.p. motors made by the Westinghouse Electric and Manufacturing Company at its East Pittsburg factory.

Acetylene Gas-Lighting.—We have received a copy of No. 1 of the *Journal of Acetylene Gas-Lighting and Carbide of Calcium Review*, which the editor claims to be the pioneer journal of a new industry. This is another offshoot of the electrical industry, as until the development of the electric furnace and its commercial possibilities with cheap electrical energy, as derived from water power, the manufacture of calcium carbide commercially was impossible. We note that both Prof. Vivian B. Lewis and Mr. Hiram S. Maxim contribute to the new venture. We echo Prof. Lewis's hope that the new journal may tend to remove the dangers of acetylene gas-lighting.

Fan Motor for Photography.—The *Electrical Review* of New York publishes an illustration of a fan motor which has been employed in Chicago for drying negatives. A plate just from the washing tank requires ordinarily from four to six hours to become thoroughly dry, and on damp days often longer. Drying by means of artificial heat has been tried with more or less success, and often with disastrous results where the film had not been previously

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hardened. By employing an electric fan, a rack full of negatives can be dried in from 10 to 15 minutes. A number of these fans can now be seen at work in the different departments of a large Chicago engraving firm, saving 90 per cent. of the time formerly used.

Society of Chemical Industry.—A meeting of the Nottingham section of this society was held at Derby last week. Mr. F. J. R. Carulla read a paper on the recovery of sulphur from sulphuretted hydrogen. After giving an account of the Claus process, the author described a method in which he was interested, and by means of which a good yield of sulphur could be obtained. The principle upon which this method depended was the mutual inter-action of sulphuretted hydrogen and sulphurous acid gas, by means of which sulphur was precipitated in a fairly pure state. Mr. R. M. Caven then gave an account of some investigations in which he had been engaged in conjunction with Mr. A. Hill, a senior student at the University College, Nottingham. The authors have devised a new process for the estimation of cuprous oxide, by means of which the analysis of sugars may be considerably shortened.

Direct Cable Communication with the West Indies.—The surveying steamer "Britannia" has returned from the West Indies after having found a suitable bed for the new cable to Jamaica. The "Scotia" left the Thames on Monday morning for Bermuda with the cable on board, which has been manufactured by the Telegraph Construction and Maintenance Company, Limited. The new cable is expected to be laid and opened to the public on January 31 next. Hitherto messages to the West India Islands and British Guiana have been sent *vid* the United States and Cuba, thus passing through foreign hands, but when the cable is laid from Bermuda to Turk's Island and Jamaica, messages can be sent *vid* Bermuda over entirely British territory. The Direct West India Cable Company, who own the new cable, are reducing the rate to Jamaica by 2s. 10d. a word, or nearly 50 per cent.

Society of Engineers.—The forty-fourth annual general meeting of the Society of Engineers was held on December 13 at the rooms of the society, 17, Victoria-street, Westminster, S.W. The chair was occupied by Mr. George Maxwell Lawford, president. The following gentlemen were duly elected by ballot as the council and officers for 1898—viz., as president, Mr. Wm. Worby Beaumont; as vice-presidents, Messrs. John Corry Fell, Henry O'Connor, and Charles Mason; as ordinary members of council, Messrs. James Patten Barber, Joseph Bernays, George Burt, David Butler Butler, Percy Griffith, Richard St. George Moore, Nicholas James West, and Maurice Wilson, as hon. secretary and treasurer, Mr. Percy Fairfax Nursey; as hon. auditors, Messrs. Alfred Lass, F.C.A, and Samuel Wood, F.C.A. The proceedings were terminated by a vote of thanks to the president, council, and officers for 1897, which was duly acknowledged by the president.

Science in its Relations to Commerce.—At the last monthly club dinner of the Article Club the subject of debate was "Science in its Relations to Commerce." Mr. F. H. Bowman, D.Sc., chairman of the Chloride Electrical Storage Syndicate, presided, and in introducing the subject of debate sketched the history of science in relation to industrial pursuits, pointing out how much commerce, industry, and the arts had profited from the advances particularly of electricity, chemistry, and engineering. Prof. Ayrton, representing electrical science, thought that capitalists might aid science, they having been aided by science. The great development he looked forward to in the early part of next century was the burning of coal at the pit's mouth, sending the energy thus obtained by means of overhead or underground wires to the big towns, and thence transforming it into mechanical energy for driving engines, and mechanical energy for cooking and for warming our buildings.

English Quality.—There is an old saying, that if you want a good article you must pay a good price for it. During the last American war a lot of steel rails were bought in England and laid on the Straitsville division of the Baltimore and Ohio Railroad. In tearing up these rails a short time ago it was discovered that they had been made in 1863. The rails were still in a very fair condition, and it was said that for light motive power would last 10 years longer—giving a total life of 44 years. It is an eloquent testimony to the quality of English steel; and certainly a good enough price was paid for it, for we are told that the rails were bought during the war at a cost of about £25 per ton, which is about four times higher than the present market price. If the original purchasers are alive they must derive some satisfaction from the knowledge that although, owing to circumstances over which they had no control, they bought in a dear market, they have received good value for their money.

Fire Prevention.—Some time back we announced the formation of a body called the "British Fire Prevention Committee," which originated in connection with the Paris charity bazaar fire. We now learn from Mr. George E. Monckton, the assistant secretary, that the scope of the committee's work has been gradually extended, and embraces all matters relating to urban fire protection. Mr. Monckton considers the recent disastrous conflagration in Cripplegate a sufficient reason to inform us that active steps are being taken to deal with the question of fire protection from a more serious view than has hitherto been the case, and primarily from the aspect of fire prevention. There is no doubt that the majority of our fires could be prevented, and their extent could certainly nearly always be limited with the aid of better planning and construction, no matter how excellent and efficient fire service is. The question of fire prevention has so far been much neglected. The number of members who have joined the committee up to date is over 200.

A Third-Rail Line in Germany.—The Wann See Railway, for which there was lately issued a prize competition for proposals to enable the increased traffic to be coped with, is to be worked by electricity, if the trials now to be made are successful. The line, which is about 7½ miles long, is between Berlin and Zehlendorf. The trial train is expected to make 15 double journeys per day with a load of 210 tons each. The current is to be conducted to the train by a special conductor rail 1ft. above the edge of the running rails. The conductor rails will be carried upon insulators placed four to five yards apart. The latter will be fixed upon wooden saddles, which will be firmly attached to the ends of the sleepers. The return current will pass through the running rails. The compressed-air brake now in use is to be retained; the air will be pumped by electromotors, but trials will also be made with an electrical brake. The line current will be used to light the carriages. Accumulators on the cars will be employed to prevent extreme fluctuations in the light.

An Addition to Electrical Periodicals.—A new electrical journal has been started at Vienna, the short title of which is as follows: *Elektrotechnischer Neuigkeits-Anzeiger und Bezugsquellen-Wegweiser*! The editor, in his preface, says that the paper is not intended as a scientific publication, but is meant chiefly for the practical man and the manufacturer as a guide in the many branches of electrical engineering. It will deal with new inventions and achieve-

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ments, and among the novelties in the first number we notice a new electrical safety lamp for mines. It is an application of a new patent cell in which Planté plates are used. The positive electrode has a capacity of 74·7 ampere hours. The lamps complete weigh three kilogrammes and maintain a 3-c.p. lamp for 18 hours. They are also provided with reflectors, and there is a specially-constructed arrangement, similar to a switchboard, where the lamps are recharged, which effects a great saving of time. This periodical, which contains very good illustrations, will at present only be published monthly on the 1st.

Municipal Motorcars.—It is an interesting and no less significant sign of the times that the Vestry of St. George, Hanover-square, are seriously considering the adoption of motorcars to take the place of horses in municipal work. At the last meeting, Colonel Sir Howard Vincent, M.P., moved that it be referred to the Committee of Works to consider the application of electric or motor traction for the service of the parish. The hon. member said the Vestry had of late wasted a good deal of time in discussions with reference to the purchase of horses. He thought motor traction would prove a good substitute for horses in the parish; at least there would be no harm in trying the experiment. The discussion on the motion was decidedly humorous at the expense of the horse, who has still a long life of usefulness before him in spite of the advance of science. One member of the Vestry remarked that the time was speedily coming when it would be the most common thing to see a motorcar, and the most uncommon thing to see a horse. The motion was finally carried by an overwhelming majority.

Frictional Differential Gear.—A correspondent from Germany sends us details of experiments made by H. Longchamps on friction driving. The arrangements of the test consisted of discs of various substances, such as leather, compressed paper, and wood, mounted on a horizontal axis, running on a disc of cast steel mounted on a vertical axis. In this way the position of the friction disc on the surface of the cast-steel disc varies the relative speeds of the two axles. This differential gear is exceedingly useful for driving machine tools by electricity, as minute changes of speed can be effected. The percentage efficiency of the combination with various powers and friction discs running on cast steel were as follows:

B.H.P. transmitted.	Leather.	Paper.	Wood.
·5	52·84	52·05	52·53
1·0	65·49	64·70	65·61
1·5	73 16	72·65	73·4
2·0	71·93	76·44	76·88
2·5	71·03	73·3	—

Experiments with a hardened steel disc running on cast steel gave no results, as power could not be transmitted by the combination.

Honour to whom Honour.—We called attention recently to the fact that the honour of discovering wireless telegraphy was claimed for a Scotchman, and in prefacing a lecture at Dundee a short time ago on "Telegraphy without Wires" by Mr. Richard Kerr, F.G.S., the chairman (Dr. Sinclair), said the subject was of peculiar interest in Dundee, as it was in that town, something like half a century ago, that the idea of telegraphy without wires was first conceived and submitted to the test of practical experiment by that modest and unassuming man of genius, James Bowman Lindsay. In the *Dundee Advertiser* of April 11, 1834, he found that Lindsay made the astounding prediction that houses and towns would be lighted by electricity, that electricity would be used for heating houses, and for driving machinery, instead of steam; and years before the suggestion of an Atlantic cable came across from the other side as a brand-new American notion, a plan of connecting the two countries by ocean telegraphy had emanated from Lindsay's fertile brain.—Mr. Kerr said in every town he had visited and lectured on wireless telegraphy he had mentioned what facts he knew of Mr. James Bowman Lindsay, and everywhere his name had been well received. It was with peculiar interest and pleasure that he stood that night in Lindsay's town, where he did such wonderful things more than 40 years ago.

Ugly Street-Lighting.—In Columbus, Ohio, there is a system of street-lighting which appears to us to have but one merit, and that is novelty, if we may describe novelty as a merit. An illustration of the system is printed in our New York namesake, and with that before us we can only wonder however it came to meet with the approval of the authorities. It consists of 19 arches stretching right across the road, and containing 50 16-c.p. lamps to the arch, placed at street intersections. The arches are made of steel angle iron, connected by lattice work, forming a triangular truss. Attached to this is a galvanised iron hood or reflector, with the lamps beneath, and extending below the rim of the reflector. The arches are erected upon the poles of the street railway, and they have an average span of 61ft. and a depth of 12ft. They are raised 20ft. from the ground at either end of the arch, and have 32ft. clearance in the centre. According to English ideas the system is very ugly and inefficient, and the appearance of the street is utterly spoiled. The street in the illustration has architecturally a very good sky line, and the appearance of a row of latticework arches extending as far down the street as one can see is very inharmonious and offensive to the eye. People in this country complain of a double overhead trolley wire, even when it is on T-shaped columns, but we dare not contemplate what would happen if a system such as we have described were proposed in any town in this country.

The Engineering Dispute.—The ballot papers from the delegates of the allied trades to the branch unions have been sent out. The men are asked first to vote in favour or against acceptance of employers' terms on management; and, secondly, to declare for or against the endorsement of the offer made by the affiliated societies' representatives at the conference. "The offer made," it is explained, "was provisional acceptance of employers' terms, and return to work on the basis of a 51 hours' week throughout the federated area." The result must be returned to the general office of each society concerned by the first post on the morning of the 27th inst. As soon as this information was made public the following telegram was sent from Glasgow by the secretaries of the Federation of Engineering and Shipbuilding Employers: "Dear Sirs,—We observe it widely reported in the Press that in the ballot now in process a vote is being asked on a 51 hours' week. We disclaim the slightest intention to interfere in the affairs of the allied unions, but we are desired by our committee in case of misapprehension to send you the present communication. As stated at the recent conference, the employers cannot recede from the position distinctly intimated at the commencement of the dispute that no reduction of hours can be made, and that before any settlement can take place the present demand must be dropped. The effort made by the allied unions to compromise on the basis of a 51 hours' week having been declined, the employers regret that the question of 51 hours should have been introduced into the vote, owing to the danger of its confusing the issue. The subject of this communication being of important general interest, we are giving it to the Press.—Yours faithfully, Thomas Biggart and James Robinson, secretaries. Messrs. Sellicks and Barnes, London."

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Electricity in Ship Designing. — An experimental tank is now in course of construction at the Washington Navy Yard for the testing of models of ships, and it has some new features which make it interesting. The structure is to be 500ft. long by 45ft. wide, and the water will be 14ft. deep. Around the inner walls of the tank and several feet above the water a track will be laid running perfectly straight until the ends of the building are reached, and here a curved recess is formed in which the models will be started. On the track will be four electric motors, geared in the same way as those used on electric tramways. These will work in pairs, being connected by a transverse shaft extending from side to side, and carrying at its centre a depending lever, to which the model will be attached. When the motor carriages are in motion the little ships will be towed along at a speed corresponding to that of the trucks, and the force exerted will be measured by a dynamometer, secured at the lower portion of the carriage. One of the two sets of motor carriages will be used as an auxiliary power for higher speeds. The maximum motive force will be about 100 h.p., and an electric plant will be specially built for the work. The models are to be made 20ft. long, which is a much larger size than has yet been used. Owing to the variation of the track and the gearing of the wheels this system does not commend itself to us when we compare it with the system which has been in use in the English dockyards for the past 10 years. We should think a wire connected to an electric motor would be far more reliable. Talking of the Washington Navy Yard reminds us that the *Electrical Engineer* of New York states that electricity for driving machinery there is becoming more used as time goes on. The present electric plant, which it is probable will be very considerably augmented at no distant date, consists of nine dynamos, which, besides supplying power for machinery, furnish current for 1,000 lights.

Metropolitan Railway Bill.—The Metropolitan Railway Company have duly deposited their Bill for next session in the Private Bill Office of the House of Commons. The Bill is divided into six parts. By Part 2 the company seek powers to alter the levels of their existing railway for a distance of over $1\frac{3}{4}$ miles between Kingsbury-Neasden Station and Kilburn-Brondesbury Station, and also to acquire additional lands adjoining their stations at Northwood, Willesden Green, Wendover, Quainton Road, and Chorley Wood. Under Part 3 important powers are sought to acquire certain properties in Marylebone-road, Finchley-road, and Euston-road for the purpose of "maintaining openings for the ventilation of their railway." The plans of the proposed openings are to be subject to the approval of the local authority within whose parish the ventilation works will be placed, and in the event of any disagreement between the company and the Vestry, the plans are to be approved by a civil engineer to be nominated by the Board of Trade. By Part 4 power is taken by the company to work by electricity the whole of the traffic on their railway or on any part of their system, including the lines owned jointly by them and the Metropolitan District Railway Company. For this purpose it is sought to erect a generating station on land adjoining their Edgware-road Station, and power is also sought to enter into agreements with the Metropolitan District Railway Company with reference to the working of both systems by electrical power. Under Parts 5 and 6 of the Bill additional powers are proposed to be conferred on their Surplus Lands Committee for dealing with lands between Pinner Station and Verney Junction Station, and between Chalfont-road and Chesham Stations. Power is also sought by the Metropolitan and District Joint Committee to accept a lease from the South-Eastern Railway Company of all the lands above the Joint Committee's Cannon-street Station. No new capital powers are sought under this Bill.

A Protest and a Suggestion from America.—Mr. F. A. C. Perrine, the editor of *Electrical Engineering*, a magazine published in Chicago, has something to say in the December number about English criticism and English investments. He protests in a peaceable way against the attacks made in the English technical journals against American engineers and engineering methods, and claims that the slip-shod work is not entirely of American origin, and that American engineers are as much disposed to take advantage of perfection in the art as any. The editor goes on to say: "There is more reason for an English criticism of American over-development of water power than there is for the spirit we have noticed above. At the same time, if these English journals would cease branding this over-development as American and would aid us in warning their investors against the true cause of over-development, many of the foolhardy hydro-electrical schemes would never have existence except upon paper, since in most cases these foolish companies are capitalised abroad and not in the United States. American investors are more familiar with the map of the United States, with the significance of distances here, and with the distribution of population in different localities. That these are not familiar to the English investor is very apparent as one examines the transmission schemes capitalised abroad and developed on the Pacific coast. In one place we find an English company developing power transmission from a water power in the mines, which is supposed to sell power to the mine owners, in spite of the fact that the same English company is already selling to these mine owners hydraulic power on long-time leases at low rates. Another English company has developed over 1,000 h.p. for an electrical transmission of 20 miles to a town situated in the heart of one of our worst deserts. Two other companies have developed between 2,000 h.p. and 4,000 h.p. each for transmission to a town having an old name, but which has never had a population larger than 10,000, and where all the manufactories that are in sight cannot use over 1,000 h.p. . . . Much of the country west of the Sierras is barren desert, and while water powers may easily be developed near this desert, a manufacturing population can never be expected to grow up without neighbouring agricultural opportunities. The two go inevitably hand-in-hand, and to a man familiar with the character of the country and with the possibility of increasing population, water-power development is a safe investment; but it is never wise to depend entirely upon the representations of the promoters of such companies without this knowledge. This the European journals could properly emphasise, and they would be doing a benefit to American engineering and American industrial development by preventing their readers from losing money in foolish schemes which are so extensively capitalised abroad."

National Electrical Code.—We have received a copy of the special edition of the rules and requirements for the installation of apparatus and wiring for electric light, heat, and power issued by the National Conference on Standard Electrical Rules from the headquarters of the American Society of Mechanical Engineers at New York. From the preface we learn that this code is the result of the united efforts of the delegates of the various electrical, insurance, architectural, and allied interests, who have resolved to recommend them to their respective associations. The general suggestions are that in all electric work, conductors, however well insulated, should always be treated

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as bare, to the end that under no conditions, existing or likely to exist, can a grounding or short-circuit occur, and so that all leakage from conductor to conductor, or between conductor and ground, may be reduced to the minimum. In all wiring, special attention must be paid to the mechanical execution of the work. Careful and neat running, connecting, soldering, taping of conductors, and securing and attaching of fittings, are specially conducive to security and efficiency, and will be strongly insisted on. In laying out an installation, except for constant-current systems, the work should, if possible, be started from a centre of distribution, and the switches and cut-outs, controlling and connected with the several branches, be grouped together in a safe and easily accessible place, where they can be readily got at for attention or repairs. The load should be divided as evenly as possible among the branches, and all complicated and unnecessary wiring avoided. The use of wire-ways for rendering concealed wiring permanently accessible is most heartily endorsed and recommended, and this method of accessible concealed construction is advised for general use. Architects are urged, when drawing plans and specifications, to make provision for the channelling and pocketing of buildings for electric light or power wires, and in specifications for electric gas lighting to require a two-wire circuit, whether the building is to be wired for electric lighting or not, so that no part of the gas fixtures or gas piping be allowed to be used for the gas-lighting circuit. The rules are divided into six classes, and we learn that trolley wires must have a double insulation from the ground. In wooden pole construction in traction work the pole will be considered as one insulation. For the diminution of electrolytic corrosion of underground metal work, ground return wires must be so arranged that the difference of potential between the grounded dynamo terminal and any point on the return circuit will not exceed 25 volts. (In England this difference is fixed at 7½ volts.) As regards incandescent lamps in series circuits, no electromagnetic device for switches and no system of multiple-series or series-multiple lighting will be approved. Switches in constant-potential systems must not be single-pole, except when the circuits which they control supply not more than six 16-c.p. lamps or their equivalent. Tubes or conduits are to be considered merely as raceways, and are not to be relied upon for insulation between wire and wire, or between the wire and the ground; for the code says that the object of a tube or conduit is to facilitate the insertion or extraction of the conductors to protect them from mechanical injury, and, as far as possible, from moisture. In rubber-covered wire insulation, the insulating covering must be solid and not readily carry fire, and it must show an insulating resistance of one megohm per mile after two weeks' submersion in water at 70deg. F., and three days' submersion in lime-water, and after three minutes' electrification with 550 volts. With respect to interior conduits the rules say that insulated metal conduits must have not more than the equivalent of four quarter bends from outlet to outlet, the bends at the outlets not being counted.

Royal Institution.—Prof. Oliver Lodge, F.R.S., professor of physics in University College, Liverpool, will deliver at the Royal Institution a course of six lectures (adapted to a juvenile auditory) on "The Principles of the Electric Telegraph." The first lecture will be given on Tuesday, December 28, and will deal with "The Production of an Electric Current." The remaining lectures of the course will be as follows: on Thursday, December 30, "The Detection of an Electric Current"; Saturday, January 1, "Land Telegraphy"; Tuesday, January 4, "Ocean Telegraphy"; Thursday, January 6, "Principles of Wire and Cable Signalling"; and Saturday, January 8, "Space Telegraphy." In the first two lectures Prof. Lodge will explain some elementary electricity, as our readers will see by the following, which is extracted from the syllabus issued by the Royal Institution. An electrified body manifests itself by electric force, usually attraction, and the region of this force is called an electric field. An electrified body in motion constitutes an electric current, which will be explained by the behaviour of electrified pith balls, and positive and negative charges behave just oppositely to each other. Atoms of matter are often (perhaps always) electrically charged, some positively, others negatively, therefore the atoms in a metal can pass a charge on from one to another, and so transmit it to a distance. This is metallic or wire conduction. Electric force is chemical action at a distance. Chemical affinity is electric attraction over ultra-microscopic distances. A liquid conveys a current by means of opposite atomic processions, which is electrolytic conduction, and has visible chemical results. The lecture then deals with the chemical method of producing a current by a voltaic cell, and explains that two differently oxidisable metals immersed in an oxidising liquid and connected by a wire can maintain an electric current through the liquid and through the wire so long as the circuit is closed. The same two metals immersed in a potentially oxidising gas, and connected by a wire, can maintain an electric force or voltaic difference of potential in the space between them. A wire can convey a current to a definite distant place, if it be insulated from any return conductor everywhere except at that place. In connection with this, insulators will be described. No current can flow continuously except in a closed circuit. The same is really, though less obviously, true of fluids—*e.g.*, the case of coal-gas. The lecture concludes with an explanation as to the amount of gap needed to stop an electric current, the diversion of an electric current, and the reversal of an electric current in some portion of its circuit, and a description of keys, switches, and commutators. The second lecture is more advanced, and deals with the detection of an electric current. A current through any substance produces heat; a current through any liquid (electrolyte) produces chemical decomposition, and every kind of current, convection, displacement, or any other kind, produces magnetism. The magnetism exists all round about the current, and its region is called the magnetic field. Compass needles in such a field are usually deflected, and pieces of iron in such a field tend to move it from where it is weaker to where it is stronger—*i.e.*, they are usually attracted. Hence a magnetic field produces visible mechanical results, and so is easily detected. It serves, therefore, as an indicator or detector of the current to which it is due. Galvanometers, needle signalling instruments, electromagnets, electric bells, the Morse recording instrument, the action of a fixed magnetic field on a movable current, the behaviour of suspended coils, and the "siphon recorder" are next dealt with, and the lecture concludes with an explanation of the fundamental principles of the electric telegraph. A current produced by a voltaic cell or battery can be started and stopped, or reversed, or weakened, or strengthened, by a suitable key or switch or commutator at one end of a long insulated wire; and it can be detected with a suitable instrument by means of its magnetic properties at the further end of that wire, the circuit being completed by another wire or by any other conductor, such as the earth. From the foregoing it will be seen that Prof. Lodge is going to make his lectures not only very complete and interesting, but "understanded of the people" as well, both old and young.

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NOTES ON ACCUMULATOR CONSTRUCTION.

BY DESMOND G. FITZ-GERALD.

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ERRATUM.—In the last section (XLI.), p. 774, column 2, line 37, for "By treating any commercial sample of peroxide of lead," substitute "By treating any commercial sample of red-lead."

XLII.

The reader possessed of a test tube, an indicator for acids, and a small quantity of the sesquioxide Pb_2O_3 may readily investigate for himself the correctness of the statement that "no oxide of lead but peroxide can exist in the presence of sulphuric acid." To some distilled water in the tube he may add one drop of sulphuric acid and then stir up with the fluid five grains of the pure minium, which would be more than sufficient to neutralise the acid, supposing it to be decomposed by the latter. He will observe that the minium retains its red colour—instead of assuming the dark puce colour of the peroxide—and that the solution, tested by the indicator, remains acid. Even the addition of a further portion of minium does not neutralise the latter—at least within the period of time ordinarily occupied by such an experiment.

To proceed more scientifically, add to the water in the test tube 10 cubic centimetres of decinormal sulphuric acid; and, as indicator of the presence of the latter, add further a sufficient quantity of a solution of methyl orange (para-sulpho-benzine azo-dimethylaniline) to produce a distinct light-red coloration. The original colour of this indicator in dilute solution is bright yellow, and this will be its colour when the acid is neutralised. Now 10 cubic centimetres of the $\frac{N}{10}$ sulphuric acid contains one-thousandth of the monad gramme equivalent. The atomic weight of PbO = 222. Both the elements being dyad, the mass of 222 grammes is the dyad gramme equivalent, and 111 grammes constitute the monad gramme equivalent. The quantity of PbO equivalent to the above volume of decinormal acid is therefore ·111 gramme. This will be contained in ·111 × 2·08 = ·23088 gramme of Pb_2O_3. To be on the safe side, take ·25 gramme of the compound, in very fine powder, add it to the acid, and stir thoroughly. Observe that the red lead retains its colour, and that the solution, when clear, retains its light-red coloration. By adding further portions of red lead, it is possible, in time, to neutralise the acid; but it is not possible, I think, to convert the red compound into the brown peroxide.

XLIII.

"It is well known to chemists that when an equivalent of a metallic oxide (K_2O, MgO, ZnO, $H_2Pb_2O_3$, PbO, etc.) is added to an equivalent of an acid (*e.g.*, H_2SO_4) the two equivalents neutralise each other to form a salt." Now this sounds very plausible; and few, perhaps, would venture to controvert the dictum. Nevertheless, it belongs to the older chemistry, and must be accepted with certain qualifications. It is an incautious generalisation, which "ought to be," but is not, quite correct. If, for instance, the hydrated ferric oxide (Fe_2O_3,H_2O) be heated to dull redness, after parting with its water at a temperature of 608deg. F., it suddenly contracts in bulk, and undergoes an unexplained molecular change, during which it glows brightly for a few seconds. In this condition it will not neutralise acids, or can be made to do so only with great difficulty. Even by boiling in water, if the boiling be continued for eight or ten hours, this hydrate, without necessarily becoming altered in chemical composition, undergoes an analogous change, indicated by the variation of its colour from brown to brick-red; after which the oxide is insoluble in strong boiling nitric acid. Other similar examples could be quoted; but more ordinary instances of inertia in combination are of greater interest in connection with the present subject.

I have shown that red lead can exist, at least for considerable periods, in presence of excess of dilute sulphuric acid. But now I have to go further, and to show that the same assertion may be made in relation to pure anhydrous protoxide of lead. In commerce, this is now almost invariably termed litharge (or, as most house-painters pronounce it, lithridge). Formerly, the light-yellow oxide, which has not been subjected to fusion, was called *massicot*. From the fact that impurities were frequently ground up with it, and that it could not be used, consequently, for glass-making, this material fell into disrepute; and, when a light-coloured oxide was required, *litharge of silver* was supplied, and this purer material grew in demand. But, for the glass manufacture, litharge containing a certain percentage of red lead, or *litharge of gold* (I am not responsible for these absurd names) is preferred; since the additional oxygen brings about the oxidation of carbonaceous impurities in the *fritt*. By certain furnace manipulations, the oxide can be obtained in a crystalline form, when it is termed *flake litharge*. The protoxide of lead is slightly soluble in water, giving to it an alkaline reaction.

Now let us make a brief comparative test of the action of dilute sulphuric acid upon the protoxide of lead and some other protoxides. I take five test tubes half filled with water, and in each case add 10 cubic centimetres of $\frac{N}{10}$ sulphuric acid* and a sufficient quantity of methyl orange to give a distinct red coloration. To the first tube (A) I add 10 cubic centimetres of the $\frac{N}{10}$ solution of caustic (or carbonated) potash (or soda). The colour of the fluid *instantly* changes from light red to bright yellow.

To the second tube (B) I will add magnesia (MgO) in excess—*i.e.*, rather more than one-thousandth of the monad gramme equivalent. Since MgO is dyad, this will be $\frac{40}{2 \times 1{,}000} = 0{\cdot}02$ gramme; and I will add 0·03 gramme. The magnesia is in very fine powder, and I stir it well into the acid. The colour changes to yellow, but *not instantly*.

To the third tube (C) I add oxide of zinc (ZnO) in excess. One-thousandth of the monad gramme equivalent would be (since the compound is dyad) $\frac{81}{2 \times 1{,}000} = 0{\cdot}0405$ gramme; but (always to be on the safe side) I add 0·041 gramme of the oxide finely powdered, and made into a cream with water. I stir well, but the colour does not seem much inclined to change. We have to continue stirring, and to "wait a wee." At last! The red has given place to yellow.

To the fourth tube (D) I add an excess of the hydrated protoxide of lead ($H_2Pb_2O_3$). Considered in relation to the weight of oxide of lead in it, this is a tetrad molecule, and one-thousandth of the monad gramme equivalent will be $\frac{464}{4 \times 1{,}000} = 0{\cdot}116$ gramme. But I will add 0·12 gramme, well mixed with water, as in the last case. I continue stirring, but the colour does not change. No doubt there is a powerful affinity in play; but for some reason it takes time to act. I am getting tired of stirring, and it seems to have no effect. Why does it not combine? That is the question. Let us leave it for an hour or two . . . Ah! now there is a slight yellow coloration just above the subsided oxide.

To the fifth and last tube (E) I add excess of anhydrous protoxide of lead—pure litharge. The monad gramme equivalent, as we already know, is 0·111 gramme. But in the hope to avoid long waiting I will add 0·2 gramme—a very considerable excess of this substance which gives an alkaline reaction to water. The oxide has already been levigated. Let us mix it well with water before adding it to the acid. Now let us stir. Stirring seems to be no use. I am getting tired. Please relieve me, and stir for an hour or two. What! My trusty assistant, have you got tired also? "Patience et longueur de temps," says La Fontaine, "font plus que force et que rage!" Do not break the tube, but let us leave it until the morning. . . . What! No signs of yellow? In the name of the eternal verities of chemistry, and of the authorities I have quoted, will the

* It may perhaps be useful to mention here that in volumetric analysis the normal (N) solution of the acid contains, in grammes, half the (dyad) atomic weight—*i.e.*, $\frac{98}{2} = 49$ grammes of the monohydrated acid (H_2SO_4), this being the monad gramme equivalent.

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yellow never come? I doubt it. Let us put the tube aside for a fortnight, and pass on.

It was Frankland who first pointed out that the compound resulting from the action of sulphuric acid upon litharge is $S_3Pb_5O_{14}$, or, as it would be more usually expressed, $3PbSO_4 2PbO$. Time is required even to produce this. No doubt the compound $PbSO_4$ *can* ultimately be produced from the same components, with the acid in considerable excess; but the complete reaction does not take place readily, because, as I think, it is preceded by others between plumbic compounds, involving affinities which have to be successively overcome.

XLIV.

It is important to point out—and the observation may give the reader a clue to the object of some of the foregoing contentions—that the hitherto obscure endogeneal reactions and affinities which have just been referred to, and which are retarding and resistant when PbO_2 has to be separated from PbO in the compound Pb_2O_3, or when $PbSO_4$ is to be produced by the action of H_2SO_4 upon PbO, have not to be overcome in the *discharge* of a lead secondary couple until the P.D. falls to 1·85 volts. In the *charge* they are resistant, and energy is expended in overcoming them; in the discharge they are adjuvant, and constitute a collateral source of energy. Mr. Swinburne points out (XL.) that the high E.M.F. of the lead secondary couple has to be accounted for. That is the desideratum when the percentage of PbO_2 in the peroxide plate varies from 95 to 48, and the E.M.F. varies from 2 to 1·85 volts. But a phenomenon equally requiring explanation is the low E.M.F. of the same couple when the percentage of PbO_4 varies from 41 to 36 and the E.M.F. varies from 0·6 volts to practically nil. The former phenomenon has never yet been satisfactorily explained; when it is so, the explanation will probably apply to the latter phenomenon also. This, at the present moment, has been explained only by the supposition, presently to be considered, that the active material becomes so "clogged" and "shielded" by lead sulphate as to become practically inert. But before entering upon this question, or any other, I think I am fairly called upon to show how the presence in a discharged peroxide plate of protoxide of lead, in an uncombined condition or combined only with lead peroxide, as in the sesquioxide Pb_2O_3 or with lead sulphate to form a basic sulphate such as $PbSO_4PbO$, may be verified by direct evidence.

XLV.

If a freshly-discharged lithanode plate, or the active material from a freshly-discharged peroxide "grid," be removed from contact with the acid electrolyte, and, after washing and reducing to powder, subjected to the action of dilute nitric acid, considerable quantities of nitrate of lead $[Pb(NO_3)_2]$ will be obtained in solution. But this is really no evidence of the presence of protoxide, since dilute nitric acid exerts a solvent action upon sulphate of lead, which is admittedly present in the spent active material. The most satisfactory method of proof I have been able to devise is slow, if quantitative results are required; but is quick and certain so far as a qualitative determination is involved. It is, in fact, a variation of our recent experiments with a measured quantity of sulphuric acid, tinted with methyl orange. To a few ounces of water contained in a test tube or other glass vessel add a few drops of the solution of this indicator (or of Congo red). The solution will be yellow. Add a cubic centimetre of, say, $\frac{N}{10}$ sulphuric acid: the solution becomes light red. Now add, say, one gramme of the dried and pulverised "spent" peroxide material, and stir with a glass rod. With this comparatively large proportion of the solid, the solution quickly resumes its yellow coloration. The qualitative determination is now complete: the acid has been neutralised by lead protoxide. We may now attack the quantitative determination. From causes which have been sufficiently referred to, this will be a somewhat lengthy operation. Add another cubic centimetre of the acid, and diffuse the solid as before. The solution, reddened by the acid, will again become yellow. Proceed in the same manner until acid has been added in excess, and the solution retains its red coloration in defiance of stirring and the exercise of patience. Then, if the quantitative determination is to be accurate, perform a "backward titration" with $\frac{N}{100}$ alkali, added cautiously until the yellow coloration appears. Then the weight of protoxide of lead present in the quantity of spent peroxide treated will be—

$$\cdot0111 \times n - \cdot00111 \times n \text{ (grammes)};$$

n being the number of cubic centimetres of the $\frac{N}{10}$ acid, and n the number of cubic centimetres of the $\frac{N}{100}$ alkali.

XLVI.

The following experiments are not put forward as settling the vexed question as to the action of lead sulphate, mixed or in combination with the active material of the peroxide plate, in reducing the E.M.F. of the lead secondary couple, but only as a step in this direction.

Series (A), with Platinum Supports.—Three platinum strips were taken (the size is immaterial). No. 1 was coated with a stiff paste of electrolytic peroxide and water. The active material was held in position by a strip of fine cotton fabric bound with cotton thread. No. 2 was coated with a stiff paste of equal volumes of electrolytic peroxide and lead sulphate, maintained in position as above. No. 3 was coated with a stiff paste composed of equal volumes of electrolytic peroxide and barium sulphate, maintained in position as before. Barium sulphate suggested itself as a beautiful material for "clogging" and "shielding" the peroxide; whilst, on the other hand, it cannot give rise to any internally-generated affinities and reactions.

Immersed with a spongy-lead plate in sulphuric acid of density 1·263, and tested against a Clark standard cell: No. 1 gave 2·01—2·00 volts; No. 2, 1·73—1·75 volts; and No. 3, 1·83—1·86 volts. The three couples were then respectively charged for three minutes from a battery of E.M.F. about three volts. No. 1 then gave 2·17 volts; short-circuited for five seconds it gave 1·87, rising to 2·13—2·17 volts. No. 2 gave 1·97—1·91—1·89 volts; after short-circuiting, 1·40 volts. No. 3 gave 2·11—2·10 volts; after short-circuiting, 1·37—1·45—1·46 volts.

Series (B), with Peroxidised Lead Supports.—The supports were treated in the same way as those used in the former series of experiments: No. 1 gave 2·04 volts; No. 2, ·32—·34 volt; and No. 3, 1·26—1·24 volts. The coated strips were then made anodes in acid of the above specific gravity for five minutes: No. 1 gave 2·19—2·17 volts; No. 2, 1·02—·60—·45 volts; and No. 3, 2·14—2·15 volts. The couples were afterwards recharged for 10 minutes: No. 1 gave 2·20—2·15—2·10 volts; No. 2, 2·11 falling to 70 volts; and No. 3, 2·2—2·09—2·05 volts.

Experimental results seldom appear altogether consistent; nor do these. Although by no means conclusive, they indicate that the clogging and shielding action is by no means the only cause of the fall of E.M.F.

PRACTICAL USE OF WATER RHEOSTATS.*

BY EDWARD J. WILLIS.

Anyone can make a water rheostat, and anyone can run one, but the first time one tries the job there is some uncertainty as just how to begin, and just what it will do after you have got it running. This article is not to help those who know all about water rheostats, but to give a few pointers to those who may have to take up the job for the first time, and also to offer a few suggestions to those who have already had such experience.

As in most other things, it depends upon the purpose for which the resistance is needed just how it had best be made. The usual water resistance is not a steady resistance. By this I do not mean that it is a fluctuating resistance—*i.e.*, jumping up and down—but it will not stay at any one thing for a long time under a heavy current. It is, if properly made, most readily adjustable, and with at all careful handling, entirely satisfactory results may be obtained; but he who thinks he can leave a water resist-

* From the *American Electrician*.

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ance at a certain number of amperes, and go up-town and come back and find the ammeter where he left it, would probably be surprised to find his amperes twice what he wanted. This action of decreasing its resistance is particularly noticeable if the plates are new. Use readily changes the surface character. It is also caused by electrolytic action increasing the amount of salt held in solution by the water. The result of this action is that the plates must be lifted out of the water from time to time to counteract the increasing conductivity. It is sometimes surprising to find how rapidly such an increase of resistance takes place, especially if too much salt is added to the water when starting.

A good many tables of conductivity per cubic foot of water at such and such percentage of salt, etc., and also much data as to current density per square foot submerged, are available. It is not, however, the opinion of the writer that the tables of either water resistance or current densities are of much service in the operation of the water rheostat. There are two factors so readily and so widely variable that it is very much easier to start with a resistance considerably higher than needed and cut down to what is wanted, than it is to go to much figuring in the matter. The two factors referred to are the percentage of salt in the water and the extent of immersion of the plates. As one can start with plates out and no salt, it can be easily seen that with a little practice the current can be adjusted up to the capacity of the rheostat.

A water rheostat, as usually constructed, consists of two plates partly immersed in water, one being connected with the positive lead and the other with the negative, and either or both plates adjustable, so as to vary the extent of immersion. The method of lifting the plates, of course, depends upon conditions, size of plates, etc. As a rule, a block and fall is very convenient and cheap, as the ropes themselves form good insulators.

It is well to screw the plates to a good-sized timber, such as a sawed tie, and attach the falls by screw eyes to the timber. Flexible cables form the best method of connecting the plates. The character, thickness, etc., of the plates is not important. It is usually best to purchase old iron boiler or tank plates. Rust makes no difference, but it is best to remove paint. The thickness of the plates is not important, so long as they are thick enough to prevent their striking against each other when handled, and thus forming short-circuits. The distance apart of the plates is also unimportant, as the resistance is not affected by this.

It is best to place the plates 5in. or 6in. apart, so as to prevent any possible chance of their touching each other. The tank may be either of iron or wood. Wood is the best, as it is less likely to short-circuit the plates, and is easier and safer to handle. The wood tank is also much better suited to railway circuits, as the iron tank is quite likely to make a ground.

The first question which naturally arises when one starts to make a water rheostat is, How big must the tank be, and how large the plates? As stated before, this depends upon the purpose for which you want the resistance. It is safe to say that they are generally made too large, and that the usual water resistance is considerably underestimated in capacity. It is best to look upon a water rheostat as a method of dissipating heat. Electricity practically takes the form of heat as soon as it reaches the rheostat. One of the best ways of absorbing heat is to tranform it to a latent heat. As soon as the water in the rheostat starts boiling this process has commenced, the steam produced taking up the heat.

The rheostat should be placed outside of the building, or so located that its vapour or steam will not injure the machinery or electrical apparatus. When so located, the rheostat can be permitted to boil away. The capacity of the rheostat is therefore like that of a kettle, dependent upon how soon it will boil over. By putting in water in place of that boiled away, a constant level may be maintained. Should it be desired to force the rheostat, a current of running water can be introduced, and by providing suitable overflow arrangements, the capacity of the rheostat can thus be greatly increased. The easiest way of introducing water into the rheostat is by the means of a hose let down to the bottom of the tank. It might be well to suggest that a wire-wrapped hose is a dangerous article, especially if railway circuits are under test.

Use an old piece of hose, as the boiling water will probably ruin a good hose. By regulating the water flowing in with the cock or valve to which it is attached, excellent results can be obtained. One is inclined to use more water than necessary. Often the tank boils away steadily and quietly, and it is only necessary to replace the water as evaporated. Sometimes if the resistance is decreasing, owing to the electrolytic action on the plates, by turning on more water, the old salt water is flowed off, and the resistance of the rheostat can be kept steady by regulating the water. If the current of water run into the rheostat is very large, one might think that the large current of fresh water would weaken the salt solution and increase the resistance too much. This increase of resistance may take place under very heavy work, but the writer has not found this to have been the case in any of his work.

The following test, made by the Baltimore and Suburban Railroad, gives an idea as to how large currents may be carried by comparatively small plates. This road not very long since tested a 100-kw. booster and an 800-kw. generator by lowering with block and fall iron plates into the dock alongside the power-house. The data on the booster tests are—plates 1ft. × 5ft. × ¼in.; maximum depth of

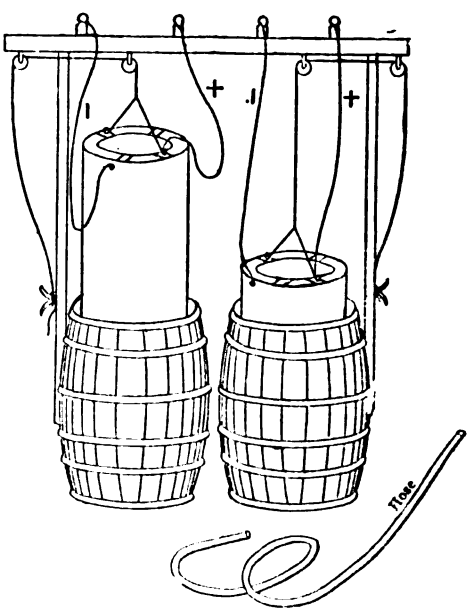

FIG. 1.—Barrel Water Rheostat.

immersion, 2ft.; maximum voltage, 625; maximum current, 800 amperes; maximum immersed surface, 2 square feet; maximum current density per square foot immersed, 400 amperes. On the generator tests the same plates were used, the maximum depth of immersion being 2ft.; maximum voltage, 550; maximum amperage, 1,450; maximum immersed surface, 4½ square feet; maximum density per square foot of immersed surface, 322 amperes.

It is not generally the case, however, that the salt water is found convenient to the power-house. Wells or ponds can be used by putting salt in them. It is usually the case, however, that it is best to put in some form of tank. The writer recently conducted a test on two 300-kw. units, in which a tank 4ft. by 4ft. by 5ft. was used. This tank could easily handle 1,000 amperes at 550 volts. Running water from a fire hose was found necessary to keep the tank from too violent ebullition. The maximum depth of immersion of plates was 3ft.; the maximum area immersed, counting both sides of both plates, was 36 square feet; maximum current density per square foot, 280 amperes. Much higher current density can be used if the body of water is large, as when the plates are thrown over a dock or submerged in a pond.

For the usual run of work, testing, etc., the writer would suggest the construction shown in Fig. 1. A 55 or 60 gallon barrel is used, and an ordinary sheet of galvanised iron rolled over and riveted to a cylindrical form makes the outside plate. The inside plate, which should be the

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positive one, is made of the same material about 6in. smaller in diameter.

One barrel so equipped will easily handle 50 kw., and on a pinch with plenty of running water, and where steadiness is not essential, 75 kw. to 100 kw. may be taken by the barrel. By putting in one of these barrels for every 50 kw. or 75 kw. according as to whether steadiness is essential or not, one can obtain very satisfactory results without much cost as to construction. As all the barrels are not likely to boil over at the same time, fairly steady results may be obtained, even when driving these barrels quite hard. Where accurate regulation of current is needed, such as for one or two arc lamps on a 500-volt circuit, or a vitascope, etc., the writer would suggest that the plates be cut away to a spiral form, as shown in Fig. 2. By this method the current starts from practically nothing, going steadily up to a maximum, and the regulation becomes more sensitive as the current diminishes. (The engraver should have made the spiral edges straight in Fig. 2 instead of jagged.)

It would not be out of the way to caution anyone using a water rheostat for the first time as to the small amount of salt needed. The amount of salt depends upon the voltage and the current needed. With the 60-gallon barrel mentioned above and 550 volts, a tablespoonful of salt is an abundance; and if a small current, say, under 50 amperes, is needed, it would probably be better to use no salt at all, but simply to start up the rheostat and let it run a while until the electrolytic action has produced sufficient conductivity. If on putting in salt the current does not immediately respond, wait a little while, for it takes some time for the salt to diffuse, even with stirring. One should not keep on putting in salt if the rheostat does not start up to the desired current. If too much salt is put in at first,

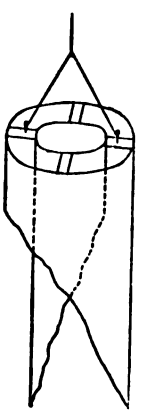

FIG. 2.—Rheostat with Spirally Cut Plates.

the conductivity will increase too rapidly, and the test will probably end with the plates only just a little bit in the water. This is bad, as it not only reduces the ease of adjustment, but also concentrates the heat at the surface of the water, and in so doing reduces the capacity of the rheostat.

Where a perfectly steady resistance is required, an immersed wire rheostat may be employed, which is ordinarily the wire-box rheostat dipped in a barrel of running water. Very fine wires may be used if a good supply of running water can be kept going through the barrel. German silver is probably the best wire to use, as it does not easily rust. Iron wire can be employed, but it has to be carefully dried and varnished after being used. If too much varnish be allowed to accumulate on it, it is likely to make it burn out. The capacity of such rheostats is very small, probably not being usually over one-tenth that of a plate rheostat of the same size.

Persons have sometimes curiosity as to the voltage of the water in a water rheostat. The voltage of the water varies with the location. Around and at the negative plate it is nothing. At the positive plate it is positive. Between the two it falls off gradually. The result is, that the amount of current felt on immersing the hand into a water rheostat depends upon the place where the hand is immersed, and the extent of immersion. If the hand reaches from a negative to a positive locality a very heavy shock is sustained. A water rheostat with sufficient distance between the plates to enable a man to bathe without danger of touching the plate, would form an almost ideal electric bath in which a current in any desired direction, and of any desired strength, could be obtained by a single movement of the body.

A NOTE ON WATER RHEOSTATS.*

BY E. A. MERRILL.

Several years ago I, in conjunction with several other students, made a short series of experiments on the use of water rheostats with small currents. These experiments were for qualitative rather than quantitative results, and therefore only generalisations can be drawn from them; but as such generalisations may have a certain value through indicating the direction in which more accurate results can be obtained, they are here recorded.

A trough of rectangular section, about 6in. deep and wide by 6ft. or 8ft. long, was constructed out of planed pine boards. This trough was first filled to within about an inch of its depth with water from a hydrant water probably of an average purity, it being used for drinking purposes and drawn from reservoirs up among the country hills.

Two triangular electrodes were made from sheet copper and crudely attached to copper leads. The source of current was a storage battery, this serving both to give a constant E.M.F. for any given set of conditions and a convenient method for varying the E.M.F. to suit different sets of conditions. Measurements were made with a Weston ammeter in circuit, with one of the electrodes and a Weston voltmeter across the termials. By varying the E.M.F. as the resistance in circuit was varied, a wide range of readings was possible without at any time exceeding about 20 amperes.

A very few readings showed that though the water was chemically far from absolute purity, yet it was too pure to give satisfactory results as a resistance—its resistance proved to be approximately 100 ohms for a volume 1ft. in length having a cross-section of one square foot. This extremely, and unexpectedly, high resistance made it necessary to bring the electrodes so close together for large currents and low pressures, say 10 amperes and 10 volts, that fine gradations were impossible, the slightest movement causing wide and erratic fluctuations. It was observed that so long as the current density was sufficiently low not to cause violent ebullition, the resistance was but little affected by changes in the current density or by the length of time it flowed.

It was also observed, both in this and the further experiments, that when the current density was sufficient to cause violent ebullition, the apparent resistance fluctuated constantly and widely, due doubtless to the gathering of gas bubbles on the surfaces of the electrodes, thus diminishing their effective area.

The next experiment consisted in taking new series of measurements after diluting the water with various quantities of commercial oil of vitriol or sulphuric acid, the trough having first been cleaned and supplied with fresh water.

The reduction in resistance was even more marked than with a salt solution for equal quantities of acid by weight. The results are tabulated below, and are for a volume of the solution 1ft. in length, and having a cross-section of one square foot.

Per cent. acid.	Resistance in ohms.
·174	4·12
·435	1·75
·724	1·10
·985	·85

Per cent. acid by weight.

The use of acid gave fairly uniform results. For a given degree of dilution the resistance remained nearly constant with varying current densities and over considerable periods; the gases escaped freely from the surfaces of the electrodes and corrosion was slow.

The next experiment consisted in taking new series of measurements after mixing various quantities of table salt in the water. The change in the resistance of the salt solution was very marked, and the results, reduced to the

* From the *American Electrician*.

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equivalent of a volume of the solution 1ft. in length and having a cross-section of one square foot, are given in the following table:

Per cent. salt.	Resistance in ohms.
·23	7·84
·46	4·65
·70	3·12
·93	2·38
1·16	1 9
1·39	1·48

Per cent. salt by weight.

The use of salt gives a cheap and convenient method for widely varying the resistance in circuit, but we found it very untrustworthy for accurate work. The chlorine gas set free in the decomposition of the solution is extremely corrosive, eating away the electrodes very rapidly, and forming a heavy scum of a comparatively low specific resistance, which gradually accumulating on the surface rapidly diminished the ohmic resistance between the electrodes. The results given above are from readings taken when the surface was clean. Moreover, this scum served to imprison bubbles of hydrogen, and when an electrode was withdrawn from the solution they were occasionally ignited as the current was broken with a flash often sufficiently intense as to be dangerous if one's hand or face were too close.

STEINMETZ'S INDUCTOR DYNAMO DESIGN.*

In inductor dynamos the armature and field-magnet coils are stationary and the induction is produced by a change in the path of the magnetic flux effected by the teeth or poles of the rotating inductor. In consequence in part of the magnetic circuit the magnetism varies, and this part, to avoid eddy currents, must be laminated, while in the other parts the magnetism is stationary, and solid material may be used. It is, therefore, of importance to avoid changes in magnetism in the solid part of the structure in order to avoid excessive heating and loss from eddy currents.

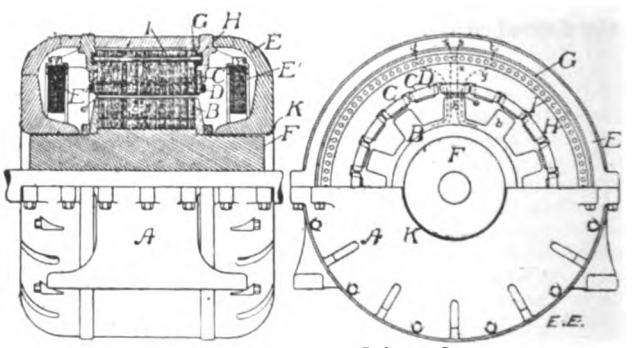
During the rotation of the inductor, the length of the path of the lines of magnetic force, and thereby the reluctance varies, periodically in the laminated portion of the armature, which tends to make the magnetic density vary periodically also. To keep this periodic variation of magnetic density from extending into the solid part of the magnetic circuit, Mr. C. P. Steinmetz inserts an auxiliary air-gap between the solid and the laminated part of sufficient length to make the magnetic reluctance of the shortest and of the longest path across the armature iron and auxiliary air-gap practically equal, and thus the magnetic density at the point of entrance into the solid part of the magnetic circuit practically uniform.

Another feature of Mr. Steinmetz's design consists in the use, in an inductor dynamo, of a short-circuited or squirrel-cage winding surrounding the outer edge of the armature iron. The magnetic reluctance of the air-gap between the inductor and the armature, especially in unitoothed single-phase machines, is less when the inductor tooth stands in front of an armature tooth than when it stands in front of a slot. Thus the magnetism in the latter case tends to decrease, and this induces eddy currents in the whole magnetic structure. The use of the short-circuited winding tends to obviate this difficulty.

The accompanying engravings show a machine constructed according to these principles, it being applied to a dynamo of the well-known Thomson inductor alternator type, but it might equally well be applied to any other machine of the same general class. Fig. 1 is an end elevation, partly in section, of such a machine; and Fig. 2 is a side elevation, partly broken away for convenience of illustration. In Fig. 1, A is the yoke or external portion of the armature core. B is the inductor, consisting of the yoke, F, and the laminated teeth, *b b*. C C are the armature teeth, consisting, as is usual in such machines, of laminated iron, the yoke, E, being ordinarily made of cast iron or mild steel. Surrounding the inductor and supported by the yoke are the field-magnet coils, E' E', they being stationary. G is the auxiliary air-gap above referred to, separating the laminated armature iron from the yoke, E. Between the yoke, F, of the inductor and the supporting yoke, E, of the armature is the air-gap, K, and the usual air-gap, *e*, is also located between the inductor and the armature.

The action of this part will be best understood from Fig. 2. The magnetic lines entering from the tooth, *b*, in the upper part of the figure and threading the coil spread out in both directions in the iron of the armature, reaching the yoke, E, at the point, *s*, in a practically straight line from the tooth and at the point, *t*, over the path, *y*, which is curved and is considerably longer than the path, *x*, having, therefore, higher magnetic reluctance. The magnetic density at *s* will be greater than at *t*. By the rotation of the inductor at the next moment the inductor tooth, *b*, will stand in front of the next tooth of the armature, and the path to the point, *t*, will be approximately straight, while that to the point *s* will be curved, and thus higher density will exist at the point *t* than at the point s. To avoid these pulsations of magnetism in the yoke, E, is the object of the air-gap, G. The reluctance of this gap being very large as compared with the reluctance of the armature iron, as pointed out above, makes the total reluctance of the path, *y*, practically equal to the reluctance of the path, *x*, and thereby ensures practically an uniform distribution of magnetism in the yoke.

To assist the effect referred to, Mr. Steinmetz also provides a short-circuited squirrel-cage winding consisting of the copper pins, I (Figs. 1 and 2), which pass through the



FIGS. 1 AND 2.—The Steinmetz Inductor Dynamo.

iron of the armature near its outer edge and are connected upon each side of the iron by the short-circuiting bands, H, also of low-resistance metal. Any pulsation or variation of the magnetic flux reaching the outside of the armature acts to induce secondary currents in this short-circuited winding. These currents tend to magnetise at the points of lower magnetic density, and to demagnetise at the points of higher density, and thus cause a uniform distribution of the magnetic flux at the outer part of the armature—that is, when the flux enters the solid structure. The action of this winding is also beneficial in causing uniform distribution of magnetism and in preventing pulsation of the magnetism in the entire magnetic circuit due to the differences of reluctance in the main air-gap of the machine caused by the revolution of the inductor. As already pointed out, the reluctance is less when the inductor teeth stand in front of the armature teeth and greater when they stand in front of a slot, thus giving rise to changes in the distribution of the flux and inducing eddy currents in the whole structure. It has been proposed to remedy this to some extent by winding the field-magnet coils, E', upon a solid copper ring or spool. While thus useful, the construction indicated acts in a more efficient manner because it influences directly the armature iron of the machine.

* From the *Electrical Engineer* (New York).

DUST DESTRUCTORS.

BY GEORGE WATSON, A.M.I.C.E.

A meeting of the Gloucestershire Engineering Society, with Mr. R. Read (president) in the chair, was held in the Guildhall, Gloucester, on the 14th inst. It was announced

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that Mr. Ernest Sykes, A.M.I.C.E., of London, would read a paper on "Refuse Destructors," but through illness that gentleman was unable to come, but his place was ably supplied by Mr. George Watson, A.M.I.C.E., of Leeds, who delivered a lecture on the same subject, for a report of which we are indebted to the *Gloucester Journal*.

Mr. Watson commenced by saying that having had to take Mr. Sykes's place at a very short notice, he had been unable to prepare a written paper and would therefore be obliged to confine himself to a few remarks upon the Horsfall destructor in the hope of leading up to a discussion of the subject. He would treat the matter in a somewhat general way even at the risk of infliction upon experts, like the president and others in the room, of information with which they were already familiar. In confining himself to this particular destructor, he said he was identified with the one bearing the name of Mr. William Horsfall, of Leeds, and he would tell them frankly at the outset that he was biassed by being the servant of the firm that was making and offering for sale that particular apparatus, and he would endeavour to put forward his opinions in such a way as to challenge comparison with other systems. He would not take them through the history of the subject, though some of them might not be aware that it went back to very ancient times, but he would merely say that it was now generally admitted to be just as necessary that refuse should be removed from among the population as it used to be in the nomadic times that the population should move itself from time to time from the refuse and rubbish of the camp. The question might be asked, Why must refuse be removed and dealt with at considerable expense by destruction? and the reply was that a large proportion of it was putrescible, and that if it were left in heaps to be dealt with by what he would call the slow-combustion processes of nature, it gave off during those processes offensive and dangerous emanations, giving rise to a class of diseases sometimes called putrefactive diseases, such as diphtheria, diarrhœa, and the like, and therefore it was not a question of mere convenience, though that in itself might be a sufficient reason for removing and dealing with such material, but the fact was that it was absolutely necessary for health that town refuse should be removed and dealt with with the least possible delay. Mr. Read, in his presidential address to the society, remarked that in a few years' time the collection of house refuse would have to be done at night. There was no doubt that that was the proper time for such operations, when the streets were clear of other traffic, but in practically every town the refuse was collected either in the night or in the day during a period of about eight hours, and not during the whole 24 hours. That made it necessary to store the refuse near the furnaces in sufficient quantity to keep them going throughout the whole 24 hours. It needed hardly to be remarked that actual destruction of matter was a thing impossible and unknown, and the word "destructor" was a misnomer. Probably the name "converter" would have been applied to this apparatus had it not been that it was already monopolised by the more famous and important apparatus in connection with steel manufacture. But the name destructor was now so general that perhaps there was no longer any need to cavil at it.

The functions of a destructor, then, were to receive offensive and putrescible matter and convert it into harmless and useful products. There came from the destructor clinkers, fine ash, tins, and steam power. The clinker was taken sometimes to a breaker, similar to a stonebreaker with mechanical riddles in connection with it, from which the clinker emerged in the form of large pieces suitable for concrete, and smaller pieces of a gritty nature suitable for filling in the interstices in tar paving, or for spreading on slippery roads. Another portion of the clinker might go to the mortar mills, and being ground fine, and mixed with a proper proportion of lime, would make excellent building mortar, which was generally sold ready mixed to builders, who fetched it away and used it without further treatment, paying a good price for it; or it could be mixed after grinding with Portland cement, and made into paving slabs, building blocks, or bricks. The fine ash could also be used, to some extent, for similar purposes, and he had known it to be used as the basis for disinfecting powder when treated with carbolic acid. He did not mean to say that the fine ash had any disinfecting property in itself, but that it formed as good a basis for that purpose as any other finely divided clean material. With regard to tins, these were sometimes used in the manufacture of copperas, but the difficulty was, as a rule, to bring them from places like, for instance, Blackpool, which was a considerable distance from any chemical works, to the place where they might be utilised. In connection with this point he had heard it suggested that these tins should be pressed and bundled in order to reduce the large cost of carriage which was due mainly to their large bulk in proportion to their weight.

The last and most important product of the refuse destructor was heat, which could by the application of sufficient boiler heating surfaces be converted into steam. The first use for such steam power that occurred to the mind of everyone in connection with destructors was the production of electricity. A great deal had been heard recently about combined plants, and there was no doubt that electric lighting lent itself more readily to such a combination than some other uses, because electricity works were still wanted in many towns, though it could not be denied that the length of time during which the electric lighting plant demanded such power was short. He strongly recommended that, in addition to the electric light, some use should be found for the power during the hours when the electric light station did not demand it, so as, if possible, to utilise the whole of the power produced by the destructor. As examples of such uses, Mr. Watson mentioned grinding, sawing, and stone-breaking, and the heating of public baths and wash-houses, which required a good deal more steam than some people imagined. Then there was pumping, which often required to be continued throughout the 24 hours. At Norwich the steam from the refuse burning was to be utilised for raising sewage. Finally, there was the question of selling power to outsiders, such as millowners, or other steam users. Some people seemed to think it was outside the rights of a public body to sell this power, but he would refer them to Leicester, where the power had been sold by the Corporation to a neighbouring mill for some considerable time, and with a certain amount of success; and he urged that if such an opportunity presented itself for combining the sale of power to a mill during the day, with the use of the power during the night for the electric lighting, it should not fail to be taken advantage of. But in regard to combining the destructor and electric light plant, he would go so far as to advocate the putting down of a sufficient number of cells to destroy the whole of the refuse in 12 hours instead of working the destructor on an equal rate throughout the 24 hours, thus concentrating the power during those hours when it might be usefully employed in the electric light station. This would involve a larger capital outlay for destructors, but it would be found, on going into figures, that it would pay exceedingly well to go in for this larger expenditure in order to apply as much power as possible in the production of electricity. Finally, with regard to the amount of power available from the destructor, he quite agreed with the remark of the president in his opening address to the society that, taking a low estimate of the value of town refuse, 1lb. of muck would evaporate 1lb. of water into steam, at, say, 140lb. pressure per square inch. Without going into detail, he would like to remark that means had been proposed for the storage of power of the destructor so as to utilise it to its full extent during the time of high load. They were all doubtless acquainted with Mr. Halpin's system of thermal storage, which he believed was a very useful apparatus; and, further, there was the means of storing electricity by accumulators, which, though very expensive as to first cost, could be applied on a reasonable scale so as to give great economy.

Coming now to closer quarters with the furnaces themselves, the question of the storage of refuse was first dealt with, and it was insisted upon that sufficient accommodation should be made to hold all the refuse required to be stored without causing any difficulty in emptying the carts. Mr. Watson strongly recommended that, as far as possible, machinery should be avoided in the means provided for handling the refuse. Lifts were no doubt good and necessary where space was limited or land was valuable, but they required a special man always in attendance to work them and to keep them in order, and at Nottingham, where one had been employed for some years, it was now proposed to substitute an inclined road. Different methods of feeding the furnaces when arranged in single cells, and also when arranged back-to-back, were then described in detail, and the difficulties attending any form of automatic and continuous feeding, owing to the enormous variety of materials brought to the destructor, were dealt with. The burning, however, was the most important feature of the whole process, and in regard to that, the lecturer said it might be well to adopt the Scottish method of direction, and indicate which way one ought not to go, rather than lay down rules as to the way one ought to go. In the first place, the destructor must not work at a low temperature; first, for the important reason that empyreumatic vapours, dangerous to health and offensive to the nostrils, were given off at low temperatures; and, second, because if a low temperature were adopted it would be impossible to get the maximum amount of steam power out of the gases. It might be argued that if the temperature were kept low by drawing through the furnaces a very large excess of air that the increased volume of gases would compensate as regarded steam raising for the loss of temperature occasioned by the excess of air, but it had to be remembered that the amount of steam raised depended entirely on the difference between the initial temperature of the gases and their final temperature passing up the chimney; also, of course, upon the volume. The final temperature, however, was practically fixed, as the steam-boiler, even when provided with a feed-water heater, would not reduce the gases much below 300deg. F. To reduce the matter to absurdity, therefore, it might be imagined that sufficient air

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was drawn through the furnaces to keep the temperature always considerably below 300deg. F., in which case it would not, of course, be possible to raise any steam at all to the required pressures. From this it would be seen that it was necessary to keep the initial temperature of the gases as high as possible, and that the increase of their volume would not to anything like the full extent compensate for a low initial temperature. He would go further, and say that the furnaces must not be provided with screens and fume cremators. These, although not in themselves harmful, were in his opinion evidences of failure. In some cases a screen might be useful in order to prevent the distribution of evening newspapers by the destructor chimney, but surely everyone would admit that the newspapers should never by any possibility escape out of the furnaces themselves. Unburned paper was the strongest possible evidence of imperfect combustion. Again, a screen was not of the slightest use in preventing fine dust from being drawn up the chimney, and fine dust had been proved over and over again to be one of the most serious troubles that had arisen in connection with destructors. In illustration of this point, a large circular dust-catcher, as applied to the Edinburgh destructor, was shown and described, and was asserted by Mr. Watson to have been successful in preventing the escape of dust. He further stated that it had been certified by the engineers in charge that no nuisance was now caused by that destructor.

As regarded fume cremators, the lecturer was also of opinion that they were evidences of failure. They were a confession that the temperature in the furnaces themselves and in the main flue common to the furnaces was not sufficient to enable perfect combustion to take place, and it was most unreasonable that large quantities of expensive fuel should be burnt in the main flue of the destructor in order to bake the gases, which were capable in themselves of burning at even a higher temperature than that to which they were subjected. In arguing against the use of high temperatures, many people had said that a destructor could not be constructed to withstand the very high temperatures sometimes reached, but in answer to that Mr. Watson said the destructor must not be built in ordinary firebrick, but a very special material must be used, capable of withstanding not only high temperatures but the changes of temperature which took place every time the furnace was clinkered, and also on Sundays, when, although the fires might be banked up until Monday morning, considerable falls of temperature took place. Bricks for lining such furnaces must contain a large proportion of silica, and yet not sufficient to render them brittle and liable to crack under the changes of temperature to which they were exposed. Again, the destructor must not have tie-bolts through its inward parts. It was absolutely necessary that the tie-bolts should be removed as far as possible from the heat, and that dog-stays of sufficient length must be used to brace the furnace from top to bottom. Again, to raise a controversial point, he would say that the destructor furnaces must not be mixed up with the boilers. Many people had argued, and had put their opinion into practice, that in order to obtain the greatest possible amount of steam from destructors, it was necessary to sandwich the boilers and the cells alternately. Such people fell into the error of considering each cell as a separate institution, instead of regarding the destructor as a whole. He preferred to consider the block of furnaces as a destructor, and as the source of heat, and to place the boilers as near as possible to that block of furnaces. People spoke of loss of heat by radiation, but how could there be a loss of heat from a main flue completely covered and enclosed by destructor cells? If the heat of one of the nearest cells escaped by radiation, it would simply be carried back into cells further on in the series, and would not be lost. But as a matter of practice it was found that the temperature at the end of the main flue under the block of cells was actually higher than it was opposite the opening from one of the cells further back. This was easy to understand, because the furnaces were not all at equal temperatures, and the main flue formed a mixing chamber and served to maintain the average heat at the point where the gases from all the furnaces were mixed together. By placing the boilers, therefore, at the end of the main flue the maximum heat was obtained, while at the same time very serious drawbacks attendant upon the mixing of the furnaces and boilers together were avoided. One of these was the difficulty of carrying tie-bolts through the block of furnaces if interrupted by boilers standing up between them. A further important drawback was the difficulty of cleaning and inspecting boilers when so placed between the cells.

A detailed description of the Horsfall destructor furnace was then given by the lecturer, aided by a number of diagrams. Particular stress was laid upon the method of keeping the top of the furnaces cool in order to prevent the stewing of the refuse; the drawing of the whole of the air for combustion from the deck of the furnaces, so as to ventilate the refuse-receiving house; the improved steam-blast apparatus for creating the forced draught, and the cast-iron sides of the furnaces through which the whole of the air for combustion was forced by the steam jets. These cast-iron sides served the double purpose of preventing the clinkers from adhering to and undermining the furnace arch, and of warming the air for combustion. The means adopted for rendering the blast apparatus silent were described, and considerable stress was laid upon the position of the exhaust of the furnaces, which being placed in the top of the furnace arch and in the front of it, over the hottest part of the fire, ensured that the whole of the products of combustion, together with the fumes given off by the green refuse lying at the back of the furnaces, were subjected to the highest temperature of the furnaces before being allowed to escape.

In conclusion, Mr. Watson remarked that in the comparison of different kinds of furnaces it was absolutely necessary that all the circumstances prevailing be taken into account. Whether the refuse was collected every day, or only perhaps once a month, made an enormous difference to the amount of handling required. Refuse which had been lying in a wet ashpit for a month frequently weighed double as much in proportion to its bulk as dry refuse collected every day, and, therefore, a ton of such refuse represented a less number of people by one-half than a ton of dry refuse from daily collections. But moisture in refuse had only to be warmed to be evaporated and passed up the chimney, and a great deal more labour was represented by a ton of dry refuse than by a ton of wet, as well as a larger proportion of the population. For instance, in Edinburgh, where the refuse is collected dry every day, it measures about 80 cubic feet to the ton, whereas at Oldham and Leeds, where it is allowed to collect in wet ashpits, it only measures 40 cubic feet to the ton. Then, again, the wages paid and the hours worked varied so much in different localities that great care had to be taken in comparing figures as to the cost of labour. He would only give one figure as to cost of burning, and that was one recently obtained from Mr. Jessop, superintendent of the Horsfall destructor at Oldham. This gentleman stated that the cost of burning, excluding interest on sinking fund, and after deducting receipts for mortar, etc., was 1s. 1¼d. per ton. The labour only amounted to 9¾d. per ton. It was further stated that no allowance had been deducted from the cost for steam supplied to the electricity works. He would say that in comparing different destructors it was essential first to ascertain that they were perfectly free from nuisance either from smoke, dust, or any other cause. Further, they must be constructed in such a manner as to withstand high temperatures and changes of temperature, and to cost only a reasonable amount for repairs. In this connection he would say it was usual to allow 10 per cent. for maintenance and depreciation of the destructor furnaces themselves, and he believed that was a reasonable figure. Then the destructors must be compared as to capacity of steam raising, and there was no doubt that the one which would raise the most steam would have very much in its favour. But the last and most important factor was the cost of labour in burning the refuse. This, he ventured to say, was of almost more importance than all the rest put together, and after making due allowance for the different conditions under which the destructors worked, it would be found that the one in which one man in an eight hours' shift could deal with the largest quantity of stuff, measured preferably by bulk, would be the one that ought to be adopted. In making comparisons of this kind, it was usual to state the cost of labour per ton, but in the lecturer's opinion it was preferable to state the amount of refuse not by weight, but in cubic yards, which a man could burn in an eight hours' shift. This would give true comparison of the working of destructors.

Discussion.

At the conclusion of the lecture, the **President**, in proposing a vote of thanks to Mr. Watson, said he thought they could congratulate themselves upon having that gentleman, who had proved a very good substitute for Mr. Sykes, and had given them a most interesting lecture, dealing with the dust destructor from its crudest form up to its latest developments. A great deal depended upon the quality of the refuse to be destroyed, and that depended upon how it was stored by householders, and how soon collected. When stored in ashpits it did not get collected oftener than once a month at least, or for a longer period. The refuse was then in a wet and putrid condition, and very nasty stuff to deal with. In Gloucester they got over that difficulty by the collection of the whole of the refuse three times a week, so that it was comparatively in a fresh and dry condition. Therefore he thought the refuse of Gloucester one of the best kinds for destruction in the furnaces It was now becoming almost imperative to burn refuse, because in most towns the means of disposing of it by any other method were getting fewer and fewer, and the difficulty increased of finding suitable tips where the refuse could do no harm. In conclusion, the President referred to some of the main difficulties mentioned by Mr. Watson in his lecture to be overcome in connection with a dust destructor, as, for instance, the difficulty of the refuse only coming at certain periods during the day, the storing of the refuse and avoiding any stink arising therefrom, and keeping up a regular temperature in the furnaces.

Mr. C. H. Scott seconded the vote of thanks, and asked the lecturer a question or two on the furnaces. He was of opinion that 10 per cent. per annum, the amount mentioned by Mr.

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Watson for the depreciation and repair of the furnaces, was too low, and he thought 30 or 35 per cent. should be allowed. While agreeing that the dust destructor should be erected at some place convenient to get at, he did not think it should be put where there were houses, because he held that it was impossible to prevent dust, smoke, etc., and when they had to depend upon human agency they could not assure prevention against such things, and the nuisance it might cause might be very serious, and no advantage would be caused by combining the electric light and the dust destructor.

Mr. J. W. Howard expressed an opinion that hydrocarbon, in the form of spray, could be used with advantage over the refuse to facilitate the burning, and increasing the output of steam.

Mr. W. A. Walton, speaking from an electrical point of view, said he had always felt a sort of prejudice against dust destructors, and, so far as he had seen any account of their results, they failed to justify their use, or, at all events, to confirm the somewhat extravagant claims that were sometimes made by those interested in their construction. He repeated that he did not think those claims had been substantiated by destructors in actual work. He fully appreciated the systematic clinkering of the furnaces so as to keep an even temperature in the main flue, but they had yet to find what the value of the refuse collected in Gloucester was for that purpose. With regard to the dust destructor at Shoreditch that had been making considerable noise in the world lately, and great claims made for it, he thought that Shoreditch was most favourably situated for a very good class of refuse from shops, warehouses, and such like, but there was a considerable amount of coal being burned there also not altogether accounted for. Thirty tons per week had been used in order to consume some of the refuse, and although it had been stated that this was used only on Saturday and Sunday, he contended that they could not possibly get rid of that quantity of coal for the output forthcoming. Then at Cheltenham they had as good a class of refuse as at Gloucester, and more of it, but he did not think the use they put their dust destructor to was at all a promising inducement for Gloucester.

Mr. Watson explained that at Cheltenham they had only a natural draught, and the boiler was of an old type.

Mr. Sisson and others having spoken, the **President** said it seemed to him that more had been expected of dust destructors than perhaps they were capable of doing. It had been a very fascinating idea that they were going to prove a sort of gold mine capable of producing all the power required for the electric light. The first object of a destructor was to get rid of the refuse, and to consume it in a way that was sanitary and convenient, and reduce it to the smallest minimum possible. If in doing that they could utilise the heat thereby developed in raising steam, he did not see why they should not do so; but whether it was best to use that power to help the electric light, or to use it in any other way, was a matter for consideration.

The vote of thanks was carried unanimously.

In replying to the discussion, **Mr. Watson** said he appreciated the kind remarks of the president and the support given to some of his opinions, particularly upon the subjects of high temperatures and the combination of destructors and electric light, which Mr. Read had warmly advocated. With regard to Mr. Scott's remarks as to the life of the bars, he was much interested in the comparison made with a Wilson gas producer, and though he had admitted that the blast was at a considerable temperature by the time it reached the ashpits, still it was found the steam had a very important effect in protecting the ironwork of the furnaces and the grate bars themselves. He might say he had seen a set of bars taken out at Oldham after five years' continuous use, and they were little, if any, the worse for wear. With regard to the doubt that had been raised as to placing the amount for maintenance and depreciation only at 10 per cent., which he had previously stated, he might say that that would not be true if the brickwork only of the furnaces were considered, but taking it upon the whole value of the furnaces, including the ironwork and other permanent parts, he believed it to be a true figure, although he admitted that they had not as yet had the furnaces working at high temperatures for so long as 10 years, they being but of recent date. Four cells which had been working for more than four years had required no repairs beyond a little pointing, and looked nearly as good as new. With regard to the combination of electric light and destructors in Gloucester, he must say he entirely differed from Mr. Scott in his comments on that point. It was found in several places, such as Cheltenham, that the destructor and the electric light station were already upon the same ground, and in other towns they were found very near to one another, for the very obvious reason that it was just as necessary, if not more so, that the destructor should be in the centre of the town in order to save carting, as it was that the electric light station should be in a central position in order to save the cost of copper mains, and the loss of electrical energy in passing along them; while by the refuse destructor being placed centrally the cost of carting saved, when it was remembered that cartage cost at the very least 6d. per ton per mile, was very heavy. In Edinburgh, Oldham, and Leeds the dust destructor was in the very centre of the population, and no complaints were now being heard. He was prepared to say that a destructor should be constructed in such a manner as not to give rise to any nuisance, and, therefore, there was no reason why it should not be placed in juxtaposition with the electric light station, and being so placed the power should be used to the fullest possible extent. It would then be found to be very economical. With regard to Mr. Howard's remarks he would say that approximately 35 i.h.p. per cell could always be obtained from burning refuse only, and he thought it would be quite feasible to burn liquid hydrocarbons in the form of spray in such a manner as to increase the output of steam during the hours when it was required. He thought the time for putting coal into a destructor was past. He sympathised with the opinion of Mr. Walton as to over-statements that had been made as to the capacity of destructors for giving steam in connection with the electric light. No doubt certain plants had been boomed too much, but he submitted that it was absurd to condemn a useful combination merely because certain people had over-rated the advantages to be obtained by it. With regard to the Shoreditch apparatus, the time had not been sufficient to test the accuracy and reliability of the figures. It would be a great pity if, because certain disappointments had arisen, a reaction were to set in against the use of the power from destructors.

The meeting, which was largely attended by members of the society, representatives of the City Council, and business gentlemen in the city, concluded with a vote of thanks to the president.

It may be added that at Oldham one Lancashire boiler and a new chimney has already been supplied to the dust destructor, at the cost of the Electric Lighting Committee, for the purpose of raising steam for the electric lighting, and had proved so successful that the Electric Lighting Committee are now going to the expense of a second Lancashire boiler to work at a 140lb. pressure per square inch, which when set to work is expected to provide the whole of the steam available from the destructor, and to effect a very large saving in the working of the electric light station. The first boiler has already been going for 18 months, and in addition to sending about 120 h.p. daily to the electric light station, it has supplied the whole of the steam required for the forced draught to the furnaces themselves, for driving two mortar mills, and also for driving the machinery of the Horse and Provender Committee in a neighbouring yard, thus enabling them to shut down a Cornish boiler which they formerly had to work every day. Again, at Ashton-under-Lyne a destructor on the Horsfall system has been put down in combination with the electric light and electric tramway power station, and in that case the whole of the steam available from the destructor will be utilised during a very large proportion of the time it is at work; in fact, it may be stated that the steam will be almost entirely utilised. At Norwich, a large proportion of the power required for sewage purposes is to be supplied by the burning of the town refuse in Horsfall furnaces. Other important schemes are on the way, but as we understand they are not yet finally settled, it would be premature to publish them. It will, however, be seen that although some disappointment has been felt at the result obtained at Shoreditch, there is no doubt that further particulars and definite proof of the value of the power available from the burning of rubbish will soon be forthcoming.

INSTITUTION OF ELECTRICAL ENGINEERS.

A special meeting of the Institution was held on Friday last at the rooms of the Chemical Society, Burlington House, to finish the discussion on Mr. L. Epstein's paper on "Accumulator Traction on Rails and Ordinary Roads." The chair was taken by Sir Henry Mance at 8 p.m. After the usual formal business, the President asked Mr. Macmillan to read the two following communications on the above subject:

Mr. Desmond G. Fitz-Gerald: It had not occurred to the author of the paper, nor to those who had commented on it, to compare the accumulators ostensibly available for traction some two or three years ago with the existing ones. It would be interesting to do so, and also to glance at the directions in which improvement would probably be made. In the following Table (1) was a limited sample of the data upon which—even less than two years ago—traction by accumulators had to be based. Anything much in advance of these was wild and visionary—were laboratory experiments and "so-called" inventions. The following figures (Table 2) were to be compared with those which were verified three years ago. They were those obtained from an electric cab which ran in the race from Paris to Bordeaux 2½ years ago. These results no doubt were but roughly approximated, but they had not been disproved or contradicted. The main characteristics of the cell were the embedded supports and the external envelope of perforated celluloid. About 2½ years ago a young electrical engineer was testing an accumulator which bore a strong resemblance to that of Donato Tommasi, but which was called the I.E.S. cell. This he compared with an E.P.S. cell, and found that when the former was discharged at a rate of 6·25 times the maximum safe rate of discharge of the latter, the capacity was 3·4 times greater than the E.P.S. cell. Unfortunately, he made a double mistake, in that he selected for comparison the L type of E P.S. cell instead of the T or K type, which would certainly have been more suitable for comparison, and he omitted to state which type he selected; but his observations were nevertheless correct and had borne strange fruit, for they now had in actual use, working the electric cabs, another battery bearing a strong resemblance to that of Tommasi, but called, on the *lucus a non lucendo* principle, the Faure-King instead of Faure-Tommasi accumulator. The last table (Table 3) was a comparison with the accumulators mentioned above. It was true that perforated celluloid had quite recently been replaced by perforated vulcanite, but the above results were obtained with the former material and by the very gentleman who

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said he had used a great number of tons of celluloid, and had a large and distressing experience of its use. Although he (Mr. Fitz-Gerald) had taken out a patent—No. 7,636, 1886—for the use of perforated celluloid to retain peroxide active material, he did not claim the credit for its introduction or advocated its continued use. He regarded it as a thing which had proved useful, but which could, and would, be dispensed with. It had been stated at the last meeting that an American inventor proposed to replace the perforated celluloid with perforated rubber. A more mischievous suggestion it would be difficult to make, except the statement that "it is well known to everybody that celluloid is useless in a battery." Because outside the Institution there were people who were not aware that soft vulcanised caoutchouc—the use of which for the purpose in view was claimed in Faure's original patent—was a very oxidisable material even in air, and its very rapid destruction might almost be regarded as a test for ozone. On the other hand, pyroxiline, the basis of celluloid, was, under 300deg. F., one of the least oxidisable bodies known. In regard to his own idea of a traction battery, the use of very light supports for the active material was the direction in which he thought progress was to be made. The *primâ facie* objections were, of course, first, that the peroxide element would be rapidly destroyed by local action; second, that in the case of large plates with thin lead the conductivity would be insufficient. But there were two distinct methods which had been devised for obviating local action to any great extent, and a system of multiple contact with the plate had been worked out. There were other difficulties of a minor nature, but these would no doubt be easily overcome.

Table	Name of accumulator.	Normal or safe rate of discharge.	Specific capacity.	Minimum weight— Per h.p.	Per h.p. hour.
		Amps. Lb.	Amp.-hrs Lb.	Cwt.	Cwt.
1	Epstein { L23	0·193	2·14	18·1	1·63
	Epstein { T11	0·66	2·2	5 3	1·60
	(Price lists) K	0·35	1·7	10·0	3·00
	Epstein (report of Alabaster and Gatehouse), Nov., 1894.	0·164	1·856	5·7 (?) 3·8*	1·9 (?) 1·76*
2	Tommasi cell, February 6, 1895.	0·454	10		
		1·36	8·2	1·3	0·5
		3·3	5	(?) 1 7	(?) 0·55
		2·7	7		
		3·41	5·1		
		(Time, 1½ hours.) Maximum 6·82 for starting and on inclines.		Speed attained = 12½ miles per hour.	
		2·12	6 36		
		0·9	9·0		
3	Epstein, Faure King cell.	0·9	4·5	3 9	0·78

* Ayrton.

Mr. F. J. Warden-Stevens's communication was to the effect that the author's attempt to compare accumulator traction with the trolley system was not very clear. Although the trolley system had the advantage of less attention along the route, the accumulator system should require smaller plant and less attention at the central station. But it was difficult to compare the two different conditions. The idea of using a battery-car locomotive was a good one, but although it had been often suggested, there seemed to have been no attempt to carry out the idea. As we should without doubt eventually have these bogie cars, he would express a hope that they might be made to look better than the steam-cars in Birmingham or the grip-cars at Brixton, which great square things disfigured the streets more than any overhead trolley line. As the County Council were now considering a tramway on the Victoria-embankment, an effort might be made by the Institution to persuade them to adopt a combination lighting and tramway system with accumulator traction on the latest lines. There was no reason why Hanover or Paris should not be equalled or even improved upon. Referring to Mr. Epstein's remarks on the Hanover system when he suggested detaching the accumulator when the trolley section was reached, this was good from the deadweight point of view, but one of the great advantages of the Hanover system would be lost. He was referring to the regulating action of the cells on the car while being charged. This equalised the pressure locally, which would not be done if the cells were charged from the trolley wire at one point. The use of the new Tudor cells with an enormous surface of plate, as used on one of the Paris lines, was a departure which would be watched with interest. When Mr. Epstein said that the charging of the cells at a constant potential caused very high current densities, he believed he was mistaken, as owing to the extraordinary large surface of the plates the current density was never very high, and was, in fact, rather less than that usually allowed for pasted plates. Referring to the use of the series-parallel battery control instead of series-parallel motor control, or the use of a double-wound motor as in use in the electric cabs, he should say it was in every way more convenient, and should be adopted provided that no difficulty was found owing to current not being stored equally when the battery was paralleled. If one was allowed to argue from what occurred in a single cell where there were many plates in parallel, there should be little difficulty on this account.

Mr. R. J. Wallis Jones said he thought they were well in the bend of the up-hill road of electric traction. The labours of Mr. Reckenzaun, Mr. Edison, and others were about to be rewarded. He thought that accumulator traction had not had a fair trial in England. There was one point in this subject which had not received enough attention. It was the question of charging the cells. They could either have the cells large enough to run the whole distance, or small ones to be charged at different points of the route. He agreed with Mr. Epstein as to keeping the battery whole, and not dividing it up into groups of cells. He then showed a diagram of what he called a tandem coupling, such as was used on the Birmingham trams, which had not been a success. There was a great advantage in keeping the cells all in one box. It was a good thing to suspend the cells on a separate tray; then they could be easily got at, and it prevented the car from rotting, and the ebonite cases were not so liable to be broken when recharging. Cells with a positive plate of the Planté type and negative plate of the pasted type were in his opinion the traction cells of the future. Mr. Epstein in his paper said that the life of a battery was 75,000 car miles. He thought this greatly exaggerated. In his experience, allowing for defects in the Birmingham cars, 8,000 miles was the life of one set of positive plates. Mr. Epstein only allowed for the renewal of the positive plates, and seemed to think the negatives would last for ever. He (the speaker) considered that the life of the negative plate was about twice that of the positive. He thought the service in use on the Hanover trams was likely to prove of great service to them in solving the problem of electric traction.

Prof. R. H. Smith said he was none too sanguine as to the success of accumulator traction on tramlines, as it had to compete with more mechanical systems. Certainly the Birmingham line was badly laid and did not give the accumulators a fair trial. Prof. Smith then detailed the losses under the accumulator system, which, in his opinion, prevented its efficiency being equal to the trolley system. He considered that the accumulators had more chance on a locomotive, when the weight would help to give adhesion. As regards the electric cabs, they were serving a good purpose in educating the public to the self-propelled vehicles. He had noticed, or fancied that he had, that the cabs were getting more noisy. The gearing wearing might account for that. Prof. Smith then took up the mechanical problems connected with the gearing question, and said that the chief trouble was introduced by the springs altering the alignments of the various parts. He raised a very interesting point in stating that the self-propelled vehicle took considerable more power to drive it than one pulled by a draw-bar.

Mr. E. Wythe Smith said that the problem of electric traction, especially by means of accumulators, was one that had engaged his attention for some time, and, therefore, he had read Mr. Epstein's paper with the greatest interest. As to accumulators themselves, he had had opportunities of testing several different types under different circumstances, but had never come across any near the capacity Mr. Manby gave for the Marschner cells now employed on the Dresden tramways—77lb. per kilowatt-hour, that is, 13 watt-hours per pound of cell. These cells appeared to be very near the ideal, so far as that point was concerned, the best figures he had obtained being 7 or 8 watt-hours per pound of cell. The result of his experiments over a period of nine years was the belief that the Planté cell or a modification of it would survive. A good many speakers had referred to the figure given by Mr. Epstein as to the friction of vehicles on ordinary roads. He had, with his brother, made a number of experiments on this point with a phaeton on London roads. What they had endeavoured to get was the average pull in the worst weather; they had, therefore, chosen days when the roads were either very muddy or soft through excessive rains. Their experiments lasted over a period of four or five weeks, but they picked days when the roads were in the same condition. He had arranged and tabulated the results. In the table, figures in the same row referred to the same roads on different days. Every bit of road was gone over in opposite directions, and the mean of average observations taken every 20 seconds was what was given. Those results might be relied on as being correct to 10 per cent. They also took an average down journey of about three miles, part of which was on each of the different roads mentioned. When the pull was negative owing to going down-hill, it was taken as zero. This gave as a result 45lb. per ton. Comparing these figures with those already given by Prof. Ayrton for bicycles under most favourable conditions, the results appeared to point out that there was less resistance to motion for vehicles with iron tyres than was the case with pneumatic tyres. With regard to the first part of Mr. Epstein's paper, he could not say he was converted to believe in accumulators on tramcars as the proper solution to the overhead trolley system, but still favoured a form of underground trolley in which there was no slot; but in this his opinion might be biassed. His thanks were due to Mr. Epstein for his paper, especially where it had brought out the details of the different parts which go to make up an electric car system, so that they knew how far they had advanced, and where they were in the problem.

Mr. A. Dickenson, in a communication read by the Secretary, said he had read with interest the discussion and observations on Mr. Epstein's paper. He was sure those who had advocated the use of accumulators believed in what they advocated, but was it

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not difficult for those who were interested in accumulators to avoid bias in their favour? Each maker was quite sure that his was the best cell on the market. The representatives of various makers had called upon him from time to time and discussed the question, and he had never met a more sanguine body of men. Mr. Epstein, Mr. Parker, and others had discussed the question of accumulator traction as though the difficulties had been overcome. Both gentlemen had great experience, and it was difficult to understand their assertions that electric traction by accumulators could be a success. It could not yet be done commercially. He admitted that there was a large sphere of usefulness before accumulators, but up till the present it had not embraced the successful operation of tramways and other vehicles under normal conditions. Nearly all makes of accumulators had been tried on the Birmingham Central Tramways, and each maker entered on the undertaking with a light heart, and each was confident that his cell would prove successful. So anxious had the directors of the Birmingham Central Tramways Company been that they offered to let Mr. Parker's company build cars after their own design, they to guarantee (1) its satisfactory running and maintenance for 10,000 miles; (2) that the electrical horse-power should not exceed that of the existing bogie cars. Even with all this, the performance was not successful enough to warrant its extended use. All makers even now were prepared to say it could be done, but if this kind of traction was to be a success it must be by a system that could be placed in the hands of an ordinary driver, be perfectly reliable, and to work at a cost not exceeding that of the present methods.

The following reply by **Mr. Epstein** was then read: If devoid of any other merit, my paper may at least lay claim to having elicited a very interesting discussion. Considering the time occupied so far with the one and the other, I will condense my reply into as small a compass as possible. The accumulator mentioned by Mr. Manby is certainly very interesting, mainly on account of the positive electrodes also being composed of the active material alone. We all remember similar previous attempts, which, however, did not lead to satisfactory results, for, although the capacity of such plates was high, it was necessary to discharge them at a very low rate. If this difficulty has been overcome in the Marschner accumulator it would certainly mark a very decided progress, but statements with regard to accumulators possessing extraordinary qualities have been so frequent, and in so many cases unfounded, that one cannot help feeling somewhat sceptical in the absence of absolute proof. As regards the accident mentioned, when the whole of the town current, which is given as 500 volts, was by mistake sent through the cells, it would have been more valuable to know what the strength of the current was. Incidentally I may remark here that such an accident would not have happened if the precaution of inserting cut-outs or safety fuses in the circuit had been adopted. The assertion that no other cells would have stood such an accident is unfounded, as many other accumulators, especially of the Planté type, may be short-circuited without suffering any damage. Another statement which calls for criticism is the efficiency—which I take to mean energy—is said to exceed 90 per cent. Although such an efficiency may be obtained in the laboratory under exceptional circumstances, there is no accumulator in existence giving such a good result in actual practice. It would be very interesting to learn what results are obtained with that type of cell in the hands of some independent authority in this country. I am afraid that the American invention mentioned by Mr. Crompton to prevent the crumbling of material will not be found to answer its purpose, as the soft rubber envelopes will in course of time get hard and crack. It seems also only too likely that the perforations, if large enough to admit the electrolyte, are also of sufficient size to allow disintegrated material to be blown out through them. I must express my thanks to Major-General Webber and Mr. Manville for having referred to the Birmingham Central Tramway Company. As will probably have been noticed, I have intentionally abstained from alluding to anything of a personal nature. I am all the more obliged to these gentlemen for their remarks that the accumulators have not had a fair chance on the Birmingham line, and that the unsatisfactory results there should not be considered a criterion as to the merits or demerits of accumulator traction. It is a deplorable fact that the bad financial results on the line mentioned have considerably retarded the adoption of secondary batteries for traction purposes. I should have been glad to comply with Major-General Webber's wish to deal in my reply principally with the question of tramways, but this matter, if properly treated, would be so voluminous that I was afraid to introduce it on the present occasion. I may, however, take a future opportunity for bringing the desired facts and figures before the Institution. Nothing could have been more gratifying to me than Mr. Manville's remarks that my ideas correspond exactly with his own, as such endorsement proves them to be correct, and as this support justifies the hope that we shall in all probability soon witness the more general adoption of secondary batteries for traction purposes. The apparently surprising results that cells of the same make should not deteriorate more when vibrated than when still, may be explained on the hypothesis that the expansion and contraction of the material during charging and discharging does exert much more energy, tending to disintegration than the vibrating of the cell. The tractive force on ordinary level roads, which I have assumed to be 60lb., will be found, on comparing the figures obtained from different quarters, to represent a fair average, and the instance which Mr. Manville gave from his own experience—that on wood pavement 30 amperes and 80 volts were taken in one of the London cabs—corresponds almost exactly with the average of 2,500 volts mentioned by me. As regards the variation of speed obtained by dividing the batteries into groups, which may be used in parallel or series, there is not the slightest objection to this arrangement provided the sections are arranged symmetrically. Tests made by me of such an arrangement showed that the difference in the discharge of the different groups was so small as to be quite negligible. Complying with Prof. Ayrton's wish, I can add some particulars relating to the Hanover line. There are on this line 12·8 miles with overhead conductors, and 10·6 miles worked by accumulators. The charging is effected over distances varying from 1·7 to 4·8 miles, the discharging taking place over distances varying from 3 to 7·2 miles; but as there is not sufficient pressure at all parts along the trolley wire, a supplemental charge is given after the car has returned to the shed. Each car carries 208 cells; when the battery is switched on they are first arranged in two halves in parallel with resistances inserted, then the resistances are gradually cut out, and, finally, the two halves arranged in series. Prof. Ayrton will allow me to thank him for his courtesy in testifying to my love of truth, which (bearing in mind Mr. Edison's remarks *re* the veracity of accumulator men) should be considered all the more meritorious in a man who has been connected with accumulators for so many years. It offers a novel illustration of the old proverb that "there is an exception to every rule." The weight of a car with motor, or motors, and gearing, and the full complement of 52 passengers, driver, and conductor, is 8·5 tons; the weight of the dummy and battery, 3 tons—total, 11·5 tons. Still assuming that 80 watt-hours from battery terminals are required per ton-mile (a figure which I have good reasons for considering excessive), and at an output of 10 watt-hours per pound gross weight of battery, we find that, including stoppages, the battery will be sufficient for an eight hours' service. I have only one observation to offer in connection with Mr. T. Parker's remarks when he says the trouble with the cells is that they lose their capacity when subjected to abnormal discharges, as cells can be produced which do not lose their capacity even when discharged at the highest rates necessary for propelling the tramcar. Adverting to Mr. Cuthbert Hall's remarks as to the relation between volume and surface, I left it to be inferred, when speaking of the relation between the capacity and the volume of active material, that this active material is arranged in a suitable manner and the plates do not exceed a reasonable thickness. It is satisfactory and encouraging to the advocates of accumulator traction that Mr. Swan considered the causes of past failures as of a remediable kind. The discussion was appropriately wound up by Mr. Holroyd Smith and Mr. Brown, who advocated caution and a margin of safety as a preventive of failure. As regards the interesting communication from Mr. D. Fitz-Gerald, it would have been instructive to learn why cells by different makers, but all belonging to the same family, should differ within such wide limits in their capacity. The figures relating to a Tommasi cell show, amongst other results, a capacity of 10 amperes per pound of electrodes at a discharge rate of ·9 ampere, and of 9 ampere-hours at a discharge rate of ·9 ampere. Through the connecting link represented by an I.E.S. cell (of which no absolute figures are given in the communication) we arrive at the Faure-Tommasi, *alias* the Faure-King cell, with a capacity of only 4·5 amperes, or exactly half per pound of electrodes, as the identical discharge rate of ·9 ampere per pound. Now the question which I think obviously suggests itself is, what is the cause that in the evolution just witnessed, instead of the improvement which one would naturally expect, an actual deterioration of the race has taken place? Or is this falling off more apparent than real, the descendant possibly compensating by a stronger backbone and sounder constitution (for which read metallic support) the guarantees of a longer though quieter life for the absence of that excessive activity which, while it distinguishes his progenitors, predestines him for an early grave (for which read high capacity and short life). Adverting to the excellent results attained with Tommasi cells three years ago in the case of an electric cab running in Paris, and nearly 2½ years ago under the difficult conditions of a scramble from Paris to Bordeaux, is it not rather surprising that we do not find after the lapse of all these years that type in the front rank wherever batteries are used for traction purposes? As regards the properties of celluloid to withstand electrolytic action, my own experience has taught me that this material gives very uncertain results, and cannot be depended on. Sometimes it deteriorated very rapidly, while in other instances it lasted for years without apparent deterioration. But apart from the general question, I think it may safely be granted that if a maker finds it necessary to discard a certain material he has very valid reasons for it. As to crediting the material of which the separators were made with the encouraging results obtained from the cell, this is, I think, beyond the mark, for it is the electrodes in the first instance, and not the accessories, which are responsible for the results. Besides, is it not just possible that at the time of the tests the separators were comparatively new? Differing from Mr. Fitz-Gerald in the main issue, I believe that the solution of the best traction cell will be found in a Planté positive of highly-developed surface with a relatively thin layer of active material which, formed from the metallic support itself, adheres so firmly to it that envelopes become absolutely superfluous. Time and experience, and those alone, will show which of the prognostications was correct. I cannot help feeling highly gratified at the general spirit of friendliness which has pervaded the discussion, several of the speakers even going a little out of their way in order to make a laudatory and encouraging remark in my favour. I thank you for this very kind manner in which you have received my paper, and I crave your indulgence if I conclude by expressing my firm conviction that the time is close at hand when accumulators—honest, good, serviceable accumulators—will be largely used for traction on rails and ordinary roads.

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UNSOLDERED JOINTS.

The London County Council recently found fault with the arrangements at the Covent Garden Theatre on the occasion of the last fancy dress ball. Only one electric point occurs in their report on the subject, and this we propose to look into here. The other matters do not concern us professionally, but their dangerous nature or otherwise largely depends on the fact that electricity, and not gas, is used as an illuminant. Now, the electrical engineer of the Council reported to the effect that for the purposes of the ball "an installation of four hundred and thirty lamps had been fixed, the work having been done satisfactorily in most points as temporary work, but the joints, which were numerous, were dry joints—*i.e.*, unsoldered—and he is of opinion that this is unsatisfactory. The licensee objected that it is impossible to make proper soldered joints in the time allowed, and further states that the use of portable stoves is objected to in the theatre." The whole matter hinges in the word "unsatisfactory." When the reason for making a report at all is considered, it will be generally understood that the engineer was considering the safety or otherwise of the temporary work, and hence the councillors will read the word to mean that there was danger from an unsoldered joint. We then ask the question, Can any fire risk arise from unsoldered joints in temporary work when the same are well made? The fact that the fire office inspectors did not object in the present case, practically answers the question in the negative. A few extracts from wiring rules would show the general opinion on the subject. Thus one company's rule reads: "Where joints are made between two insulated conductors they should be made mechanically sound, and securing full electrical contact before soldering." Perhaps the standard rules of America put the matter rather more explicitly. In these rules, which are referred to in a note in this issue, we find the following: "All wires must be so spliced or joined as to be both mechanically and electrically secure without solder; they must then be soldered to ensure preservation." The preservation means preservation against a deterioration of the contact with time; and as the time limit in which such a joint will deteriorate to give bad contact is not reached in the few hours elapsing between the fixing up of the wires at Covent Garden Theatre and the time they are pulled out, we fail entirely to see the force of the above complaint. Looking at the matter from this point of view of the liability to deteriorate, the unsoldered but insulated joints are in a better position than the majority of the fuse contacts used in theatres and elsewhere. In the case of fuses, oxidation is not impeded by a covering of insulation, and yet the trouble arising from imperfect contact in such fuses are very rare indeed. In conclusion, we acknowledge the fact that the London County Council have done much to render our places of public entertainment safe. At the same time, their reports will lose weight if condemnation on insufficient grounds is indulged in by their officials. Since writing the above, we find that the report in question

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was withdrawn by permission at the meeting of the Council on Tuesday. The withdrawal shows the weakness of the report, as its compilers would not face discussion on it.

CORRESPONDENCE.

"One man's word is no man's word
Justice needs that both be heard."

"ELECTRICAL INSTALLATIONS."

SIR,—Referring to your review of my book, "Electrical Installations," in your last issue, although I do not as a rule approve of answering reviews, there are one or two points in which your criticism is inaccurate, and it is these points, not your opinions, which I wish to correct.

You refer to the absence of mathematics, and state that you do not see the need for avoiding it. The book was written for the man who has not the time and does not want to trouble with theory, especially mathematics, and who would skip it if it were included. Again, it is clearly pointed out on p. 1 that a consulting engineer is necessary, and the whole of the next page is taken up with the emphasising of this point.

You state that in the chapter on wiring the cost of labour and repairs is omitted in the estimates. These, I would point out, are included on pp. 51 and 52 in the estimate for 100 16-c.p. lamps—water power, gas and steam power. The items are omitted where motive power is already provided, because the repairs to a dynamo are so small as to be negligible when 5 per cent. depreciation is allowed, and the labour will be nothing, as there will be no extra cost for the labour entailed over that already required to look after the engine, shafting, etc., for the works.

In conclusion, while you, of course, are quite entitled to your opinion that I have attempted too much in a given space, I am sure that you have misunderstood the object of the book, which was, not to write a text-book, but, mentioning your criticism, to give general ideas on many subjects and special information in certain parts. The certain parts are those which I have found by experience are most important to the class of professional men for which the book was written, and which are usually but little understood. For instance, it would be ridiculous for me to do more than indicate the technical arrangement of a building when writing for architects, as you seem to expect.—Yours, etc., F. J. WARDEN-STEVENS.

London, S.W., December 21, 1897.

CONSOLATION.

When the rash contractor waileth for the work that has gone wrong,
When he weeps to know that THE profession know it;
O, let him sweet nepenthe seek in this consoling song,
And if he feels like swearing, simply "blow" it.
For though his name may raise the jest among those in the know,
And though his stock may swell and make him tearful:
It's a very, *very* evil wind that good to none doth blow,
And his trade competitors will feel more cheerful.

When Demon Fog is choking us, when black the air and sour,
When life is dark and dismal as a prison,
When speech is blindly sulphurous as fumes which overpower:
O, think what lovely load curves have arisen!
And sense the joy of station chiefs and those who hold the scrip
Of lighting works; you bet there's no repining;
For if there's silvery edging to the cloud, you take my tip,
To the fog there is an eighteen-carat lining.

Ho, all you central-station men who work the mid-day shift
On Saturday, the 25th December,
Refrain from letting feelings into profanation drift
Because of this; but thankfully remember:
That turkey's indigestible, mince-pies would make you ill
(The fox that hated grapes may serve as warning),
You'll miss the black-draught afterwards, you'll miss the loathly pill,
And you'll miss the going to service in the morning.

J. H. C. B.

FORTHCOMING EVENTS.

The following are some of the announcements for the forthcoming week:

TUESDAY, DECEMBER 28.—Royal Institution (Prof. Oliver Lodge's first Christmas lecture on "The Principles of the Electric Telegraph"), 3 p.m.

THURSDAY, DECEMBER 30.—Royal Institution (Prof. Lodge's second lecture), 3 p.m.

SATURDAY, JANUARY 1.—Royal Institution (Prof. Lodge's third lecture).

INSTITUTION OF CIVIL ENGINEERS.

At the ordinary meeting on Tuesday, December 21, Sir John Wolfe Barry, K.C.B., F.R.S., the president, in the chair, the paper read was on "A New Transmission Dynamometer," by Mr. W. E. Dalby, M.A., B.Sc., A.M.I.C.E.

In transmission dynamometers in which the deformation of a spring was used to measure the work being transmitted, the mechanism might be divided into two parts: (1) the measuring springs, and the apparatus fixing them to the several parts of the dynamometer; and (2) the apparatus used to measure the deformation of the spring. The paper treated of a new device for measuring the deformation of the spring.

The deformation of the spring was in general communicated to two pieces of the dynamometer, causing relative angular displacement between them. Thus, if one end of the spring was fixed to a pulley and the other end to the shaft on which the pulley was mounted, the relative angular displacement would be between the pulley and the shaft. To measure this whilst the pulley and shaft were rotating, a sprocket wheel was fixed to the pulley and another of equal diameter to the shaft. Over these an endless band was placed, arranged to form two loops, the parts of the band forming one loop leading the one to the sprocket wheel and the other to the opposite side of the other sprocket wheel. In these loops were placed guide pulleys mounted in frames, constrained by a slide to move in the direction of the band. A relative angular displacement of the sprocket wheels was necessarily accompanied by a relative linear displacement of the guide pulleys in the loops proportional to the torque acting between the shaft and pulley, and by suitably calibrating a scale to measure their distance apart, this torque, or change in torque, might be read off directly.

To obtain a good fit, and yet at the same time avoid any sticking of the slide, the frame carrying the guide pulleys had only six properly-arranged points of contact with a group of three bars forming the slide, and to control the motion of the pulleys in any position and constrain them to follow the motion of the loops a spring was arranged to act on a cord connecting the two frames in such a way that the guide pulleys were always compelled to sit in their respective loops, the tension on the spring causing them to do so being constant.

Two dynamometers had been made on these principles for the engineering laboratory at Cambridge. One was arranged on a main driving shaft, the dynamometer being formed by connecting a pulley driving a dynamo to the shaft by means of a spring, a sprocket wheel was fixed to the shaft, and another of equal diameter was fixed to the pulley boss. An endless steel band passed over the sprocket wheels so as to form the loops described was used to operate two guide pulleys mounted in frames, free to slide in the direction of motion of the band. This, the apparatus for measuring the torque, was placed several feet below the shaft in a convenient place for observation. A second dynamometer was made on the same principle, but arranged to be self-contained. Any machine could be driven through it, and the power given to the machine directly observed. The dynamometer was used to measure the power given to a dynamo. Measurements were made of the work required to overcome the belt friction, journal friction, of the work lost in hysteresis and eddy currents, and of the efficiency of the dynamo at different outputs.

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QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We shall also in future give *two shillings and sixpence* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared, and should be written on one side of the paper only. Questions may be sent at any time.

QUESTIONS.

22. What are the advantages and disadvantages of (1) running all the feeders and alternators in parallel; and (2) using a machine to supply each separate feeder?—A. D. MARKHAM.

23. What are the chief advantages and disadvantages of slot-wound continuous-current armatures as compared with the smooth-core type?—A. D. J.

ANSWERS.

Question No. 17.—What are the various methods of running arc lamps from an alternating-current station, and which method do you consider best?

[The first two answers are so good and so nearly equal that we have decided to give to each 7s. 6d.—ED. *E. E.*]

Answer to No. 17 (*awarded* 7*s.* 6*d.*).—Methods of arc lighting from alternate-current works, and which is best?

Systems.—A. From 'bus bars:

1. Rectified current.
2. Motor-generators.
3. Separate circuits from works.
4. Separate circuits from sub-stations.
5. In groups or singly from distributing mains; clock control.
6. In groups or singly from distributing mains; hand control.

B. Separate continuous-current plant.

A 1. *Rectified Current.*—Cheap in initial cost, compared with A 2 and B, and more efficient at all loads; has a higher lamp efficiency than where the alternating current is used, higher voltages can be used than with continuous-current machines, and lamps are controlled from works. Other advantages are sometimes claimed, but they consist of the necessary good points which are common to all other systems. Rectifiers give no trouble if used in conjunction with proper generating plant and treated with care. There is no difficulty in running them in parallel with other machines, or combined with private lighting from a single set. The commutators spark, but this is not so bad as it looks, and helps to light up the works; it necessitates daily brush trimming and a bi-annual grinding of commutator.

A 2. *Motor-Generator.*—The principal advantage here is the use of continuous-current lamps, but a lower voltage would have to be used than with alternate-current and rectified-current systems.

A 3. *Separate Circuits from Works.*—This means alternate-current lamps, which, while not so efficient as continuous-current or rectified-current lamps, are more reliable, when used with (Crompton's) choking coils. These coils are put in shunt across the arc terminals, and help to regulate the arc; they also prevent a broken circuit, in the event of mechanism sticking when carbons are apart, by inserting a resistance equal to the arc. The cut-out devices of continuous-current or rectified-current lamps are not infallible, and frequently fail to act, thus burning up the mechanism.

A 4. *Separate Circuits from Sub-Stations.*—This necessitates visiting the sub-stations to switch on; though the want of control from the works is not always a bad thing in some districts, as if men are working on the circuits during foggy weather, there is less likelihood of an accident if the switching is done near the lamps. Also the load goes on in instalments. This is more likely to be used for extensions in outlying districts.

A 5. *In Groups or Singly from Distributors, Clock Control.*—Used mostly in America, and reputed very successful.

A 6. *Ditto with Hand Control.*—A seemingly old-fashioned practice, but is useful where policemen can be requisitioned to do the needful switching on and off at proper times. In most works, in any case, a man is sent around the circuits to see all O.K.

B. *Separate Arc Plant.*—A saving in lamp efficiency, more than balanced by a loss in generating efficiency, over alternate-current lamp systems; and going out of fashion.

Enclosed lamps are now used on some networks, and these tell particularly in favour of alternate-current lamps, owing to the greater length of arc. Fewer men are needed for the trimming on account of the carbon's longer life.

On the whole, control from works is desirable, especially where the maximum of light is not needed during certain hours of the night. A proportion of the lamps can then be extinguished altogether, where two circuits light one street; or the arcs may be exchanged for incandescents on the same post lit from the distribution mains, where (Edmunds) automatic switches are in use, these lights being switched off at daybreak by running a momentary reverse current through the arc lamps.

It goes without saying that in designing a station the best system is that in which the least variation in types of machinery is embodied, so that, given more efficient alternate-current lamps, the separate circuit system (A 4) would appear to meet the case. At present, however, the rectified-current system is very fashionable, so it is presumed that engineers are satisfied that its extra cost, initial and maintenance, is more than compensated for by the higher efficiency of the lamps themselves.—J. H. C. B.

Answer to No. 17 (*awarded* 7*s.* 6*d.*).—There are six methods which are in use, or which might be used for this purpose: (1) separate engine and continuous-current dynamo; (2) alternating-current motor driving continuous-current dynamo; (3) rectifier; (4) series of alternating-current lamps across the high-tension mains, or with a suitable transformer interposed; (5) series-parallel across the distributors with a switch for every few lamps; (6) each lamp from a separate transformer with a switch. These may be collected under three heads: (*a*) series; (*b*) series-parallel; (*c*) parallel. It is an extremely difficult matter to give any definite opinion as to the best method, as circumstances differ. However, methods Nos. 1, 2, 3, and 4 may be compared with each other. The series system is used when there are a large number of lamps to be lit and extinguished at one time, and when the lamps are not a great distance from the supply station. There is no doubt that methods 1, 2, and 3 are preferable to No. 4, because continuous-current or rectified-current arc lamps are much more efficient and give a better distribution of light than the alternating-current arc. However, the direct-running alternating-current arc series system will be much the cheaper and require less attention than the others, and as interest on capital and cost of attention have to be considered as factors in the total efficiency (commercial), as well as the actual efficiency of the arc itself, it is a very debatable question whether the alternating series system is not the best. One point which is against it is that a really good alternating-current arc lamp is difficult to obtain, while there are many good continuous-current lamps obtainable which are cheap. I would, however, personally incline towards a continuous-current arc lamp, as it would no doubt give a steadier light and be less trouble.

In considering the various methods of obtaining a continuous current or its equivalent in an alternating-current station, it must be remembered that the ideal system is one which uses the same generators as the alternating current, from the point of view of efficiency. The separate engine and dynamo, while they do not comply with this condition, have much to recommend them when there are a large number of lamps. In the first place, a failure of the private lighting plant will not affect the public lamps unless the boilers have also broken down, and this is undoubtedly a great advantage. In the second place, the engine is always running at its full load, and is therefore efficient, as it can be of a reasonable size under the conditions stated; the load is

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steady on it, and therefore it will need little attention. Continuous-current dynamos are now made which give 2,000 volts without trouble at the commutators. The objection usually urged is that the constant-current dynamo is a very inefficient affair. Now, I would suggest that the constant-current dynamo need not be used. An ordinary series machine can be used, and the regulation can be carried out automatically if desired, or by hand, as at St. Pancras. When there are some 40 arc lamps in series, very little increase of current will result if one lamp does go out, and it should not do so, and it can easily be compensated for. Of course, where a great proportion of the series is switched off before the other, this does not apply; but in how many cases is this done? The use of an alternating motor instead of the engine is, I think, very advisable; as a rule, in the newer central stations accumulators are used, and these might be used instead of the synchronous motor. If it is synchronous, so much the better; very little attention will be required. This will improve the load factor of the large engines, and where there are few lamps, a great economy will result both in steam and attention. The rectifier—a small synchronous motor driving a commutator—is no doubt efficient, and I understand that the Ferranti rectifier has in some cases proved very satisfactory. The great advantage of this rectifier is that, when once going, the current is perfectly regulated, and when the commutator brushes are carefully set, the sparking is not serious. The whole arrangement is so ingenious that one feels a great compunction in criticising it, but there is no doubt that if for any reason the motor should fall out of step, nothing will save the lighting. The rectifier must be stopped and started afresh. This is a great disadvantage, and when cost is also considered, it is doubtful if it is preferable to the motor-dynamo. It is found, however, that the oscillation of the current makes the lamps burn steadily owing to the vibration of the lamp parts preventing sticking. Of these systems, I would, as a rule, prefer the motor-dynamo.

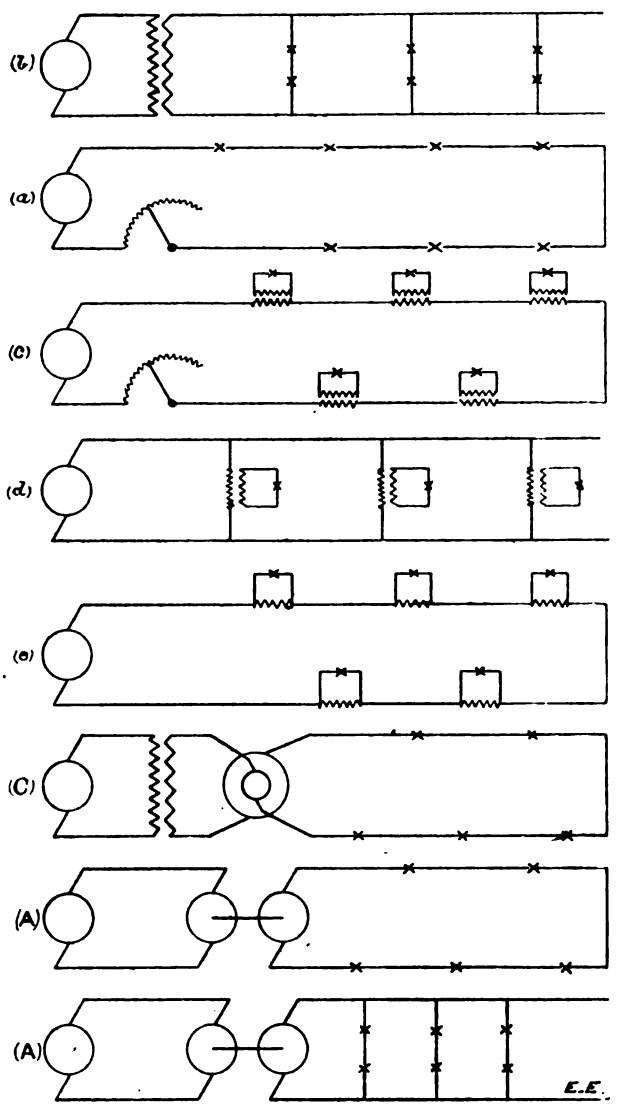
Where the arc lamps are required in detached clusters, the series-parallel system is good; if the objection to alternating-current arcs is left out of the question, it is also very cheap, but has the disadvantage that a man is required to switch on and off at several points. The problem of the steady running of series-parallel arcs, even continuous-current ones, has hardly been definitely settled, so this system is not likely to be greatly used for alternating currents, at least for some time. The separate transformer for each lamp is very good where an arc is required at an important crossing, or where the arcs required are few and far between. It is better if the primary of the transformer is switched off. The alternating-current parallel arc is, I believe, fairly reliable, and for this reason it will be used, no doubt, more than the series-parallel.

To summarise, I would prefer a series system where there are many lamps, say over 40; and of the series systems I think the motor-dynamo is rather the better, although the rectified current runs it close. Where the lamps are required in batches of, say, 3, 6, and 12 on 100, 200, and 400-volt mains respectively, the series-parallel system is good and convenient if the good lamp is obtainable; and where isolated lamps are required the separate transformer is the best. The use of enclosed arc lamps when they are made practically will be of great use in these two latter cases, as they will in the former remove the need for running in series, and in the latter remove the transformer in many cases. The other great advantage is that they require much less attention and save the greater cost of the carbon bill, when compared with the ordinary lamps. I would refer enquirers about the financial aspects of the question to Mr. Boot's paper, early in the year read before the Municipal Engineers at Manchester.—W. FENNELL.

Answer to No. 17 (*awarded* 2*s.* 6*d.*).—There are several methods of running arc lamps from an alternating-current station, and they can be classed under two heads: (1) lamps burning with alternating current; (2) lamps burning with direct current.

1. *Alternating-Current Arc Lamps.*—(*a*) Arcs may be run in series from the high-pressure mains, the number of lamps in the circuit depending on the pressure of the alternator. At 2,000 volts, about 50 lamps may be put in series. A regulator is required in the circuit, so that if a lamp be disabled in any way the pressure may be kept at that required for the remaining lamps. This is rather a wasteful method.

(*b*) Arcs may be run in parallel circuits from the low-pressure mains. If the pressure be 100 volts, two lamps may be put in series with one another in each branch. With 200 volts, five lamps can be put in series. If one of the lamps in a series breaks down, a resistance or choking coil must be put in its place, or the remainder would be extinguished.



(*c*) Instead of burning the lamps direct from the mains, either high or low pressure, each lamp may have its own transformer placed in the base of the post or within the lamp case. The primaries may be connected in *series* with the high-pressure mains, and the lamps joined to the secondaries. It is necessary to put a regulating resistance in the mains.

(*d*) Another method of using separate transformers, and one which does not necessitate a regulating device, is to connect the primaries of the transformers in *parallel* with the mains, each lamp being connected to its own secondary. In this system the lamps are entirely independent.

(*e*) In this case the arcs are connected in series with the mains, with a choking or "reactance" coil as a shunt to them. So long as the lamps burn properly, very little current is wasted in the coil. But if the circuit is broken in the lamp, the whole of the current goes through the choking coil, and prevents the extinction of the other lamps. There is a continual waste in this reactance coil of about 5 per cent. of the current used in the lamp.

If alternating-current arcs be used, then either (*b*) or (*d*) would be the best method, and the choice of either would

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depend upon local conditions. All the methods except (*b*) enable the lamps to be switched on and off from the main station, or a similar centre. (*b*), (*c*), and (*d*) have the advantage that the high pressure is kept from the lamps, and (*e*) is to be preferred because of its greater freedom from trouble in case of the failure of any lamp.

2. *Direct-Current Arc Lamps.*—In this class we may place both continuous-current lamps proper and also those which burn with "rectified" alternating currents.

(A) Continuous current by means of a motor-generator. This machine consists of an alternating-current motor driving a direct-current dynamo. The lamps may be connected to the mains in series or parallel, according to the voltage.

(B) Continuous current by means of separate steam-driven plant. This is exactly as in (A), except that the motive power is a steam-engine instead of a motor.

(C) By using rectifiers a small synchronous alternating-current motor drives a commutator, which changes the prime current into an uni-direction current. The rectified-current arcs are connected in series with the mains, the regulation being done by a constant-current transformer in connection with the rectifier. In this there are moving coils, which are repelled from the position of best action by fixed coils, according to the current which is flowing through them, thus tending to keep the current constant and making the pressure that which is required in the mains, whether there be many or few lamps on.

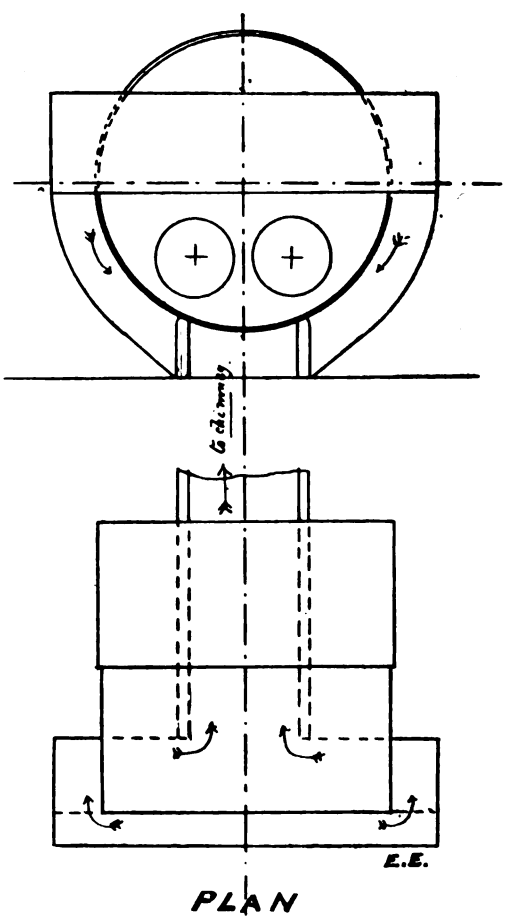
There is no example of (A) in this country at present, but it is a method which has a great deal to recommend it. (B) and (C) are both common, and each has its own advantages and disadvantages. (C) is undoubtedly more economical than (B), in that it enables one plant to be kept loaded all night instead of two, each perhaps partly loaded. Speaking generally, it may be said that direct-current arcs are better than alternating for street-lighting, and that of the last three systems mentioned, (A) and (C) are better than (B).—T. A. LOCKE.

Question No. 18.—What is your opinion on the use of the marine type of boiler for central stations?

Best Answer to No. 18 (*awarded* 10*s.*).—The question of the most suitable boiler for central-station work is one which is very largely attracting the attention of electrical engineers, and too much cannot be said or written on the subject, as the diversity of opinion is very great. The decision as to the type of boiler to be laid down is largely influenced by special circumstances in each case, no two stations being designed alike; but, briefly, some of the most important conditions to be considered are as follows: (*a*) Small floor space for as large a power as possible; (*b*) small initial cost for erection and foundations; (*c*) steady steaming and dry steam; (*d*) accessibility for inspection and cleaning; (*e*) economy of working and upkeep. For sake of comparison, a Lancashire boiler is taken as the standard.

Now, a marine boiler fulfils the first two conditions (*a* and *b*) admirably, as the floor space is small, being 25 square feet per 1,000lb. of water evaporated per hour, and a large amount of boiler power can with these boilers be put in a small space, which in some stations is a great consideration, as many are limited in their ground. A range of marine boilers also looks very neat and compact. The cost of foundations and flues is practically nothing compared with that of a Lancashire boiler, no brick flues being required at all, the boiler being self-contained, though I saw a marine a few months since in which the gases were taken down the side of and underneath the boiler, the cast-iron seating blocks forming the flue walls (see sketch). This arrangement will not appreciably add to the cost of erection, but will tend towards the increase of efficiency of the boiler by giving a greater heating surface and warming the cold water at the bottom of the boiler, which latter will greatly help the circulation of the water both when getting up steam and when under steam. Another advantage of the marine type is that they do not require a brick chimney, but can be fitted with an iron one, especially when used with forced draught. To mention a case that came under my notice the other day, three marine boilers, 10ft. 6in. by 10ft. 6in., fitted with Ellis and Eaves's induced draught, had an iron chimney 3ft. 9in. diameter and 20ft. high, or about 33ft. from firebars to chimney top. Here we see the cost of a brick chimney and foundations is entirely done away with, though there is the upstanding cost of keeping the fan machinery and accessories in good working order, which is again counterbalanced by the increased saving in coal bill.

(*c*) The marine boiler is a steady steamer, and gives dry steam when properly proportioned—*i.e.*, when the steam space is large enough. Many boilers of this type are cramped in the steam space. In some marine boilers with small steam space the percentage of water in the steam may be as high as 4 per cent., whilst in a Lancashire it is usually about 1·5 per cent. The marine boiler raises steam



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fairly quickly, but should be fitted with an hydrokineter or other circulating arrangement, as should all boilers, excepting water-tubes.

(*d*) The next consideration is not so well fulfilled by a marine. They are not very accessible in all parts for cleaning and inspection, but there is no part that is absolutely inaccessible. The water to be used should be clean and soft, or the boiler is apt to get into a bad condition if used for a long time without cleaning, and a lot of time and trouble must be taken to get it into good order again. If the water is hard, and no means are taken to soften it, a marine boiler had better not be used, as the tubes get covered with scale, and it is impossible to keep the boiler in anything like the order it should be in, if it is to do its work well and economically. On the other hand, the outside of the boiler is always accessible, and can at all times be kept in good order and inspected, so there is no chance of corrosion going on unseen or damp lodging anywhere near.

(*e*) In the matter of economy the marine stands well up in the list, evaporating about 10·28lb. of water per pound of coal, which is a little more than a Lancashire without an economiser, but a little less when the economiser is used. If forced draught is fitted this figure is increased, and the efficiency and economy of the boiler is greater. The cost of repairs is about £18 per annum, and the life is from 18 to 20 years.

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The deductions to be got from the above may be put in a few lines: when the space is limited, and costs must be kept as low as possible consistent with good work, and the water is clean and soft, or *reliable* means are taken to make it so, then a marine boiler would seem to be the best investment, especially if fitted with artificial draught; but if the space and finances admit, and the water is hard and cannot be softened, then a Lancashire boiler and economiser, or one of that type, should be put into the station.—TOM A. CUNLIFFE.

Answer to No. 18 *(awarded* 2*s.* 6*d.).*—There is no doubt that the marine type of boiler has to a great extent been kept in the background as regards central-station work, but in the few stations where they have been installed the results have been very satisfactory. The advantages of the marine boiler as compared with the Lancashire boiler are quite worthy of notice. The marine type raises steam very much more quickly; the circulation is far better; it does not require a great amount of floor space, or to be set in brickwork like the Lancashire boiler. On the other hand, it has the disadvantage of not being so easy to inspect and clean as the Lancashire, and if good results are desired great care must be taken in cleaning. The difficulty of access to the tubes and combustion chamber is a great drawback, and as the combustion-chamber tops are the first to be affected by low water, any carelessness in cleaning may bring about disastrous results. The tubes sometimes give trouble by leaking or splitting. In the first case they usually leak at the combustion-chamber end, but that can be stopped by using the expander, or, if worn thin, they can be driven through from the smoke-box end or rebeaded. In the second case the ordinary tube-stopper will suffice. As regards setting the boiler, the brickwork may be dispensed with altogether. The boiler is placed in bearers, which are bolted down on the concrete floor. If another boiler is added, a wrought-iron stay between the two will keep both steady. With respect to firing and general care of the boiler, an ordinary intelligent fireman would soon master its peculiarities. A very noticeable feature is the way that the manhole doors are secured in marine boilers. It is far and away more economical, safer, and more labour-saving than the Lancashire boiler manhole. Instead of 15 or 20 bolts and nuts to run down and make easy every time the cover is taken off, and the joint made of putty, as in the latter case, the door, on which there is a shoulder all round fitting into the manhole, is put on from the inside. Outside the shoulder is placed a flat asbestos ring. Two dogs on the outside then secure the door. An asbestos joint well blackleaded would last many times without renewing. The life of a marine boiler is about 15 years.—A. BROUGHTON.

Answer to No. 18 (*awarded* 2*s.* 6*d.*).—In discussing this subject, comparison must be made between the various types of boilers. Briefly, the Lancashire boiler, the oldest type now used, at any rate for electric light, has the following advantages: it is fairly cheap, has very long life, requires very little attention, and has a large water capacity. Its chief disadvantage is the length of time, two to six hours, required to get up steam, owing mainly to its large water capacity. This latter is mentioned above as an advantage, and when a sudden increase of load has to be dealt with it is an advantge. Another disadvantage, especially in large towns, is the great space it occupies, and also the difficulty of getting it to its destination in a crowded neighbourhood. It also requires a lot of brick setting, thus adding to the cost. Also, unless an economiser is used, a great deal of the heat of the products of combustion is wasted. Owing to the variation of load in an electric light station as a rule, if Lancashire boilers are used alone, they must, when the load is light, be kept under steam for sudden emergencies, as they cannot be forced much. This, of course, is not economical. This has led to the wide use of other types of boilers for electric light and traction stations—namely, water-tube, locomotive, and marine boilers. Very often these types are used in conjunction with Lancashire boilers, the latter taking the ordinary level load, while the others are forced for heavy loads, for these latter types are much faster steam generators than Lancashire boilers. The marine type has no great advantages over the locomotive and water-tube types, but it has a good many disadvantages. It takes a little less space, but not much less; it requires very little setting, but so do the others. All three require a large amount of attention, the marine type being the most difficult to clean. The efficiency of the latter is also not so high as that of the water-tube type. The water-tube type is also the cheapest of the three. These three types all require much less space than Lancashire boilers, thus decreasing the cost of ground and buildings. They have not nearly such a long life, however, as the Lancashire type. It is thus seen that where there is a great variation of load, and where space is limited, Lancashire boilers are not economical or practicable. Either they must be used in conjunction with the other types, or the other types must be used alone; and of these other types, it is clear that the water-tube type is in most respects the best and most economical, the marine type having no real advantage.—C. H. R. THORN.

THE BRITISH MUSEUM.

The Trustees of the British Museum have, says the *Standard*, decided to discontinue the opening of the exhibition galleries on week-day evenings from 8 to 10 p.m. after the close of this year; and, instead, to keep them open until 6 p.m. all the year round.

The evening opening commenced in February, 1890, on the installation of the electric light, the galleries, however, being opened only in sections, as the electric plant is not powerful enough to light up the whole building. At first the eastern and western portions of the museum were opened on alternate week-day evenings, but the number of visitors so rapidly declined that the galleries were afterwards further subdivided into three sections. The numbers, however, have still continued to decline. The experiment of evening opening having thus had a fair and patient trial will now be abandoned, and a lengthened exhibition by day will be substituted, during the months when the museum has hitherto been closed at 4 p.m. or 5 p.m., according to the season of the year. On and after Monday, January 3 next, the exhibition galleries will be kept open throughout the year from 10 a.m. to 6 p.m., with this reservation, however, that during the dark hours, when the electric light has to be employed, only half of the museum (the eastern and the western galleries alternately) can be opened to the public. It is believed that the extension of time will be appreciated by visitors, particularly during the winter months, when hitherto the closing hour has been 4 p.m. The arrangements for opening on Sunday afternoons will not be altered, visitors being admitted at hours varying between 2 p.m. and 7 p.m., according to the season of the year.

THE MANAGEMENT OF BOILERS AND STEAM PLANT, INCLUDING DETAILS OF STEAM PIPES AND FITTINGS.*

BY A. B. MOUNTAIN, BOROUGH ELECTRICAL ENGINEER, HUDDERSFIELD.

(Concluded from page 788.)

Probably the fittings attached to a boiler are the most serious cause of annoyance, and it is scarcely possible to over-estimate the importance of them. The same fittings are required for all boilers, the size depending upon the evaporative power of the boiler, and it is surprising to find the different classes which are in use. Commencing with the water-gauges, there should in all cases be two on each boiler, so that the correct level of the water may be obtained. These should be so constructed that if a glass is accidentally broken, the steam and water which would rush out will be instantly stopped. The gauges should also be protected, so that the pieces of glass are not allowed to fly outwards. High and low alarm valves, and steam safety valves should all be of ample size. No greater mistake can be

* Paper read before the Northern Society of Electrical Engineers.

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made than in reducing the size of a safety valve. The main stop valve should be large, so that the steam does not have to leave the boiler at a high speed. Small valves are frequently the cause of water being carried with the steam into the steam-pipes. It has been suggested by some makers of fittings that it is desirable to fix another valve adjoining the main stop valve, for the purpose of stopping the steam being admitted accidentally into a boiler in which a man might be working. There have been several accidents of this kind, and a really reliable valve for isolating purposes would be useful. Unfortunately, the steam usually leaves the boiler in short pulsations corresponding to the periods of admission to the engines, and these pulsations cause a valve to speedily knock itself to pieces, or, at any rate, to damage its face and seat so badly that it is not steam-tight. Two feed valves should be arranged for each boiler, so that any accident will not stop the supply of water, and it is, of course, desirable to arrange the feed pipes in the ring form, or with two distinct ways of feeding. A blow-off valve must be fixed to each boiler, and the author has found it extremely desirable to have these so arranged that they can be very easily inspected. It is very usual to connect the blow-off valve with the drain, and if this is done it is impossible to tell if the valve is leaking; and, in addition to this undesirable contingency, some fatal accidents have taken place owing to the blow-off valve of each boiler being opened at the same time, allowing the steam from one boiler to get back to the other, and scald the men employed cleaning. This trouble has led to the introduction of many ingenious arrangements to avoid the danger of leaving the valve open, but in the author's opinion they should be quite unnecessary, and only add considerably to the expense and complication of the fittings, which should be devoid of as many refinements as possible. The chief trouble with high-pressure steam fittings are caused by the expansion due to the high temperature of the steam. It is very usual to see fittings quite tight with a water pressure and also with a low steam pressure, but quite unfit for employment with a pressure of 150lb. to 200lb. per square inch, and the author has found it advisable to insist upon all fittings being tested with steam to a pressure considerably above that at which they are required to work. It should be a rule in all well-managed works that all fittings should be carefully examined and cleaned at least every 12 months, and unless this is done even the best fittings will prove unsatisfactory.

Having arranged the class of boiler, method of firing, and fittings, the next step is to convey the steam to the engines, and it is again evident that in an electricity works some special method must be devised so that the supply may never be interrupted by the failure of the joints, pipes, fittings, etc. Roughly summed up, there are three systems in use: (1) The single main, with the boilers feeding in and the engines drawing out; (2) the ring system, so arranged that any section can be disconnected; (3) the twin system, with two ways of supplying each point. All these methods have advantages for and against them, and it is more or less a matter of choice which should be adopted. The first, in the author's opinion, is not sufficiently safe to be employed where continuity of supply must be considered as the first requirement. The size of the main steam-pipe is also an important point; as the size increases the condensation becomes greater. It is quite possible to arrange feeders to the points where the supply is required, and by doing this reduce the size of the ring. The feeders being opened only upon heavy loads considerably reduces the condensation, which even in a small works is an exceedingly costly item. The author has found it desirable to place receivers having considerable capacity close to each engine. These act as steam dryers as well as maintaining the pressure, and as they are only in use while the engine is running, they do not, therefore, add considerably to the amount of condensation. It is, of course, most desirable to arrange all valves upon branches so that they stop the supply as close as possible to the main, and thus reduce the length of live pipe, as well as leave the engines' cylinders cool for inspecting purposes. The pipes should be free to expand, and it is absolutely necessary either to arrange large bands or expansion joints for this purpose. The drainage of steam-pipes is a subject upon which another paper might easily be written. There are innumerable steam-traps designed to allow the water to readily flow away, but the author is surprised that the American method of dealing with this difficulty has not been more generally adopted in England, as it is most desirable to conduct the hot condensed water back to the boiler, if possible, without the help of a pump. One of the American methods employed may be very briefly described. It consists of a small pipe, the one end being connected to the steam-pipe at the point from which it is desirable to drain the water, the other end being led direct to the boiler. Supposing that the boiler pressure was 150lb. per square inch, and the pressure upon the steam-pipe at the point desired to be drained 145lb. per square inch, it would be necessary to allow the pipe to rise, say, 12ft. above the water-level in the boiler to enable the water to return to the boiler, a check valve being arranged at the top of the pipe so that the water can go into but not return from the boiler.

In conclusion, the author would point out a few of the difficulties he has experienced in working with water-tube boilers under the conditions stated in this paper. The cracking of the brickwork seating, and consequently the admission of cold air, has been a source of considerable annoyance, and the author is not aware of any method of construction which will prevent this, although several different methods have been tried. The firebrick lining of the boilers will also require constant renewal, and the author has found large firebrick slabs placed at the side of the furnaces last much longer than brickwork, and are more easily replaced. After the boilers had been at work some time, it was found that a considerable amount of pitting was taking place. This was due to the soft condensed water, and was stopped by limewashing the whole inside of the boiler, or by admitting lime with the feed water; but if the latter course is adopted care must be taken to admit only a small quantity of lime, or a deposit in the form of scale will form on those portions of the boiler subjected to the greatest heat. The admission of oil with the feed water is, however, one of the most serious difficulties the author has had to overcome. There are many forms of filters which may be used. These consist generally of Turkish towelling, or cocoanut matting, wrapped round a perforated cylinder or plates, and are fixed upon the feed pipes so that the water entering the boiler is compelled to pass through the filtering medium. Another class of filter may be used, in which coke or sawdust is employed as the filtering medium, but the author has found that the great point against any form of filter fixed upon the feed pipes is that the water is passing through the filtering medium at too great a velocity, and he has found that if a filtering tank is placed under the condenser into which the hot water flows, and the water allowed to pass through a much larger area of filtering material at a very slow speed, much more satisfactory results can be obtained; but even with a duplicate arrangement, oil will find its way into the boiler in small quantities, and the boilers must be frequently cleaned. Although cleaning a boiler once every month or six weeks may entail considerable expense, it is to a large extent returned by the increased evaporation. The importance of keeping boilers thoroughly clean cannot be over-estimated, and in the author's opinion this is the greatest cause of the difference in the figures obtained when testing, and this applies to all types of boilers. The great aim of the engineer in charge of the works will be to obtain the most steam at the least cost, but unfortunately it is hardly possible to make a satisfactory comparison, because the cost of fuel varies very considerably, and it may be that the engineer with a high figure for fuel is really working more economically than another engineer whose figures are much lower, owing to the fact that the price of coal depends largely upon locality. In an electricity works, owing to the very varying demand, a very large proportion of the fuel is used for banking up fires in reserve boilers. It would therefore seem advisable to employ the poorest class of fuel possible to be obtained, provided it can be delivered to the works at a very cheap rate, in preference to burning less fuel of a more expensive kind. The author has found, from careful tests, that the cost of fuel per pound of water evaporated depends almost entirely upon this question of price, and not upon quality. But if poor fuel be employed, more boilers will be required, and it may easily happen that the capital charges upon the additional boilers will outweigh the small advantage gained from the use of poor fuel.

The author would finally express his regret that he has only been able to touch upon the outskirts, as it were, of this important subject, which affords ample scope for deeper research and opportunities for some most interesting experiments, and although he feels that there is nothing in this paper of which those present are not fully aware, he yet hopes that this subject which he has had the honour of bringing before them may be the means of inducing an interesting discussion upon this important question.

CORK TRAMWAY ORDER.

We insert the following regulations issued with respect to the Cork Tramway Order, which has just been issued, to remind our readers of the type of the regulations now in force. The regulations for Dundalk are practically identical:

Regulations, dated October 14, 1897, made by the Board of Trade under the provisions of Section 37 of the Cork Electric Tramways Order, 1897, made by the Lords Justices and Privy Council in Ireland under the Tramways (Ireland) Acts, 1860 to 1896, for regulating the employment of insulated returns, or of uninsulated metallic returns of low resistance; for preventing fusion or injurious electrolytic action of or on gas or water pipes or other metallic pipes, structures, or substances; and for minimising as far as is reasonably practicable injurious interference with the

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electric wires, lines, and apparatus of parties other than the promoters, and the currents therein, whether such lines do or do not use the earth as a return.

Definitions.—In the following regulations, the expression "energy" means electrical energy; the expression "generator" means the dynamo or dynamos or other electrical apparatus used for the generation of energy; the expression "motor" means any electric motor carried on a car and used for the conversion of energy; the expression "pipe" means any gas or water pipe or other metallic pipe, structure, or substance; the expression "wire" means any wire or apparatus used for telegraphic, telephonic, electrical signalling, or other similar purposes; the expression "current" means an electric current exceeding one-thousandth part of one ampere; the expression "the promoters" has the same meaning or meanings as in the Cork Electric Tramways Order, 1897.

REGULATIONS.

1. Any dynamo used as a generator shall be of such pattern and construction as to be capable of producing a continuous current without appreciable pulsation.

2. One of the two conductors used for transmitting energy from the generator to the motors shall be in every case insulated from earth, and is hereinafter referred to as the "line"; the other may be insulated throughout, or may be uninsulated in such parts and to such extent as is provided in the following regulations, and is hereinafter referred to as the "return."

3. Where any rails on which cars run or any conductors laid between or within 3ft. of such rails form any part of a return, such part may be uninsulated. All other returns or parts of a return shall be insulated, unless of such sectional area as will reduce the difference of potential between the ends of the uninsulated portion of the return below the limit laid down in Regulation 7.

4. When any uninsulated conductor laid between or within 3ft. of the rails forms any part of a return, it shall be electrically connected to the rails at distances apart not exceeding 100ft. by means of copper strips having a sectional area of at least one-sixteenth of a square inch, or by other means of equal conductivity.

5. When any part of a return is uninsulated it shall be connected with the negative terminal of the generator, and in such case the negative terminal of the generator shall also be directly connected, through the current indicator hereinafter mentioned, to two separate earth connections, which shall be placed not less than 20 yards apart. Provided that in place of such two earth connections the promoters may make one connection to a main for water supply of not less than 3in. internal diameter, with the consent of the owner thereof and of the person supplying the water, and provided that where, from the nature of the soil or for other reasons, the promoters can show to the satisfaction of an inspecting officer of the Board of Trade that the earth connections herein specified cannot be constructed and maintained without undue expense, the provisions of this regulation shall not apply. The earth connections referred to in this regulation shall be constructed, laid, and maintained so as to secure electrical contact with the general mass of earth, and so that an E.M.F. not exceeding four volts shall suffice to produce a current of at least two amperes from one earth connection to the other through the earth, and a test shall be made at least once in every month to ascertain whether this requirement is complied with. No portion of either earth connection shall be placed within 6ft. of any pipe, except a main for water supply of not less than 3in. internal diameter, which is metallically connected to the earth connections with the consents hereinbefore specified.

6. When the return is partly or entirely uninsulated, the promoters shall in the construction and maintenance of the tramway (*a*) so separate the uninsulated return from the general mass of earth and from any pipe in the vicinity; (*b*) so connect together the several lengths of the rails; (*c*) adopt such means for reducing the difference produced by the current between the potential of the uninsulated return at any one point and the potential of the uninsulated return at any other point; and (*d*) so maintain the efficiency of the earth connections specified in the preceding regulations as to fulfil the following conditions—viz.: (i.) That the current passing from the earth connections through the indicator to the generator shall not at any time exceed either two amperes per mile of single tramway line or 5 per cent. of the total current output of the station. (ii.) That if at any time and at any place a test be made by connecting a galvanometer or other current indicator to the uninsulated return and to any pipe in the vincinity, it shall always be possible to reverse the direction of any current indicated by interposing a battery of three Leclanché cells connected in series if the direction of the current is from the return to the pipe, or by interposing one Leclanché cell if the direction of the current is from the pipe to the return. In order to provide a continuous indication that the condition (i.) is complied with, the promoters shall place in a conspicuous position a suitable, properly connected, and correctly marked current indicator, and shall keep it connected during the whole time that the line is charged. The owner of any such pipe may require the promoters to permit him at reasonable times and intervals to ascertain by test that the conditions specified in (ii.) are complied with as regards his pipe.

7. When the return is partly or entirely uninsulated, a continuous record shall be kept by the promoters of the difference of potential during the working of the tramway between the points of the uninsulated return furthest from and nearest to the generating station. If at any time such difference of potential exceeds the limit of seven volts, the promoters shall take immediate steps to reduce it below that limit.

8. Every electrical connection with any pipe shall be so arranged as to admit of easy examination, and shall be tested by the promoters at least once in every three months.

9. Every line and every insulated return or part of a return except any feeder shall be constructed in sections not exceeding one-half of a mile in length, and means shall be provided for isolating each such section for purposes of testing.

10. The insulation of the line and of the return when insulated, and of all feeders and other conductors, shall be so maintained that the leakage current shall not exceed one-hundredth of an ampere per mile of tramway. The leakage current shall be ascertained daily before or after the hours of running when the line is fully charged. If at any time it should be found that the leakage current exceeds one-half of an ampere per mile of tramway, the leak shall be localised and removed as soon as practicable, and the running of the cars shall be stopped unless the leak is localised and removed within 24 hours. Provided that where both line and return are placed within a conduit this regulation shall not apply.

11. The insulation resistance of all continuously insulated cables used for lines, for insulated returns, for feeders, or for other purposes, and laid below the surface of the ground, shall not be permitted to fall below the equivalent of 10 megohms for a length of one mile. A test of the insulation resistance of all such cables shall be made at least once in each month.

12. Where in any case in any part of the tramway the line is erected overhead and the return is laid on or under the ground, and where any wires have been erected or laid before the construction of the tramway in the same or nearly the same direction as such part of the tramway, the promoters shall, if required so to do by the owners of such wires or any of them, permit such owners to insert and maintain in the promoters' line one or more induction coils or other apparatus approved by the promoters for the purpose of preventing disturbance by electric induction. In any case in which the promoters withhold their approval of any such apparatus the owners may appeal to the Board of Trade, who may, if they think fit, dispense with such approval.

13. Any insulated return shall be placed parallel to and at a distance not exceeding 3ft. from the line when the line and return are both erected overhead, or 18in. when they are both laid underground.

14. In the disposition, connections, and working of feeders the promoters shall take all reasonable precautions to avoid injurious interference with any existing wires.

15. The promoters shall so construct and maintain their system as to secure good contact between the motors and the line and return respectively.

16. The promoters shall adopt the best means available to prevent the occurrence of undue sparking at the rubbing or rolling contacts in any place and in the construction and use of their generator and motors.

17. In working the cars the current shall be varied as required by means of a rheostat containing at least 20 sections, or by some other equally efficient method of gradually varying resistance.

18. Where the line or return or both are laid in a conduit, the following conditions shall be complied with in the construction and maintenance of such conduit: (*a*) The conduit shall be so constructed as to admit of easy examination of and access to the conductors contained therein, and their insulators and supports. (*b*) It shall be so constructed as to be readily cleared of accumulation of dust or other *débris*, and no such accumulation shall be permitted to remain. (*c*) It shall be laid to such falls and so connected to sumps or other means of drainage as to automatically clear itself of water without danger of the water reaching the level of the conductors. (*d*) If the conduit is formed of metal, all separate lengths shall be so jointed as to secure efficient metallic continuity for the passage of electric currents. Where the rails are used to form any part of the return they shall be electrically connected to the conduit by means of copper strips having a sectional area of at least one-sixteenth of a square inch, or other means of equal conductivity, at distances apart not exceeding 100ft. Where the return

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is wholly insulated and contained within the conduit, the latter shall be connected to earth at the generating station through a high-resistance galvanometer suitable for the indication of any contact or partial contact of either the line or the return with the conduit. (*e*) If the conduit is formed of any non-metallic material not being of high insulating quality and impervious to moisture throughout, and is placed within 6ft. of any pipe, a non-conducting screen shall be interposed between the conduit and the pipe, of such material and dimensions as shall provide that no current can pass between them without traversing at least 6ft. of earth, or the circuit itself shall in such case be lined with bitumen or other non-conducting damp-resisting material in all cases where it is placed within 6ft. of any pipe. (*f*) The leakage current shall be ascertained daily, before or after the hours of running when the line is fully charged, and if at any time it shall be found to exceed half an ampere per mile of tramway the leak shall be localised and removed as soon as practicable, and the running of the cars shall be stopped unless the leak is localised and removed within 24 hours.

19. The promoters shall, so far as may be applicable to their system of working, keep records as specified below. These records shall, if and when required, be forwarded for the information of the Board of Trade.

Daily Records.—Number of cars running; maximum working current; maximum working pressure; maximum current from the earth connections (*vide* Regulation 6, i.); leakage current (*vide* Regulations 10 and 18, *f*); fall of potential in return (*vide* Regulation 7).

Monthly Records.—Condition of earth connections (*vide* Regulation 5); insulation resistance of insulated cables (*vide* Regulation 11).

Quarterly Records.—Conductance of joints to pipes (*vide* Regulation 8).

Occasional Records.—Any tests made under provisions of Regulation 6 (ii.); localisation and removal of leakage, stating time occupied; particulars of any abnormal occurrence affecting the electric working of the tramway.

HEREFORD ELECTRIC LIGHTING.

REPORT BY MR. THOS. L. MILLER.

The following report and letter respecting the electric lighting of Hereford were considered at the Council meeting last week. The report is addressed to Mr. Alderman Carver, the chairman of the Hereford Gas Committee, under the date of December 7, 1897. It reads as follows:

Dear Sir,—In accordance with instructions received from the town clerk and yourself, in company with your gas manager (Mr. Parlby) and the city surveyor (Mr. Parker) I drove round Hereford for the purpose of inspecting the various available sites for the proposed electricity supply works, and as you expressed a wish that I should, in addition to the question of site, consider the system of supply best suited to your requirements, and the probable cost of the proposed scheme, I beg to report to you as follows. The sites visited were (1) the cattle market; (2) the gasworks; (3) the slaughter-house; (4) the old gasworks site; (5) the outfall works.

The cattle market site is very central, and there is ample room for the necessary works and also for extensions. This site, however, labours under the disadvantage that all fuel would have to be carted, thus adding 1s. to 1s. 6d. per ton to the coal bill.

The gasworks as a possible site has the following advantages: (1) the electricity works and gasworks could be placed under one management, thus reducing the expenses under this head to a minimum; (2) coke breeze, at a cost of about 3s. per ton, could be used as fuel, and thus a by-product from the manufacture of gas could be used for generating steam for the electricity works; (3) by replacing the existing seven steam-engines by electromotors, and by doing away with the present steam-boiler, the machinery at the gasworks could be worked more economically, and in addition a saving of nearly £200 per annum in wages effected to the gasworks; (4) there is ample land available at the gasworks, and belonging to the Corporation, for any extensions that may be required, and there is also a plentiful supply of water for condensing and boiler feed. The only objection I can see to this site is that it is some distance from the centre of the city, but in view of extensions to the residential portions of the city, I may point out that it is more convenient for serving these portions than is the slaughter-house site.

The slaughter-house site is somewhat nearer the area of supply than is the gasworks, and one of the advantages claimed for this site is that by combining the electricity works with refuse destructors, the cost of production of electrical energy would be greatly reduced. On this point the city surveyor informs me that the amount of refuse available would be about 30 tons per day, which I estimate would produce steam for a maximum of 50 i.h.p., and as at full load about 200 i.h.p. will be required at the electricity works, it will be at once seen that a considerable amount of coal or coke would have to be used in addition to the refuse in order to produce the steam necessary for generating this power. Supposing, however, that the whole of the fuel was saved by using this refuse for producing steam for electrical purposes the saving would only be about ½d. per unit generated, and against this would have to be put such additional charges for management as would be incurred by having a separate establishment.

The old gasworks site and the sewage outfall works are neither of them, in my opinion, convenient sites, the former on account of the small space available for extensions, and the latter on account of its distance from the area of supply.

After carefully considering the relative advantages and disadvantages of the sites above enumerated, I am strongly of opinion that, all things considered, the gasworks site is the best, and I would advise your committee to adopt this site for the proposed electricity supply works.

System of Supply.—I would recommend that the system of supply to be adopted be that known as the direct-current three-wire system, and that the pressure to consumers' terminals be 220 volts.

Capacity of Proposed Works.—I would recommend that in the first instance generating plant be put down capable of supplying current to, say, 4,000 8-c.p. lamps alight at one time, or, say, 6,000 8-c.p. lamps connected to the mains. This plant would be so arranged that when the demand became so great as to require an extension of the plant, such extensions could be carried out at a minimum cost. Thus I estimate the above plant would cost £7,200, while the necessary extensions required in order to double its capacity would only cost an additional £2,750. In the first instance, however, I would only recommend an expenditure of about £7,200 on generating plant and machinery.

Distributing Mains.—I estimate the cost of the distributing mains required to be laid in the scheduled streets at £3,946, and the service connections and meters at, say, £1,270. These mains, I am of opinion, will be of ample size for the requirements of these streets for many years to come.

Feeder Mains.—In my rough report of yesterday I included the sum of £4,345 for feeder mains and potential leads; on going more carefully into the matter to-day I find that such mains would be capable of supplying current to, say, 9,600 lamps of 8 c.p. connected to the mains. In addition to this, I have made an estimate of the cost of feeder mains for, say, 16,000 and 20,000 lamps of 8 c.p. connected to the mains, which I find to be as follows:

Cost of feeder mains and potential leads for 9,600 lamps of 8 c.p.	£4,345
16,000 lamps of 8 c.p.	5,535
20,000 ,, ,,	6,345

For your present requirements I would recommend you to include for feeder mains for 16,000 lamps. Should the demand in this district at any time exceed 16,000 lamps connected, it will then be necessary for you to consider an extension of these mains.

Estimated total cost.	
Generating plant for 6,000 8-c.p. lamps connected	£7,200
Feeders for 16,000 8-c.p. lamps connected, and potential leads	5,535
Distributing mains	3,946
Service connections and meters	1.270
Engine-house and roadwork	5,349
	23,300
Add engineering charges, excluding commission on buildings and roadwork, which I presume your own surveyor would carry out	896
	£24,196

Trusting the foregoing may meet your present requirements, I am, dear Sir, yours faithfully, THOS. L. MILLER.

The following letter to Mr. Alderman Carver from Mr. Miller, dated December 11, 1897, has also been circulated:

ELECTRIC LIGHTING.

Dear Sir,—As requested in your favour of yesterday, I have carefully considered the question of the working of your proposed electricity works, and would give the following estimate of the probable revenue and expenses from 4,000, 8,000, and 16,000 lamps connected to the mains. In the figures below given, I have assumed that you can borrow at 3 per cent., in which case the annual charges for interest and repayment of capital—the capital being repaid in 25 years—would be at the rate of 5·74 per cent. per annum. The capital I have taken as follows:

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4,000 lamps	£25,000
8,000 ,,	30,000
16,000 ,,	37,500

From the records of other towns, and from observations taken when at Hereford, I should expect the annual consumption per 8-c.p. lamp connected to be 20 Board of Trade units, which would give an annual consumption of—

80,000 units for	4,000 lamps connected.
160,000 ,, ,,	8,000 ,, ,,
320,000 ,, ,,	16,000 ,, ,,

The total cost of generating current, including all charges for fuel, stores, wages, repairs, and maintenance, rent, rates and taxes, and management expenses, would I estimate be :

3d. per unit for	80,000 units.
2¾d. ,,	160,000 ,,
2½d. ,,	320,000 ,,

These figures, I may say, are based on the results obtained in other similar works, and may be accepted with confidence. Including interest and repayment, I estimate the total annual charges to be :

For 4,000 8-c.p. lamps connected—to generating 80,000 units at 3d.	£1,000
To interest and repayment of capital at 4·74 per cent. on £25,000	1,435
	2,435
For 8,000 8-c.p. lamps—to generation	1,833
Interest and repayment at 4·74 per cent. on £30,000	1,722
	3,555
For 16,000 8-c.p. lamps—to generation	3,333
To interest and repayment—4·74 per cent. on £37,500	2,152
	£5,485

Revenue.—Assuming that average charges are at the rate of 6d. per unit up to 4,000 lamps connected, and that they are then reduced to 5d. per unit until, say, 8,000 lamps are connected, and that there is then a further reduction to, say, 5d. per unit, the revenue would, I estimate, be as follows :

4,000 lamps connected—80,000 units at 6d.	£2 000
8,000 lamps connected—160,000 units at 5½d.	3,666
16,000 lamps connected—320,000 units at 5d.	6,666
Financial results—for 4,000 lamps connected, deficit	435
8,000 lamps connected, surplus	111
16,000 lamps connected, surplus	1,118

These results it will be noticed are obtained after paying all charges, including interest and repayment of capital. I note in your letter you ask for results for 4,000, 8,000, and 16,000 lamps, and as there may be some confusion in the matter, I may remark it is found from experience that only about 60 per cent. of the lamps connected to the mains are alight at one time, and that, as a consequence, station generating plant for 2,400 would be capable of dealing with 4,000 lamps connected to the mains.—Trusting the foregoing is what you require, I am, dear Sir, yours faithfully, THOS. L. MILLER.

The Finance and General Purposes Committee reported to the Council that they had received from the Gas Committee the foregoing report of Mr. Thos. L. Miller, of Liverpool, upon the scheme for providing electric light in the city, and they recommended the Council to adopt the estimate furnished by Mr. Miller, amounting to £24,196, as the estimate to be deposited with the application for the provisional order. Mr. Symonds, the chairman of the committee, proposed the adoption of the report, which, after being considered in committee by the whole Council, was passed.

LEGAL INTELLIGENCE.

NORTH STAFFORDSHIRE TRAMS COMPANY v. BRITISH ELECTRIC TRACTION COMPANY.

This was an appeal by the defendants, before Lord Justice A. L. Smith, Lord Justice Rigby, and Lord Justice Collins, from an order made by Mr. Justice Day, on the application of the plaintiff tram company restraining the defendant company from interfering with the plaintiffs' tramway at Burslem. It appeared that the acts of the defendants of which the plaintiffs complained were being done while the defendants were acting in the exercise of their statutory rights, the defendants being the transferees of certain rights and authority granted by the Potteries Extension Tramways Order, 1896, as confirmed by the Tramways Order Confirmation No. 2 Act, 1896. This order authorised the construction and maintenance of certain tramways described therein. The defendants commenced an action for damages for trespass and for an injunction, and Mr. Justice Day made an order granting an interim injunction till the trial of the action.

Mr. Balfour Browne, Q.C., Mr. Cripps, Q.C., Mr. Asquith, Q.C., and Lord Robert Cecil appeared for the defendants in support of the appeal; Mr. Lawson Walton, Q.C., Mr. Herbert Reed, Q.C., and Mr. Carrington for the plaintiffs.

While the arguments were proceeding it was arranged that the case should be settled, the defendants undertaking to let matters remain as they were till January 1 and to proceed with their works as expeditiously as possible after that date, and to grant the plaintiffs certain facilities for working their tramway. On these terms the injunction was dissolved.—*Times.*

LEVY v. NATIONAL TELEPHONE COMPANY.

This was an application by the defendant company from an order of Mr. Justice Day at Chambers, dated November 13, and is rather important, because it raised the question whether householders were bound to allow the tops of their houses to be crowded with telephone poles and wires against their will. Mr. Justice Day granted Mrs. Levy a mandatory injunction requiring the defendant company to remove, within two months of that date, some 250 wires and cables erected over and above her premises, 12, Whitechapel-road.

Mr. Asquith, Q C , and Mr. Roskill appeared for the defendant company ; Mr. Upjohn, Q.C., and Mr. Miller for the occupier.

Mr. Asquith, in stating the facts upon which the application was made, said that he did not deny that a technical trespass upon the plaintiff's property was committed by the placing of a number of wires and cables upon the same, but, inasmuch as some of the wires had been in their present position for 13 or 14 years, it was unreasonable to require the defendants to remove them within the space of two months, half of which time had already expired, on a mere interlocutory injunction obtained before a judge at Chambers.

Mr. Upjohn, in support of the injunction, submitted that the action was an absolutely undefended one. His client's right, in his opinion, to have the wires, etc., removed from over her house was so clear that he believed she would have been perfectly within her rights if she had employed workmen to cut them away.

Their **Lordships** dismissed the appeal with costs, being of opinion that Mr. Justice Day had made a perfectly proper order in the matter, but the time in which the defendant company were to take down their wires and cables was extended to two months from the present date on account of the fact that more than a month had elapsed since the order was made.

MAGNOLIA ANTI-FRICTION METAL COMPANY OF GREAT BRITAIN, LIMITED, v. TANDEM SMELTING SYNDICATE, LIMITED.

On Wednesday, December 15, before the Lord Chief Justice in the Queen's Bench Division of the High Court of Justice, the Magnolia Metal Company obtained an injunction against the Tandem Smelting Syndicate, Limited, restraining them from passing off their metal for the Magnolia metal. The Tandem Smelting Syndicate, Limited, were condemned to pay the cost of the action.

COMPANIES' MEETINGS AND REPORTS.

CROMPTON AND CO., LIMITED.

A brief formal extraordinary general meeting was held at the Cannon-street Hotel on Monday, Mr. John Trotter presiding.

On the motion of the **Chairman**, seconded by **Mr. J. F. Albright**, the resolutions passed at the extraordinary general meeting held on the 29th ult. were confirmed as special resolutions. They were for reducing the capital of the Company by writing off capital which had been lost or was unrepresented by available assets and for providing for the extinction of any preference or priority on the preference shares, either in respect of past or future dividends or capital, over the holders of the ordinary shares.

BROCKIE-PELL ARC LAMP COMPANY, LIMITED.

The second ordinary meeting of shareholders was held at the Cannon-street Hotel on Monday, Lord Suffield in the chair.

The **Chairman** stated that as the directors had decided to have the accounts made up to the end of this year, there was no directors' report and statement of accounts to present that day. The auditors expected to have the accounts out in the end of February, and shortly thereafter the annual meeting would be held to consider these. In the meantime, he might say that the engineering strike had much delayed their manufactures, and they had had to procure what was wanted from foreign distances, and long distances ; and they had, therefore, had very many difficulties to contend with. Some difficulty had arisen as to the lamps already manufactured when the concern was taken over by this Company, but after legal proceedings, it was satisfactorily settled that this Company had the right to them. They had now some very considerable orders in hand ; indeed, the business had nearly doubled since the starting of this Company, and if they were allowed a little time he saw no reason why they should not carry out the original intention of the Company. He added that Mr. Brockie, their engineer, had invented a new lamp, the merits of which would be that it was cheaper and more durable than those now in use.

Some few remarks were made as to certain rumours which had got afloat that the directors had been concerned in Stock Exchange

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transactions in the shares of the Company, but this was strongly refuted by the directors both individually and collectively. It was also stated in the course of conversation that the contracts for France and Belgium had been signed and the deposits paid.

The meeting was then adjourned till the first week in March.

CROYDON TRAMWAYS COMPANY.

An important meeting of shareholders in the Croydon Tramways Company was held at 18, Eldon-street, E.C., last week to deal with the proposal to sell the Company's undertaking to the British Electrical Traction Company, Limited. The meeting was convened by a circular which stated that an extraordinary meeting of the Company had been called for the purpose of considering an agreement with the British Electric Traction Company, Limited. The object of the agreement is to carry out the sale of the undertaking and assets of the Company to the British Electric Traction Company, Limited. The near approach of the period at which the lines will become purchasable by the local authority, and the heavy expenditure which is unavoidable on the reconstruction and equipment of the lines for electrical traction, which the directors understand the local authorities make a condition precedent to any extension of the term, has led the directors to believe that the shareholders will be wise in accepting the present offer and securing now for themselves what may be considered fairly satisfactory terms.

There was a considerable attendance at the meeting. It was kept private, and a reporter of the *Croydon Advertiser* (to which paper we are indebted for this report), who presented himself for admittance, was informed that reporters would not be admitted. Enquiries among shareholders who attended the meeting show, however, that the proceedings occupied nearly two hours, the chair being taken by Mr. Carruthers Wain. It is understood that the proposal which was set forth in the circular convening the meeting was met by some of those present with a request for further time for consideration.

The opposition to the immediate approval of the agreement with the Traction Company was led by **Major-General G. F. Kaye**, who, after a motion had been submitted for the approval of the agreement, proposed as an amendment that the matter be deferred for eight weeks for further information to be placed in the hands of the shareholders. He argued at some length against the directors' proposal being approved at that meeting.

General Kaye's amendment was seconded, it is understood, by **Mr. Hone**, another shareholder, who argued that the ordinary shareholders should be paid at par, or that the Company should keep the concern.

The motion for the approval of the agreement, however, was carried by a very large majority.

A question has been raised as to the legal power of the shareholders to take the course they have taken, and we understand that probably more will be heard of it.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Bucharest.—Tenders are invited for 20,000 porcelain insulators. Specifications are to be obtained from, and tenders addressed to, the Railway Department, Bucharest, by December 30.

Bucharest.—Tenders are invited for 10,000 insulator brackets. Specifications are to be obtained from, and tenders addressed to, the Railway Department, Bucharest, by December 29.

Burnley.—Tenders are invited for the ironwork in connection with the extension of the electric lighting station. Send names to the borough surveyor, Mr. G. H. Pickles, Town Hall, Burnley, by December 24 (to-day).

Bucharest.—Tenders are invited for 22,500 kilogrammes of galvanised iron wire. Specifications are to be obtained from, and tenders addressed to, the Railway Department, Bucharest, Roumania, by December 28.

Salford.—The Town Council invite tenders for the supply of 300 yards of portable tramlines and 12 side-tipping trucks, to carry 20 cubic feet. For particulars apply to the Borough Engineer, Town Hall, Salford.

Reus (Spain).—Tenders are invited for the electric lighting of the town. The deposit is 2 500 pesetas. Specifications are to be obtained from, and tenders addressed to, the Municipality of the town, province of Taragona, by 2 p.m. on December 31.

Novorossisk (Russia).—Tenders are invited for the construction, etc., of an electric lighting installation for the town. The deposit is 5,000 roubles. Specifications may be obtained from, and tenders addressed to, the Municipal Authorities of the town by March 1 (13).

Oporto.—Tenders are invited for the installation of electric light at the station of the Minho and Duro Railway. Estimated cost 350,000 reis. Specifications are to be obtained from, and tenders addressed to, Manager of above Railway by December 30.

Catanzaro (Italy).—Tenders are invited for electric tramway or other light railway between the town and the railway station. The deposit required is £400. Specifications are to be obtained from, and tenders addressed to, the Municipal Authorities by December 30.

Morley (Yorks).—The School Board invite tenders for supplying and fixing lightning conductors to the various buildings at Bridge-street Board Schools. Sealed tenders, endorsed "Conductors," to be sent to Mr. R. Brown, clerk, School Board Offices, Morley, by December 31.

Bedford.—Tenders are invited for building offices and store-rooms at the electricity works. Particulars can be obtained on application to the Engineer at the Electricity Works. Sealed tenders to be delivered at the offices of Mr. T. S. Porter, town clerk, Town Hall, Bedford, by January 10.

Novorossisk (Russia).—Tenders are invited for the construction, etc., of an electric tramway. The deposit required is 5,000 roubles. Specifications, etc. (in French), are to be obtained from, and tenders addressed to, the Municipal Authorities, Novorossisk (Russia), by March 1 (13). The time has been extended from November 15.

Utrera (Spain).—Tenders are invited for an electric lighting installation. The provisional deposit required is 8,805 pesetas (about £340) and 17,640 pesetas final. Specifications are to be obtained from, and tenders addressed to, the Municipal Authorities, at Utrera, province of Seville, Spain, by 2 p.m. on December 27.

Newcastle-on-Tyne.—The Trustees of Heaton-road Wesleyan Church invite tenders for the installation of the electric light in the church, lecture hall, vestries, and lobbies, etc., with front and side lights. Tenders to include specification, plans, and designs of fittings proposed to be introduced. Tenders, marked "Electric Light," to be sent to Mr. J. W. Hunter, 170, Shields-road, by December 27.

Huddersfield.—The Corporation invite tenders for the extension of the electricity supply station. Specifications, drawings, and quantities may be seen, and forms of tender obtained, on application at the offices of the Borough Electrical Engineer, St. Andrew's-road, Huddersfield. Sealed tenders, endorsed "Tender for Electricity Works," must be delivered, free of charge, addressed in handwriting of tenderer or his agent, to the Town Clerk, Town Hall, Huddersfield, by January 4.

Glasgow.—The Corporation invite tenders for the supply of 2,000 tons of steel straight track rails, 200 tons of steel curve rails, and about 120 tons of steel fishplates. Specification, with form of tender and section, can be obtained on application to Mr. John Young, general manager, 88, Renfield-street, Glasgow. Tenders, sealed and marked on cover "Tender for Tramway Rails," to be lodged with Mr. J. D. Marwick, town clerk, City Chambers, Glasgow, by 10 a.m. on December 28.

Dublin.—Tenders are invited by the Dublin United Tramways Company for the supply of general stores and sundries during year ending December 31, 1898. Forms of tender (price 1s. each), conditions, and all information can be obtained, and patterns seen, at the Company's Office, 9, Upper Sackville-street, Dublin, from December 13 to 27. Tenders, sealed, and marked on outside "Tender for Stores," and addressed to the Chairman, to be lodged with Mr. Wm. Anderson, secretary, by January 3.

Tarragona (Spain).—The Secretary of State for Foreign Affairs has received a dispatch from her Majesty's Chargé d'Affaires at Madrid, transmitting copy of a Royal order inviting tenders for the construction and working of a telephone system in Tarragona. Sealed tenders will be received at the office of the Civil Governor of the province of Tarragona for 40 days, counting from Dec. 11. Further particulars of the conditions of the tenders may be inspected at the Commercial Department of the Foreign Office any day between the hours of 11 and 6.

Wolverhampton.—The Public Works Committee invite designs and tenders for motor-vans for street scavenging and the conveyance of road materials. Outline specification and form of tender can be obtained on application to Mr. J. W. Bradley, C.E., borough engineer and surveyor, Town Hall, Wolverhampton. Firms tendering do so at their own cost in every respect. Drawings and a full description of the motive power, capacity, and other particulars, addressed to the Chairman of the Public Works Committee, to be delivered by February 7.

Worthing.—The Electric Light Committee of the Town Council invite particulars and conditions under which any person, firm, or company is willing to instal and maintain the electric light in the borough for a term of years, with power to the Corporation to acquire the undertaking upon agreed terms and at stated periods. The provisional order of the Board of Trade, which is in the usual form, may be inspected, and a plan of the town, showing the compulsory area and other particulars, obtained, on application at the Town Clerk's Office, Liverpool-road, Worthing.

Canterbury.—The Corporation are prepared to receive tenders for the provision and erection, complete, of refuse destructors for the city, to be worked in conjunction with the electricity works about to be established. General site plan and arrangements proposed, together with description of works and general conditions of contract, may be obtained on deposit of £1. 1s., returnable on receipt of a bona fide tender, by application to the City Surveyor, 28, St. Margaret's-street, Canterbury. Tenders, on printed forms, to be lodged with Mr. Henry Fielding, town clerk, by December 31, at 12 noon.

Guipuzcoa.—The Secretary of State for Foreign Affairs has received a despatch from her Majesty's Consul at Bilbao, reporting that the Provisional Board appointed in connection with the electric tramway which it is proposed to lay from Zumarraga to Zumaya, in the province of Guipuzcoa, invite plans and tender, to be received by February 28, for the construction and equipment of the line. Further particulars of the conditions of the tenders for the above-named tramline and branch, which together measure 30 miles, may be inspected at the Commercial Department of the Foreign Office between 11 and 6.

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Bedford.—The Electric Light Committee are prepared to receive tenders for the supply and erection of the following plant: (Section A) one 420-b.h.p. double-acting compound enclosed engine; (B) one 250-unit alternator, with stationary armature. Specifications, with terms and conditions of tender and contract, may be obtained at the offices of Mr. T. S. Porter, town clerk, Town Hall, Bedford, on payment of a fee of 5s. for each section. Tenders, sealed and marked "Electric Lighting, Section A or B," must be delivered to the Town Clerk by January 10.

London, N.W.—Tenders are invited by the Vestry of St. Pancras for the supplying and erecting of arc lamps, posts, and circuits, complete; also feeding and distributing mains. Copies of specification, conditions of contract, and forms of tender to be obtained upon application to the Chief Clerk, Electricity Department (offices, 57, Pratt-street, N.W.), on payment of a deposit of £1, which will be returnable on receipt of a bona fide tender, accompanied by the specification. Tenders to be sent to Mr. C. H. F. Barrett, vestry clerk, Vestry Hall, Pancras-road, London, N.W., endorsed "Tender for Arc Lighting Extensions," by 12 noon on 28th inst.

Leicester.—The Sanitary Committee invite designs and tenders for motor vehicles for the collection of house refuse. The motive power, capacity, and all other particulars are to be described in a full specification, accompanied by drawings and delivered at the office of Mr. E. George Mawbey, C.E., borough engineer and surveyor, Town Hall, Leicester, addressed to the Chairman of the Sanitary Committee, by January 31. The loaded wagons would have to ascend an incline of 1 in 20, turn in a limited space, back and tip over a beam about 14in. high by 12in. in width, and when empty descend a road having a gradient of 1 in 15. The Committee do not bind themselves to accept any proposal, and firms tendering must do so at their own cost, no fees being allowed for the preparation of drawings, etc.

Gloucester.—The Electricity Supply Committee are prepared to receive tenders for the supply and erection of the following plant on the low-tension system, for the municipal electricity works: (Section A) boiler-house plant—Lancashire boilers and accessories, mechanical stokers, feed pump, injector, economiser, electric motor; (B) engine-house plant—steam dynamos and accessories; (C) overhead travelling crane; (D) switchboard and instruments; (E) accumulators; (F) mains—insulated cables and trenching; (G) public lamps—arc and incandescent street lamps and lamp-posts; (H) meters—the whole bound up in one specification. Tenderers are at liberty to tender for either section, but not for part of a section. Specification, with terms and condition and forms of tenders, may be obtained at the offices of Mr. Robert Hammond, M.I.E.E., consulting engineer to the Corporation, Ormond House, Great Trinity-lane, London, E.C., on payment of £3. 3s., which sum will be refunded on the return of the specification filled up with a bona fide tender. Duplicate copies of the specification £1. 1s. each, not returnable. Tenders (sealed and marked "Tender for Electricity Works") must be addressed to Mr. Geo. Sheffield Blakeway, town clerk, Guildhall, Gloucester, and be delivered by January 18.

Bootle (Lancs.).—Tenders are invited by the Corporation for the supply and erection of (1) Lancashire boilers and Green's economiser; (2) engines, dynamos, switchboard, condensers, condensing and feed-water pumps, balancing transformers, boosters, piping, tanks, crane, meters, wiring of electricity supply works, and alterations and additions to wiring at town hall; (3) secondary batteries and accessories; (4) feeder and distributing mains (solid system), potential leads, network and surface boxes, and service connections; (5) running of the electricity supply works for period not exceeding three years. Specifications, drawings, and form of tender can be obtained at the office of Mr. J. H. Farmer, town clerk, Town Hall, Bootle, on payment of £5. 5s. (or £1. 1s. per section), which will be returned on receipt of a bona fide tender. Any further information can be obtained from the consulting engineer, Mr. Thomas L. Miller, M.I.E.E., 7, Tower-buildings N., Water-street, Liverpool. Contractors may tender for any section or sections, but not for part of a section, and contractor for No. 2 section must also tender for Section No. 5. The contractor whose tender is accepted will be required to enter into a formal agreement under seal, with sufficient and approved securities, for the fulfilment of contract. Sealed tenders, endorsed "Tender for Electric Lighting," and addressed to the Chairman of the Watch Committee, must be sent in by 12 noon on January 10.

Madras.—Tenders are invited for the utilisation of water flowing from the Periyár Lake for purposes other than irrigation and not incompatible with the use of the water for drinking. The irrigating season extends over nine to ten months, during which time the discharge is likely to be from 1,100 to about 500 cubic feet a second, according to the demands for irrigation and the available quantity in the lake. Subject to the risk of interruption by accident or drought, supply can be given throughout the irrigation season. No supply can be guaranteed at other times, but, so long as water is available, the Government will be prepared to issue it in such daily quantities as may seem to it advisable with reference to the time which is likely to elapse before the supply is replenished by the setting in of the rains. The fall from the tunnel to the foot of the hills is approximately 900ft., and the distance measured along the course of the stream about 6,800ft. One cubic foot per second falling 900ft. is estimated to produce over 60 effective horse-power. Intending lessees should state the quantity of water required in cubic feet per second and the annual rent offered for each cubic foot per second. No rent will be charged for the first year from the date of the concession; for the second year the charge will be one-fifth, and an additional charge of one-fifth will be made every year until the full rent is reached. The whole or part of the concession may be surrendered on a year's notice being given. Lessees will construct at their own expense, on plans to be approved by Government, all the weirs and other works required to divert the water from the river below the tunnel. For further information, application may be made to the Chief Engineer for Irrigation, Madras, by whom tenders will be received up to July 1, 1898.

BUSINESS NOTES.

Bristol.—The salary of Mr. Yabbicom, the city engineer, is to be increased by £300 per annum.

Kinning Park.—The whole Council has been elected to constitute the Electric Light Committee.

Clontarf.—A call office of the National Telephone Company has been opened at Fairview this week.

Lincoln.—It has been decided to light certain parts of High-street by electricity, and 27 arc lamps are to be fixed.

Colwyn Bay.—In accordance with the surveyor's recommendation, the electric lighting station will be established at Groes.

Spain.—A project for the construction of extensive electric tramways in Segovia is under consideration by the Government.

Preston.—The Electric Light Supply Company have obtained permission to extend their electric mains along the country roads.

Ipswich.—The report referred to in our last issue, which was received by the Guardians, has again been sent back to the committee.

Shardlow.—It has been suggested to the Guardians that the Building Committee take into consideration the whole question of lighting the workhouse.

Croydon.—An installation of 150 lights is being erected at the Crown Hotel, Croydon, by Mr. G. E. Cockburn to the specification of Mr. Morgan Williams.

Blairgowrie.—The Improvement Committee of the Police Commissioners have under consideration the advisability of introducing the electric light in the district.

City of London Electric Lighting Company.—The transfer books and register of holders of debenture stock have been closed from the 17th to the 31st inst. inclusive.

Walsall.—Councillors T. P. Brownhill and Noake have been appointed chairman and vice-chairman respectively of the Electric Lighting Committee for the ensuing municipal year.

Chester.—The Lighting Committee has been authorised to have the streets and courts bounded by the city walls lighted with electric incandescent lamps at a cost not exceeding £680.

Salford.—Colonel W. Langton Coke, C.E., held an enquiry on the 22nd inst. with reference to an application of the Corporation for power to borrow £13,000 for electric lighting purposes.

Liverpool.—It is proposed during next year to expend £136,987 in extension of electric supply, chiefly to provide electric energy for the new trams, and also motive power to provide consumers.

Hastings.—At a special meeting of the Town Council a memorial was adopted asking the Board of Trade for full powers to supply electricity and to purchase the electric light company's undertaking.

Wimbledon.—Mr. Preece has submitted his proposed specifications and general conditions in connection with the electric lighting scheme, and the Council have decided to advertise for tenders on the basis thereof.

Brush Electrical Engineering Company.—The transfer-books of the 4½ per cent. second debenture stock will, in view of interest payable on January 1 next, be closed from December 20 to January 1, inclusive.

Weston-super-Mare.—The recommendation of the Council to the effect that Mr. Hawtayne be requested to proceed with the preparation of the plans, specifications, etc., connected with the scheme has been confirmed.

Batley.—A resolution directing that application be made to the Board of Trade for a provisional order authorising the Corporation to supply electricity for public and private purposes has been carried by the Town Council.

Chichester.—A long letter appears in the *West Sussex Gazette* strongly advocating that the Corporation should themselves undertake the electric lighting of the city instead of permitting a private company to obtain the powers.

Glasgow.—A petition from the Townhead Ward Committee is under consideration of a committee of the Corporation in favour of the lighting by electricity of Parliamentary-road in connection with the new car system to Springburn.

Hammersmith.—The Vestry have received tenders for two 500-i.h.p. engines and two 300-kw. alternators and exciters. A new sub-station is to be constructed immediately in Holcombe-street, at an estimated cost of £328.

Guatemala.—The Secretary of State for Foreign Affairs has received a telegraphic dispatch from her Majesty's Minister in Guatemala, stating that from January 1 export and import duties in that country will be payable in silver.

Basingstoke and Alton Light Railway.—The *London Gazette* announces that the Board of Trade have, after modification, confirmed an order made by the Light Railway Commissioners authorising the construction of the above line.

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Augusta Railway and Electric Company.—The North American Trust Company, of New York and London, are prepared to pay on and after January 1 the coupons due on that date of the bonds of the above at their London office, 95, Gresham street, E.C.

Smithfield Markets Electrical Supply Company.—We are officially informed that the shares in the Smithfield Markets Electrical Supply Company, Limited, have been considerably over-subscribed. Letters of allotment and regret have been posted.

North Darley—The Council having received notice of the proposed formation of a company to supply electric light within a radius of 26 miles from Worksop, which area includes North Darley, have agreed to await results before taking any action.

Rowley.—It is stated that the Light Railway Commissioners have, at the request of the chairman of the District Council, instructed the Electric Traction Company to include in their light railway scheme the districts of Old Hill and Cradley Heath.

Wolverhampton.—The Public Works Committee of the Corporation have discussed a report from the borough engineer recommending the adoption of motor-vans for scavenging and macadamising; and the Corporation are now advertising for the same.

Houses of Parliament.—The Houses of Parliament are partly lighted by 40 000 electric lamps, which number is being constantly increased. Fifty experienced electricians are employed to keep the system in order. But there is still a yearly gas bill of over £2.000.

Moss Side.—The District Council have decided to oppose the Bill of the Manchester Carriage and Tramways Company to obtain electric haulage and other powers, the Council only wishing to obtain a *locus standi* in order to protect the interests of the ratepayers.

Levenshulme.—With regard to the adoption of the electric light draft transfer of the Manchester Corporation, it was stated at the Council meeting that the transfer would be at the option of the Council after 21 years. After a short discussion the transfer was adopted.

Taunton.—The Town Council have forwarded a memorial to the Board of Trade praying them to reconsider the decision of the Light Railway Commissioners who had refused the application by the promoters of the Taunton light railway for an order on a technical point.

Llandudno.—At a recent meeting of the Electric Lighting Committee it was resolved that the plans presented by the surveyor, relating to the proposed application for a provisional order to construct tramways within the urban district, be approved of and adopted.

North-East Electric Railway Company.—The North American Trust Company of New York and London state that they are prepared to pay, on and after January 1, the coupons due on that date of the bonds of the above railway at its London office, 95, Gresham-street, E.C.

Cardiff and Penarth District Light Railway Company, Limited.—This Company has been registered, with a capital of £25,000 in £1 shares, with the object to apply for power to construct a light railway from Penarth to Cardiff, and to supply electric light and power.

Gloucester.—The Barton Ward Ratepayers' Association have passed a resolution to the effect that the Foley-place site was very inadequate for building the dust destructor and electric light station on, and that the meeting strongly protested against having such places erected in their midst.

Diaries.—We have received from R. F. White and Son a number of artistically got-up almanacks, blotters, etc., issued for the Sun Insurance Company, Threadneedle-street, E.C. They are apparently not "made in Germany," but designed and printed by Sir Joseph Causton and Sons.

House-to-House Electric Light Supply Company, Limited.—We are informed that the debenture stock register of this Company will be closed from the 22nd inst. to the 31st inst. inclusive for the preparation of interest warrants for the half-year ending 31st inst. and payable on January 1, 1898.

Gateshead.—An extraordinary meeting of the shareholders of the Gateshead and District Tramways Company has definitely approved of and adopted the agreement of November last between the Gateshead and District Tramways Company and the British Electric Traction Company, Limited.

Darlington.—At a special meeting of the Town Council resolutions regarding the laying down of plant for producing carburetted water gas, and making application to the Board of Trade for extension of powers contained in the Darlington Electric Lighting Order of 1890, were agreed to.

Chiswick.—With reference to the London United Tramways Bill, 1898, it appears that the Council are opposed to the application of electric traction by overhead wires to the tramways in its district, but have no objection to the other proposals in the Bill. They have notified their dissent to the Bill.

Blackpool.—At a special meeting of the Town Council, the tramway question was again discussed. The inclusion of the scheme in the Parliamentary Bill now being prepared was objected to, but eventually it was agreed to let the ratepayers have the final word at a public meeting to be held shortly.

Hove.—The Hove Electric Lighting Company, Limited, have again notified the Council of their intention to lay mains in Ventnor-villas as far as No. 8, and further informed the Council that they intended to extend these mains the whole length of Ventnor-villas, from Church-road to Eaton-road.

Willaston.—The Willaston Electric Lighting Works Company, who have secured premises near to the station, having asked the Nantwich Rural District Council for its support of the movement, the Council have offered no objection to the scheme provided that the company did not interfere with their rights.

Sandgate.—The plans served on behalf of the promoters of the Folkestone and District Light Railway Company and the electric tramway company respectively, and the draft order served on behalf of the former company, have been considered by the Council, and further consideration postponed for a week.

Bournemouth and Poole Electric Supply Company.—We are informed that the applications for the 6,000 preference shares amounted to 13,233, or an excess of 7,233, and the applications for ordinary shares considerably exceeded the number offered for subscription; also that letters of allotment and regret have been posted.

Harrogate.—The National Telephone Company have obtained the permission of the Council to use the streets, etc. The distribution poles are to be of steel, and will also act as ventilators to the sewers. The sanction of the Local Government Board has been received for the loan of £15,750 for extending the electric lighting system.

German Budget, 1898.—The Budget presented to the German Parliament on the 30th ult. contains a sum of £2,718,202. 8s. for new buildings and railways, £1,170,000 of which are apportioned to the army, £300,000 to the marine, £800,000 to the railways, £260,000 for post and telegraphs, and £55,000 for various public works in the African colonies.

Sedgley.—At its last meeting plans relating to the proposals of the Electrical Corporation respecting the district of Sedgley were placed before the Council. The Chairman said the Council ought to see that the inhabitants were benefited if they gave the corporation a license to become occupiers of their roads. The matter was referred to a committee.

Somerset.—At the last meeting of the Drainage Commissioners, the Clerk produced the parliamentary notice issued by the Bridgwater Town Council in connection with the provisional order for the electric lighting powers, some of which, such as crossing rivers, might affect the Commissioners. It was decided that the engineer should report on the provisional order.

Camberwell.—The Vestry have agreed, after considerable discussion, to the "reception" of a notice from the London Electric Supply Corporation to lay high and low tension distributing mains in certain districts, and to raise no objection to the Brush Company being granted power by the Board of Trade to lay down a system of continuous current.

Belgian Contracts.—An announcement in the *Bulletin Commercial* states that all tenders and letters referring to the contracts for the Belgian Government Departments of Roads and Bridges, Railways, and Posts and Telegraphs, must be sent to the Bureau des Adjudications (Musée Commercial), rue des Augustins 17, Brussels, where specifications may be obtained.

Burnley.—At the last Council meeting a letter was read from Messrs. Todd and Lamb stating that their company would repay all expenses should the approval of the Board of Trade not be given to the electric light order. They had supplied the Board of Trade with information which would satisfy them that the transferees were able to fulfil the responsibilities that would devolve upon them.

Swansea.—At the last meeting of the Town Council the Chairman of the Property and General Purposes Committee, referring to the appointment of a sub-committee to carry out the proposal to light the Oxford-street market by electricity, stated that the lamps were already on the ground, and the foundations for the engine and dynamo laid. It would be a great benefit to traders when completed.

Northwich.—The first installation of electric light was completed last Saturday, and the illumination of one of the large places of business in the salt district attracted large crowds of people. The electric current is being supplied by the Northwich Electric Supply Company, Limited. The three-wire low-tension system has been adopted, and the generating station is in Beswick's-road, Winnington.

Plymouth.—We are informed that the Noah's Ark Inn, Old Town-street, which has just been entirely rebuilt, is to be fitted throughout with electric light. The installation is equivalent to 140 8-c.p. lamps, power being supplied by a Crossley high-speed gas-engine. The work has been entrusted to Messrs. Robinson, Sadler, and Co., of the above-named town, who also have several other important contracts on hand.

Country-Mansion Lighting—Embley Park, Hants, the seat of Major Spencer Chichester, has been fitted up with a very complete electric light plant for upwards of 250 lights, in addition to electric pumping arrangements. Duplicate oil-engines and dynamos are installed, in addition to a 200-light storage battery. The work has been carried out by Messrs. Veritys to the specification of the consulting engineer, Mr. Morgan Williams.

Eastern Telegraph Company, Limited.—The Board of the Eastern Telegraph Company, Limited, announce the payment on January 14 next of interest of 3s. per share, less income tax, being at the rate of 6 per cent. per annum, on the preference shares for the quarter ended 31st inst., and the usual interim dividend of 2s. 6d. per share on the ordinary shares, free of income tax, in respect of profits for the quarter ended September 30 last.

Halifax.—A committee, accompanied by Mr. Wilmshurst, electrical engineer, as representing the Tramways Committee, have visited Wolverhampton and Wednesbury for the purpose

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of ascertaining the progress being made with the motors, etc., ordered from the contractors there for the Halifax tramways. Pressure was brought to bear upon the contractors to hasten on with the work, in order to open the tramways by next Easter.

Warwick.—A letter from the Electric Extension Company, Limited, London, W.C., stating that they had entered into negotiations with the Leamington and Warwick Tramway Company for the purchase of their tramways, and had advised them that their offer was subject to their obtaining a renewal of the lease for a further period of 21 years, and asking whether such lease would be extended by the Corporation, has been referred to a committee.

Dover.—The Dover Corporation tramway has been extended from 2 to 2¼ miles. This completes the length of the whole tramway line as far as the Town Council have decided to go. The Maxton branch and the pier extension were opened for business on Saturday last for the first time. Sir F. Marindin made his official inspection of the "finishing touches" on Friday, and expressed himself extremely satisfied with the electric tramways in Dover as a whole.

Electricity in Printing Works.—The proprietors of the *Financial Times* have laid down a very extensive and complete lighting and power plant in their new premises in Clare-market. The current is employed for upwards of 600 lights, as well as for motive power for printing machinery, electric fans, etc. Messrs. Siemens Bros. and Co. are responsible for the plant, and Messrs. Vaughan and Brown for the wiring, Mr. Morgan Williams being the consulting engineer.

Catalogues.—We have received from Messrs. Arthur D. Studd and Co., engineers, etc., of Montague-street, Kettering, illustrated catalogues describing Brown's patent electric low-water alarm, and various plant and building machinery suitable for railway, harbour, dock, and building contractors; also from the General Electric Company, No. 13 of the "General Electrical Progress," which contains prices, etc., of electric bells, wiremen's sundries, brackets, and accessories.

Electric Street Car Manufacturing Syndicate, Limited.—We understand that a company has been registered under the above title, in which Messrs. T. H. Parker and T. Parker are interested. The object of the Company is to carry on the business of manufacturers of and dealers in motor cars, carriages, vans, cycles, and other vehicles, electrical and general engineers, boilermakers, machinists, etc. Messrs. Parker, S. Craddock, E. Lisle, and S. F. Page are named as directors.

London County Council.—At the last meeting of the Council the Highways Committee recommended that with a view of obtaining an investigation with regard to the telephone service in London, similar to the enquiry recently held as regards that service in Glasgow, the Council should make application under the Telegraph Act, 1892, to the Postmaster-General for a license empowering the Council to provide an independent municipal telephone service for London.

Chatham and Rochester Trams.—A very large meeting took place at the Public Hall, New Brompton, last week, and recorded a unanimous vote in favour of the proposed electric tramway scheme for the towns. It was stated that the total cost would be £200,000. The Council had practically given their approval to the scheme, and in another 18 months the trams would become an accomplished fact. Weekly return tickets at 9d. for the six return journeys are promised. The ordinary fare will be 2d. per trip.

Carlisle.—The Council intend to borrow £30,000 for electric light works. The Electric Light Committee have approved of a recommendation by Prof. Kennedy to make alterations in the construction of the dynamos, switchboard, etc., in order that they might be in a position to supply electrical energy for the proposed tramways. The surveyor has submitted plans, elevations, and detailed drawings of the proposed electric lighting station to the committee, and has been instructed to advertise for tenders for the work.

Kirkcaldy.—The proposal to introduce tramways has been receiving considerable attention of late, and the movement is likely to receive fresh impetus by a decision come to at a joint meeting of the Tramways and Town Council Committees, when the proposal was unanimously approved of, as was also the overhead electric system of traction. A sub-committee has been appointed to obtain a report from an electrical engineer on a combined scheme for electric lighting and traction. The tramway will extend to Dysart.

The Hansen Arc Lamp.—We have received from Messrs. Gülick and McIntyre, of 11 and 12, Great Tower-street, a list of the Hansen small-power arc lamps. These lamps are supplied adjusted to take from one ampere upwards with continuous current, and from four amperes upwards with alternate current, and the makers guarantee a steady, silent light in either case. The list is complete, and many illustrations are given, but we miss a description of the lamp mechanism. We note the lamps are short in length, and that the firm stock a variety of outdoor accessories.

Stoke-on-Trent.—The Council have received another letter from the British Electric Traction Company with reference to the Hanford extension, saying the reason it had not been started was because the promoters could not come to any reasonable arrangement with the North Staffordshire Tramways Company for working the same. The Parliamentary Committee recommend that the town clerk suggest that, by the intervention of the Corporation, some arrangement might be come to enabling the British Electric Traction Company to start the extension forthwith. This has been approved.

New Electrical Firm.—We understand that the old-established firm of D. Bruce Peebles and Co., of Edinburgh, will in the New Year start an electrical manufacturing business. Their works are being enlarged for the purpose, and they have retained the services of Mr. Roland S. Portheim as manager of the new department, and Mr. Montague T. Pickstone as their engineer and designer. Enclosed motors for traction work and for distribution of power in factories are to be the specialities of the firm. Special machinery for manufacturing these in quantity is being laid down to enable the American competition to be met.

Personal.—We understand that Mr. A. L. C. Fell, M.I.E.E., who has been representing the British Thomson-Houston Company, Limited, as resident engineer in connection with the Cork tramways and lighting scheme, has been appointed resident electrical engineer to the Sheffield Corporation.—We hear that the managing director, Mr. Justus Eck, M A., M.I.E.E., of Messrs. Laing, Wharton, and Down, has left New York, and is expected in London next week. He has spent about two months in the United States studying the latest developments in electric traction and street railway work, having visited the principal cities on behalf of his firm.

Bowley.—The General Purposes Committee have reported to a meeting of the District Council that the Midland Electric Corporation for Power Distribution had deposited notice and plans of their scheme, and of the application proposed to be made for a provisional order to enable them to supply electricity for motive power and all public and private purposes within portions of the counties of Stafford and Worcester; power to construct works, to make charges, to acquire land, to open streets, to erect and lay electric wires, etc. The committee recommended Mr. Cooksey, the Council's solicitor, to act on behalf of the Council in the matter.

Belfast.—At the last meeting of the Electric Committee, the Engineer reported certain applications received since last meeting for current, which had to be held over for the present. The architect and contractor for the new station buildings attended and explained the causes of the delay in the completion of the works, the principal of which is the dispute in the engineering trade, but as most of the structural ironwork is now to hand, the committee were given to expect that they would be in possession of the first section early in February. It was decided to recommend the Council to adopt Wright's system of charging for electric current.

Poplar.—The report presented by the Electric Lighting Committee to the last meeting of the Board of Works recommended that the instruction passed on November 23 to the committee to incur no further expense in the visitation of other districts be withdrawn, and that the committee be authorised to visit Hanley and Bradford (towns stated to be possessed of similar characteristics to the Poplar district), as decided by the unanimous vote of the members of the committee present when the question was put—the resolution of the Board of July 20, 1897—allowing to the committee expenses that may be incurred in visiting outlying electric light stations, being operative.

Leeds and Bradford Light Railway.—At a meeting of the Farsley District Council on the 20th inst., a letter was read from the Pudsey District Council asking, before they took any action in regard to the light railway scheme, for some information as to the views of the Farsley Council on the subject. The Chairman said they had been given to understand that Leeds were no more opposed to the scheme than might have been expected, but Bradford were perhaps a bit stronger. It was decided to reply that though the Farsley Council were not committed by resolution, they were favourably disposed to the new railway, and would probably approve of the scheme subject to certain conditions.

Swansea.—The special committee of the Swansea Corporation appointed to negotiate with the tramways company on matters connected with the recent triple scheme, have reported the result of an interview with the tramway company's representatives in London. It is understood that the company decline to give terms. Another important point on which the municipal authority and the company do not agree is with regard to the relaying of the lines. The Corporation take exception in many important particulars to the methods proposed to be adopted. The company contend that the Corporation have no power to insist on certain requirements. The Corporation hold a contrary view altogether. Correspondence is still taking place on all the points at issue.

Dundee.—The Bill to empower the Town Council to work the tramways within the burgh has now been published. In the Bill power is sought to acquire land for a generating station and to erect works for generating and using electric power, and to adapt the existing tramways for working the lines by mechanical power. In the event of the tramways being worked by electric power, due regard will be had to prevent injury by induction or otherwise to the Post Office telegraphic lines. "If any question arise as to whether the Corporation have constructed their electric lines or other works or work their undertaking in contravention, such question shall be determined by arbitration, and the Corporation shall be bound to make any alteration in or additions to their system which may be directed by the arbiter."

Exeter.—At the last meeting of the Town Council, the Electric Lighting Committee reported that the posts were fixed and wired ready for lighting the main streets of the city by electricity, but the surveyor was still waiting for the lamps, which the contractors were prevented from delivering in consequence of the engineers' strike.—The theatre company having asked for a reduction in the

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charges made to them, the committee resolved that it be pointed out to the company that the supply to the theatre is attendant with an amount of expense in excess of that of an ordinary consumer, as the energy has to be kept immediately available for the fullest amount of light required for the building, but that during a considerable portion of the evening the quantity of current taken is considerably reduced, but the Council trust later on to revise their charges generally.

General Electric Company.—The large catalogue of this Company in its characteristic red binding is in itself an indication of the progress of the electrical industry, and the rapid development in certain directions is evidenced by the numerous inset sheets we are continually receiving. Thus the thirteenth edition has just reached us, and on it we noticed particularly the Partridge alternating high-tension circuit cut-out. The distinctive name here warrants that the fuse in question has been designed by a gentleman knowing exactly what is required of such a cut-out. Another feature of special note is a reduction of the list prices of various fittings and accessories. This shows that the General Electric directors are endeavouring to reduce the cost of electric light outfits, and we are glad to chronicle the fact. Details of special fuses for 230 volts and some special fittings complete the page.

Bath.—The ex-chairman of the Electric Light Committee (Alderman Sturges), in presenting the report of the Electric Lighting Committee to the last Council meeting, said that on account of his increasing years he had tendered his resignation of the Electric Lighting Committee, and Alderman Taylor had succeeded him. The latter, however, suggested that he should present the report, which, though occupying a great many pages, was mostly of a technical nature. Particularly satisfactory indeed was the auditors' report, and he understood that for the following three months would be much more favourable. With regard to the progress of the work there had unfortunately been delays, but he thought they had now got over most of their difficulties. Only the previous evening he received a letter from Mr. Hammond in which he assured him things looked very healthy, and that he had no doubt it would be a great success. The report was adopted.

Leith.—At the last meeting of the Town Council, the minutes of the special committee on electric lighting showed that the committee had approved of a set of plans for the proposed electric lighting station. The electrical engineer reported that the total length of distributing mains throughout the scheduled area was 8,800 yards. The number of arc lamps required for the compulsory area will be 68 in all. By arranging the arcs in groups of eight—alternate lamps being on the same circuit—two switches would control the lighting of Leith-walk to Pilrig, and similarly the other circuits would be controlled from a point near the station. Such an arrangement would permit of the street-lighting being reduced by one-half, say, at 12 midnight, without any great distance having to be traversed by the attendant on duty. The proposed system of laying the cables in Leith is at present in use at Brighton and Chester, where it is giving satisfaction. The minutes were approved.

Hanley.—At the last meeting of the Town Council, the General Purposes Committee recommended that the application of the British Electric Traction Company for an order under the Light Railways Act, 1896, enabling them to promote an electrical tramway from Hanley to Burslem, be opposed on the ground that it is not desirable, and that the action of the town clerk in dissenting from the proposed undertaking on behalf of the Corporation be approved. The committee further reported the receipt of a letter from the North Staffordshire Tramways Company stating that they proposed to apply to the Board of Trade in the ensuing session for a provisional order authorising the construction of tramways, some of which would be in the borough of Hanley. It was likewise recommended that the town clerk communicate with the British Electric Traction Company complaining of the slow progress they are making with the laying of their line in different parts of the borough. These recommendations were confirmed.

Sheffield.—A special meeting of the Corporation was called this week to sanction an application to the Board of Trade to amend the order so as to enable them to make the purchase of the electricity works with redeemable stock. In the meantime negotiations will be resumed with a view to an amicable arrangement being come to between the Corporation and the company.—A correspondent writes to the *Sheffield Daily Telegraph* recommending the laying-down of an electric plant by the Corporation on account of the present installation of the electric light company not being nearly large enough to supply what would be required, and especially as, if bought by the Corporation, it would still want the expenditure of thousands of pounds before the requirements for the electric trams could be met, and also because as a public concern it will most heavily affect the rates. "With regard to discussing the matter in Council with closed doors and in secret," he says, "it would be rather a difficult matter to do, seeing there are, I believe, several shareholders in the Council."

Electrical Copper Company, Limited.—The first annual report of the directors of the Electrical Copper Company, Limited, with accounts to June 30 last, to be submitted to the ordinary meeting to be held on 29th inst. in London, states, according to the *Financial Times*, that a portion of the Company's works at Widnes has been put into successful operation, and copper sheets are now being produced there of a highly satisfactory quality, in execution of orders received by the Company. Owing, however, to unavoidable delays in the delivery of the machinery, notwithstanding the closest attention by the Board, the works were not ready for turning out manufactured copper until the end of October and the directors are consequently not in a position to give any report regarding commercial results. The experimental laboratory in Paris taken over by the Company was found to be too small for extensive tests of the process, and was transferred to Brunoy (near Paris), where a factory now exists suitable for experimental tests and the production of certain classes of copper sheets for sale. Attention had been given to testing the working details of the patents of the Company, and several important additions have been elaborated and covered by supplementary patents.

Folkestone.—The Council at their last meeting considered a proposal from the electric lighting company, referring to the proposed positions of the columns for electric light. The arc lamps vary from 64ft. to 86ft. and the incandescent from 40ft. to 46ft. in distance, and the standards from 18ft. to 20ft. in height. The cost of the columns would be £1,611, which would replace 200 gas standards which cost about £4 each, so that the actual cost would be £811. The electric lamps would furnish 6½ times the light at double the cost. The lighting of further roads was also advocated, and it was resolved that the borough engineer report upon the number of lamps in the area, and obtain prices from various firms as to the cost of the standards.—At a meeting called by the promoters of the light railway scheme, now before the Corporation, at the North Board School, and held last week, the following resolution was proposed: "That this meeting supports the scheme of electric tramways, and ask the representatives of the North Ward to support it before the Light Railway Commissioners and the Board of Trade." Finally, an amendment to the effect that "if tramways are to come, they should be carried out and worked by the Corporation for the benefit of the whole ratepayers," was declared carried.

Aberdeen.—At the last meeting of the Town Council letters from the Harbour Commissioners agreeing to the arrangement as to lighting the harbour quays with electricity were remitted to the Gas and Electric Lighting Committee. A letter from the session clerk of the West Parish Church complaining of the insufficient lighting of the church and the inadequate system of ventilation was referred to the Churches Committee. The letter suggested the introduction of electric light, and said that if the Council would remit the subject to a committee of the Council the session would be glad to meet them in the church or elsewhere for the purpose of discussing the proposal. It was suggested that the congregation should pay the difference between the cost of lighting by gas and by electricity, unless, indeed, the Council were prepared to put the electric light into all the churches.—Mr. L. Anderson, inspector of lighting, has been instructed by the Watching and Lighting Committee of the Town Council to prepare a report for next meeting as to the cost of erecting overhead electric lamps in certain streets. Complaints as to defective lighting in various parts of the city were remitted to the sub-committee, which now consists of Bailie Edwards (convener) Bailie Taylor, Bailie Sangster, and Councillor Meff.

Chester.—From a report of the Electric Light Committee submitted to the Corporation, it appears that on the 17th inst. the electric light works had been running a year, and the question of the expediency of determining the running contract had been discussed by the committee. The Council was asked to authorise the committee to give the necessary two months' notice for the termination of the running contract when in their judgment the time arrives for doing so. The Local Government Board, while sanctioning the borrowing by the Council of £20,000, repayable in 25 years, for the purposes of electric lighting, stated that the cost of the internal works for the lighting of the town hall, the market, and the library, should be raised under the respective Acts under which these buildings are provided, and not under the Electric Lighting Act, 1882. The Finance Committee accordingly recommended that application be made to the Local Government Board for sanction to borrow—(1) under the Municipal Corporations' Acts for wiring and fitting the town hall, £1,290. 15s. 3d.; (2) under the Improvement Act, for wiring and fitting the public market, £1,002. 15s.; (3) under the Free Library Acts, for wiring and fitting the free library, £152. 18s. 2d. It was also proposed to light certain streets with electric incandescent lamps at a cost of £680. There are now 57 gas lamps in use within that area, for which 53 incandescent lamps will be substituted, necessitating a new distributing cable. All the recommendation were adopted, and authority was given for the provision of additional lighting in various parts of the town.

Cardiff.—The attention of the Council at the last meeting was called to the fact that the substitution of the arc electric lamps by incandescent lights in the Central Market had not yet been carried into effect. This step has been recommended as an experiment in the direction of effecting a saving in the cost of lighting the market, the illumination of which wholly by electricity cost £559 a year, or £353 more than when it was lighted simply by gas. Mr. Appelbee, the electrical engineer, stated that the delay had been due to the pressure of other work in the department, and he was instructed to get the recommendation carried out by the beginning of next quarter. He repudiated the suggestion that the alleged failure of the electric lighting at the market was due to the employment of unskilled labour, which, it was said, was implied by the letter of the electric light company, who supplied the lamps. In his opinion the market was considerably better lighted by electricity than it was when gas was used.—At a meeting of the Cardiff Electric Lighting Committee on Tuesday, the electrical engineer (Mr. Appelbee) reported that the new plant at the Eldon-road station would be ready for work at the end of this month. This would enable the committee to satisfy all the

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applications for electric lighting in the town. Mr. Priestley's report on the proposed water supply from Ely for the electric lighting works was read, and it was resolved that the Waterworks Committee be asked the price at which they would be prepared to supply the water. The Chairman expressed an opinion to the effect that Mr. Appelbee's scheme for cooling plant was the best. It was decided that the electrical engineer should prepare a report showing in what respect his proposal would be the most advantageous to the town.

Leeds.—The official installation of the electric light by the Corporation took place on the 22nd inst. A series of tests had already taken place in Briggate, the results giving the greatest satisfaction to the electrical experts who either conducted or watched the experiments. The light was certainly a distinct improvement upon the more familiar gas lamp, and, considering the great vibration caused by the tramway traffic, was remarkably steady. Altogether there are 40 arc lamps in Wellington-street, Briggate, and North-street, at an average distance of 27 yards apart. The lamps are fixed on an extension of the electric tramway poles, and the current is supplied from the Corporation generating station at Crown Point Bridge. Mr. Wm. Wharam, electrical engineer, Clay Pit-lane, Leeds, has carried out the whole of the contract, under the supervision of Dr. Hopkinson.—Further progress in the preliminary arrangements for the acquisition by the Corporation of the undertaking of the Yorkshire House-to-House Electricity Company was reported at the last meeting of the Parliamentary Committee. A resolution has already been adopted recommending the Council to apply to the Local Government Board for a provisional order to enable the Corporation to issue 5 per cent. debenture stock with a view to the purchase of the undertaking, and the Town Clerk stated that all the necessary steps had been taken to give effect to the resolution.—The *Leeds Mercury* says a sub-committee of the Corporation have had an interview with Messrs. Greenwood and Batley with regard to their contract for the supply of electric cars, which has been delayed owing to the dispute in the engineering trades. Messrs. Greenwood and Batley promised to equip three additional cars at once, one car a week afterwards if the dispute continues, and two cars a week if it terminates before Christmas. The committee considered this arrangement satisfactory.

APPOINTMENTS VACANT.

Engineer.—Required, for the district lunatic asylum, Maryborough, Queen's County, Ireland, a thoroughly practical man, who must be capable of taking charge of electric lighting plant, including engines, dynamos, boilers, etc., also laundry machinery and heating apparatus. Salary £100 a year, with allowances valued at £30 a year. Applicants must be good engine fitters Application, stating age and previous experience, together with copies of not more than three testimonials of recent date, to be forwarded to the Resident Medical Superintendent by December 29.

Engineer.—The Corporation of Harrogate require a competent man to drive flywheel steam alternators, for the electricity department. He must have some electrical knowledge, be experienced in the running and synchronising of alternating-current plant, and capable of taking sole charge of the station during an eight hours' shift. Applicants, who should be ready to commence duties at once, must state experience, wages required for a week of 56 hours, age, married or single, and send two recent testimonials to Mr. George Wilkinson, M.I.E E., Electrical Engineer's Office, Montpellier-gardens, Harrogate.

Electrician.—The Hull Corporation require the services of working electrician to attend to the lighting, heating, and ventilating of the town hall, the lighting of the market hall, and other buildings under the control of the city engineer, and the telephones and other similar apparatus under his control. Applicants must have had a fair experience in pipe work as well as electrical work, and preference will be given to those who have been engaged on similar work. A list of duties and other information may be obtained of the City Engineer. Applications must be in candidates' own writing. They must state wages required, must be accompanied by copies only of not more than three testimonials (which will not be returned), and must be addressed and delivered to Mr. A. E. White, city engineer, Town Hall, Hull, by January 1.

Electrical Engineer.—The Government of Trinidad require an electrical engineer to examine and report upon the various systems—light, power, and telephone—using electric currents in Port of Spain and its vicinity, with a view to determining the risk of life and property now involved. Engagement three months, with option to Government to extend to any period not exceeding 12 months in all. Salary £25 per month. Half salary during voyage out and home. Free first class passage out and home again on satisfactory termination of engagement. The selected candidate will have to pass a strict medical examination before appointment. Applications by letter, stating age, whether married or single, and giving full particulars of experience, accompanied by copies of testimonials (not originals), with names and addresses of references of whom enquiry can be made as to capabilities and character, will be received by the Crown Agents for the Colonies, Downing-street, London, S.W., up to January 6. The Crown Agents possess no further information in respect of the above appointment, and cannot undertake to answer enquiries.

Electrical Engineer.—The Council for the Foreign Community of Shanghai require if possible by April 1, 1898, a chief municipal electrical engineer. Salary, at present rate of exchange, about £460 per annum, with quarters, coal, gas, and medical attendance. Age (single man preferred) 28 to 40. Must pass the ordinary insurance medical examination. The gentleman selected must undertake to devote his whole time to the duties. He will serve under the Works Committee, and must be competent to advise, carry out extensions, and conduct routine correspondence. There is a competent English assistant. He should have a thorough knowledge of the management of alternating plant and continuous-current arc lighting. Good knowledge of mechanical engineering, and be able to prepare estimates for independent installations. It is desirable that he should have been in charge of a central station. Three years' agreement. First-class passage and liberal leave rules. Further particulars may be obtained from Messrs. John Pook and Co., 8, Jeffery's-square, St. Mary-axe, London, to whom all applications for the appointment should be forwarded before January 15

Minor Appointments.—There are also several minor appointments vacant, for particulars of which we refer readers to our advertising columns.

PROVISIONAL PATENTS, 1897.

DECEMBER 13.

29427. Improved electric arc lamp. Henry Vincent James, Westhill, Higher Broughton, Salford.

29429. Improvements in electrical controlling apparatus. Walter Emmott, Penny Bank Chambers, Halifax.

29493. Field telephone and telegraph station. Max Bernstein, proprietor of the firm of Joh. Friedr. Wallmann and Co., 111, Hatton-garden, London. (Complete specification.)

29505. Improvements in magnetic telegraphy. Oliver Joseph Lodge, 322, High Holborn, London.

29507. Method of and apparatus for producing perforated accumulator plates. Moricz Engl, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

DECEMBER 14.

29523. Improved electrical means for preventing burglaries, for external and internal use. Charles Bannister, 28, Donaldson-road, Kilburn, London.

29528. Improvements in electric lights. James Atkinson, The Woodlands, Marple, Cheshire.

29530. Improvements in the lighting of miners' safety lamps and the like by electricity. Henry Davis, All Saints' Works, Derby.

29531. Improvements in miners' safety lamps and the like. Tom Ingham and Henry Davis, All Saints' Works, Derby.

29542. Improved electric storage batteries. John William Davies and David Loch, 74, Colomb-street, East Greenwich London.

29566. Improvements in and connected with electric motors, partly applicable to dynamos. Samuel William Maquay, 55, Chancery-lane, London.

29575. An adjustable electric light fitting, with improved detachable and rotary contacts. Alfred Ernest Albert Mortimer and William John Head, 13, Mountford-road, Dalston, London.

29585. Improvements in methods of and means for regulating alternating-current dynamo-electric machines or distributing systems. The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. (Edwin W. Rice, jun., United States.) (Complete specification.)

29586. Improvements in or relating to electrical transformers. The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. (Walter S. Moody, United States.) (Complete specification)

29587. Improvements in and relating to dynamo-electric machines and electric motors for electric railways. The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. (Edward D. Priest, United States.) (Complete specification.)

29588. Improvements in the method of and means for breaking alternating-current induction motors. The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. (Edwin W. Rice, jun., United States.) (Complete specification)

29589. Improvements in electric arc lamps. The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. (Elihu Thomson and Charles E. Harthan, United States.) (Complete specification.)

29590. Improvements in and relating to dynamo-electric machines and motors. The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. (Edward D. Priest, United States.) (Complete specification.)

29596. Improvements in combination plugs or lamp-heads for electric lamps. Jacob Fulton Gates, 45, Southampton-buildings, Chancery-lane London. (Complete specification.)

29597. Improvements in controlling devices for electric motors. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Horace See, United States.) (Complete specification.)

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29595. Improvements in electric heaters or rheostats. Frank Kraemer, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

29615. Improvements in electrical switches or variable resistances. William Benjamin Spikins and Alfred Herbert Mayes, 171, Queen Victoria street, London. (Complete specification.)

DECEMBER 15.

29665. Improvements in communicators for te'ephone plants. Georg Ritter, 18, Fulham-place, Paddington, London. (Complete specification.)

29667. Improvements in or applicable to switches for electro-motors and the like purposes. Joseph Platt Hall and William Henry Seville Craven, 70, Deansgate, Manchester.

29676. A union box for electric mains for lighting, traction, power, or other purposes. Francis Daniel Black, 115, St. Vincent-street, Glasgow.

29716. Improvements in accumulators. David Browne and Pierre Kamperdyk, 70, Palace-chambers, Westminster, London. (Complete specification.)

29728. Improvements in electric heating devices. Fernand Le Roy, 6, Lord-street, Liverpool. (Complete specification.)

DECEMBER 16.

29778. Improvements in telegraphy. Leslie Bradley Miller, 2, Gray's-inn-road, London.

29821. Improvements in electric heaters. Friedrich Wilhelm Schindler-Jenny, 89, Chancery-lane, London.

29826. Improvements in conductors for electrical machinery and in dynamo-electric machines, motors, and other electrical apparatus. John Millis, 55, Chancery-lane, London. (Complete specification.)

29834. Improvements in the construction of single-phase alternate-current motors and generators. Arthur Cecil Heap, 18, New Bridge-street, Blackfriars, London.

29835. Improvements in and relating to electric heaters. Edwin Forsythe Porter, 77, Chancery-lane, London. (Complete specification.)

29852. A new or improved underground duct for electric railway leads, and a contact slide to work therein. Hermann Theodor Hillischer, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

DECEMBER 18.

29977. Improvements in electric motors and dynamos. Charles Brooke Crawshawe and Claude William Hill, Hubert-street, Leeds-road, Bradford.

29981. Improvements in electric drilling machines, electric boring machines, and electric milling machines. W. H. Allen, Son, and Co., and John Westbeech Kempster, Queen's Engineering Works, Bedford.

29985. The patent detachable-collar electric incandescent lamp. Frank Nicholson, 41, Market-street, Manchester.

29994. Improvements in and connected with electric locomotives. William Edwin Heys, 70, Market-street, Manchester. (Jean Jacques Heilmann, France.) (Complete specification.)

30001. Improvements in railway aero-electric brakes. Charles Luyers, 8, Rue des Princes, Brussels. (Complete specification.

30020. Improvements in prepaid electric meters. Alfred Soames and Charles William Scott Crawley, 24, Southampton-buildings, Chancery-lane, London.

30037. Improvements in electric arc lamps. Daniel Lacko, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, &c., Act, 1883, Sec. 103, July 21, 1897, being date of application in France.)

SPECIFICATIONS PUBLISHED.

1896.

26864 Continuous-current electric motor-generator. Brab and Knoche.

26969. Frames for ho'ding finely-divided mass, such as the active material of electric accumulators. Holzapfel.

27209. Dynamo-electric machines. Sayers, Mavor, Coulson, and Mavor.

27323. Electric arc furnaces. The Acetylene Illuminating Company, Limited, and Day.

27992. Electrical cable couplings by means of an insulating and locking arrangement. Culligan.

1897.

203. Accumulators or secondary batteries in electrically-propelled vehicles. Roderbourg.

1150. Portable electric railways with overhead conductors. Koppel.

3346. Secondary batteries. Payen.

13976. Induction motors. The British Thomson-Houston Company, Limited. (Steinmetz.)

20501. Surface-contact or closed-conduit electric railways. The British Thomson-Houston Company, Limited. (Potter.)

23415. Dynamos. Liddle. (Farnham.)

23418. Electromotors and dynamos. Murray and Johnson.

TRAFFIC RECEIPTS.

Bristol Tramways.—The traffic returns for the week ending December 17 were £2,362. 13s. 4d., compared with £1,859. 4s. 8d. for the corresponding period of last year, being an increase of £503. 8s. 8d.

Dover Tramways.—The traffic receipts for the week ending December 18 were £109. 13s. 7d. The total receipts up to the same date were £1,692. 18s. 7d. The mileage open at present is 2½ miles.

Birmingham Tramways.—The traffic receipts for the week ending December 18 were £3 577. 11s. 1d., as compared with £2 977. 1s. 1d. in the corresponding week in 1896, being an increase of £600. 10s. 0d.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended December 19 amounted to £1,342, as compared with £1,116 in the corresponding week of the previous year, being an increase of £226.

City and South London Railway.—The returns for the week ended December 19 were £1,180, compared with £1,082 for the corresponding period of last year, being a decrease of £2. The total receipts for the half-year 1897 amounted to £24,060, compared with £24,103 for the corresponding period last year, being a decrease of £43.

South Staffordshire Tramways.—The traffic returns for the week ending December 17 were £565. 2s. 2d., as compared with £544. 14s. 6d. in the corresponding week of the previous year. The aggregate receipts so far this year were £31,541. 3s. 6d., as compared with £30,590. 18s. 0d. in the corresponding period in 1896.

S.D. Tramways, Dublin.—The traffic receipts for the week ending December 17 were £366. 6s. 10d., as compared with £414. 10s. 0d. in the corresponding week in the previous year, being a decrease of £48. 3s. 2d. The number of passengers carried was 63,574 in 1897 and 63,798 in 1896. The aggregate returns up to date are £15,035. 8s. 3d., as compared with £15,853. 18s. 1d. last year, being a decrease of £818. 9s. 10d. The mileage open is the same as last year—viz., eight miles.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	£	11½
Brush Company, Ordinary	£	1¾-2¼
—— Non. Cum., 6 per cent. Pref.	£	2¼-2½
—— 4½ per cent. Debenture Stock	100	108-112
—— 4½ per cent. 2nd Debenture Stock	100	103-105
Callender's Cable Company, Debentures	100	108-113
—— Ordinary	£	7-8
Central London Railway, Ordinary	10	9¾-10¾
——	£	5½-6
—— Pref. Half-Shares	£	1-1½
—— " "	£	4¼-4½
Charing Cross and Strand	£	12½-13½
—— 4½ per cent. Cum. Pref.	£	6-6½
Chelsea Electricity Company	£	10½-11
—— 4½ per cent. Debentures	100	113-116
City of London, Ordinary	10	26-27
—— Prov. Cert.	10	25½-26½
—— 6 per cent. Cumulative Pref.	10	17-18
—— 5 per cent. Debenture Stock	100	131-136
City and South London Railway, Consolidated Ordinary	100	66-68
—— 4 per cent. Debenture Stock	100	138-140
—— 5 per cent. Pref. Shares	10	15½-16
—— " " '96	10	13½-14½
County of London and Brush Provincial Co., Ordinary	10	13½-14
—— 6 per cent. Cum. Pref.	10	15½-16
Crompton and Co., 7 per cent. Cum. Pref. Shares	£	2 2½
—— 5 per cent. Debentures	—	89-94
Edison and Swan United Ordinary	£	2¾-3
—— 5 per cent. Debentures	£	4¼-4½
Electric Construction, Limited	£	2¾-2¾
—— 7 per cent. Cumulative Pref.	£	3¼-3¾
Elmore's Copper Depositing	£	1¾-2
Elmore's Wire Company	£	2-2½
W. T. Henley's Telegraph Works, Ordinary	10	20-21
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	£	9-10
—— 7 per cent. Preference	£	11-11½
India Rubber and Gutta Percha Works	10	23-24
—— 4½ per cent. Debentures	100	103-107
Kensington and Knightsbridge Ordinary	£	14½-15½
—— 6 per cent. Pref.	£	8½-8¾
London Electric Supply, Ordinary	£	2½-2¾
Metropolitan Electric Supply, Limited, Ord. No. 101-50,000	10	18½-19½
—— " " " 50,001-82,500	10	18½-19½
—— 4½ per cent. First Mortgage Debenture Stock	100	119-123
National Telephone, Ordinary	£	6½-6¾
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	14-16
—— 5 per cent. Non. Cum. Third Pref, No. 1-119,234	£	6-6½
—— " " " 119,235-250,000	£	4¾-5½
—— 3½ per cent. Deb. Stock, Red.	100	104-109
Notting Hill Company	10	17½-18½
Oriental, Limited, £1 shares	£	1-2
—— £5 Shares	£	3-3½
—— £4½ shares	£	7-7½
Oriental Telephone and Electric Company	£	9/16-11/16
Royal Electrical Company of Montreal	—	145-147 xd
—— 4½ per cent. 1st First Shares Mortgage Debentures	100	105-107
South London Electric Supply, Ordinary	£	2¾-2¾
St. James's and Pall Mall, Limited, Ordinary	£	17-18
—— 7 per cent. Pref.	£	10-11
—— 4 per cent. Deb. Stock, Red.	100	103-106
Telegraph Construction and Maintenance	12	38-39
—— 5 per cent. Bonds	100	103-105
Waterloo and City Railway, Ordinary	£	13½-13
Westminster Electric Supply, Ordinary	£	16-17
Yorkshire House-to-House	£	3-3½

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NOTES.

Book Received.—"Elektromechanische Konstruktionen," by Gisbert Kapp (Julius Springer and Co., Berlin).

Telephones in Brazil.—A report is current that a Belgian syndicate is about to be organised for the purchase of a Brazilian telephone concession.

The Proposed German Technical University.—It is stated that the town of Danzig is the site favoured by the Emperor for the erection of the technical university.

The Whitehaven Exhibition.—An industrial and art exhibition, comprising trades, manufacturing, mining, electrical, engineering, etc., is now being held at Whitehaven, and will remain open for a few weeks longer.

Mining Electricity.—The electric installation by the Simmer and Jack Proprietary Mines, near the Rand Victoria shaft, for supplying power to the Simmer and Jack and neighbouring mines, is expected to begin operations about the end of the month.

Telephones in Sweden.—The Swedish telephone industry is a Government monopoly. The network includes at present 27,000 instruments, distributed over about 600 stations. The population amounts to about five millions, and as nearly every town is connected, the system is extremely complete.

Berlin Tramways.—The *Morning Post* Berlin correspondent says the Royal consent has been obtained to the conversion of the urban horse tramways in Berlin into electric tramways. As the chief traffic in all parts of the city is along the tramlines, this reform, which will now be hurried on with, is a matter of considerable congratulation.

Profit-Seeking.—The Supreme Court has granted an injunction restraining the New York Board of Aldermen from selling franchises in the streets of Brooklyn to gas and electric tramway companies. The "interests of the electorate" evidently lead one into strange paths! At last we seem to have got a good reason in favour of the municipalisation of tramways.

Technical Instruction in Italy.—An institute bearing the name of Christopher Columbus has been started in the port of Genoa on board a vessel, which has been specially adapted to the purpose, with the object of providing instruction for master mariners, machinists, electricians, torpedo engineers, etc. This is the only institute of the kind which exists in Italy.

Change in Patent Law.—The new United States Patent Law, which is similar in its provisions to that of the United Kingdom, will become effective in January. It being less favourable to foreign patentees than the present law, there has latterly been an enormous rush of foreign applicants to secure protection for their inventions before the more stringent conditions come into operation.

Lecture on Tramways.—Mr. David Urquhart, London, delivered a lecture last week, under the auspices of the Dundee Institute of Engineers, on the subject of "Electric Traction for Tramways." Public feeling is growing steadily in favour of the overhead wire system for the town. Dundee has always been a tram town, and Mr. Urquhart recalled the fact that cable traction was in use on the Dundee and Newtyle Railway as far back as 1830.

Electric Trams in Pesth.—About a fortnight ago the last horse tramcar was taken off the streets of Budapest. The whole of the tramway lines have been converted into electric lines for a length of 70 English miles; while the Budapest underground railway also has electric traction, for a further distance of 53 miles. According to the *Standard*, plans for an extensive system of electric elevated and underground railways have just been made public, and received with general approval.

The Economy of the Third Rail.—It is stated that the Manhattan Elevated has decided to equip its property with an electric third rail, and if this is done the result will be awaited with great interest. Mr. Gould estimates that the use of electricity would provide economies of from £200,000 to £240,000 a year, while the annual expenses involved (interest on bonds to pay for the improvement) would be £50,000, making an addition to net earnings of about £160,000, equivalent to an additional 2½ per cent. on the capital stock.

Ancient Methods of Signalling.—An interesting article appears in the January, 1898, number of the *Cornhill Magazine* from the pen of Mr. Charles Bright, describing some of the earlier devices for transmitting messages to a distance. The author discusses what is known and conjectured of the Egyptian, Assyrian, Chinese, Chaldean, Grecian, Roman, and Persian methods, and also the experiments which were made in the last century and the present up till the discovery of the electromagnetic system 40 years ago. The article is well written, and throws almost a romantic light on the art of signalling by linking the ingenuity of the present with the ingenuity of men who lived in the earliest days of the civilised world's history.

Barcelona Exhibition, 1898.—The Department of Science and Art has received, through the Foreign Office, from her Majesty's Consul at Barcelona, information respecting the fourth general exhibition of fine arts and artistic industries to be held in that city in 1898. The exhibition, which will be precisely similar to that held in the same city in 1896, is to be opened on April 23 and closed on June 29; but the mayor of the city will be authorised to continue it for a period not exceeding one month on informing the committee of organisation. According to Article X. of the regulations, the works of the foreign artists will be admitted free of all expense to them as regards transport to Spain and back to the country of origin.

"The Electrical World."—The progress of electricity during the last quarter of a century has been marvellous, and with that progress has grown the *Electrical World* of New York. This paper, we learn, is now entering its twenty-fifth year, and we heartily congratulate it on the success and prosperity which it has deserved and earned. From a circular we have received, we learn that "in 1874, when the *Electrical World* began its career, the telephone was unknown, the electric light had only been seen in laboratories, the electric motor was a curiosity, and the labours of Gramme, Siemens, Edison, and Brush, which were destined to create an industrial revolution, had scarcely begun." From four pages in 1874, the paper has increased to 164 pages in the first issue of 1897.

The Engineering Dispute.—From the returns of the voting on the questions submitted to the men affected by the dispute, it seems that the provisional agreement as to management and the suggested compromise of a 51 hours' working week have alike been rejected by very large majorities. On the question of management, the voting was 1,041 for and 54,933 against; a majority against of 53,892. On the question of 51 hours, the voting was 8,515 for and 42,065 against; a majority against of 33,550. A conference of trade unionists is to be held in London to-morrow (Saturday) "to discuss the best means of organising support to the engineers and allied trades." It is stated that many of the federated shops will be opened at the New Year on the masters' terms. The

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outlook is far from reassuring, and there is apparent a determination on both sides to fight to the bitter end.

Water Waves of the Earth.—Some very interesting investigations are being made by the Department of Agriculture in the United States in relation to the capacity of different soils in various parts of the country to absorb and retain moisture and the quantity of moisture necessary to different crops. Further investigations will be directed by the Department towards determining the quantities of water in the soil necessary for maturing wheat and other staple crops, and for this purpose electrodes are to be placed in the ground at different depths, to show the direction and intensity of what the head of the Soils Division calls the water waves of the earth. The information to be derived from the use of these instruments is based upon the resistance of the earth to the passage of alternate currents of electricity.

Borough Polytechnic.—On Tuesday evening the sixth Christmas conversazione took place at the Borough Polytechnic Institute, and was largely attended by the students and their friends. A statement made by the secretary, Mr. W. M. Richardson, showed that the students number about 3,000, of whom one-third are women. The classes now number nearly 150, and, in addition, there is a technical day school attended by 50 boys, who, in addition to the ordinary instruction in German, French, mathematics, English, etc., receive special training in art drawing, metal and wood work. In addition to the work carried on in the Borough-road, there is a branch technical institute at Norwood, and special training in leather dressing, tanning, and dyeing is given at the Herold's Institute, Drummond-road, Bermondsey. The evening classes will all reassemble on January 5 for the next session, and the technical day school on January 11.

Unaccountable Fiction.—The *Journal* of the Franklin Institute calls attention to the fact that one of the leading electrical journals recently announced that in the death of Mr. Herbert E. Fowler, which occurred recently in Connecticut, the secret of electrically depositing copper upon wood or other rigid or semi-rigid substance is said to have been lost. "This process was made possible by coating the substance which was to be plated with copper with a liquid preparation, the secret of which was known only to Mr. Fowler. Every means had been used to induce him to patent the invention, but he declined to do so, fearing that he might lose the value of it in some way. The invention, it is stated, gave much promise of commercial value." Such is the astounding statement, but of course it is a fully recognised fact that the art of electroplating on wood, plaster compositions, and even on textile fabrics, is thoroughly well known to the trade.

The Supply of Electricity in Bulk.—A Bill has been lodged for next session, the preamble of which sets out that great difficulty is experienced by electric lighting companies and local authorities who supply electricity in providing sufficient electrical energy to enable them to meet the demands of consumers at certain times of the day, whilst the production by each separate company and local authority of sufficient energy to meet the maximum demands involves the expenditure of large sums of practically unproductive capital, and results in the consequent enhancement of the price that has to be paid for the electric light. To surmount these difficulties, the Bill proposes to confer on one company power to erect generating stations on one central spot in Marylebone on the banks of the Regent's Canal, and from this point to supply electrical energy in bulk to any "company, body, or person" at such price and on such terms as may be agreed.

Street Car Lamps.—The difficulties to be overcome in lamps for street car lighting are long life without decrease in brilliancy, and from the description given of the Edison railway incandescent lamp it seems that those difficulties have very largely been surmounted. This lamp has sufficient mechanical strength, the filament of cellulose, with a hard graphitic carbon coating, being so shaped and anchored as to protect it as well as the bulb from injuries likely to occur from the vibration and shock inseparable from street car service. The anchoring of the filament is essential. In the Edison lamp the anchor is set in the stem, and the vibration of the filament is rather checked than entirely prevented. These lamps are made in three different classes—for 500-volt circuits, for 550-volt circuits, and for 600-volt circuits—in each class the lamp being selected for a given amperage. The standard railway lamps have an efficiency of four watts per candle at full 16 c.p.

Polytechnic Day School.—The annual distribution of prizes and certificates of the Regent-street Polytechnic Day Schools was held last week. Herbert William Bywaters gained a scholarship for the Royal College of Science, tenable for three years, and several others obtained special distinction. At the present time the school has its complement of scholars, there being 528 in all, about half of whom belong to the commercial and professional division and the other half to the technical section of the school, where all boys receive a special training for engineering, architecture, and other constructive trades. One of the most important features in connection with the school work, which speaks very highly for the instruction, is the fact that the boys are greatly sought for by engineering, architectural, and other firms, where the knowledge possessed by them is considered of far greater value than a financial premium. We are informed that the demand for the lads is larger than the authorities are able to meet.

An Electrical Kitchen.—Electrical apparatus for cooking has been on the market now for a considerable time, but beyond a few technical instances we have not heard of the system of cooking by electricity being adopted to any great extent. From America comes now the information that a complete electrical kitchen has been arranged at the Duane-street station of the Edison Electric Illuminating Company of New York, which is presided over by a skilled *chef*, who serves electrically-cooked luncheons to the heads of departments and officials of the company. The apparatus used has been manufactured by the American Electric Heating Corporation of Boston. The new kitchener is reported to cook in two-thirds the time that would be needed in an ordinary stove. A loaf of bread, it is said, can be baked in 16 minutes, a pie in nine minutes, and biscuits in four minutes. It is stated that the current for electrical cooking at consumers' rates costs only slightly more than fuel for coal-burning kitcheners, but the greatest economy, of course, is effected in the saving of time.

The Duke of Argyll on Science.—A few evenings ago the Duke of Argyll delivered a lecture at Inverary on the subject "What is Science?" He said the question commonly put to the public and dealt with in public speeches was not "what is science?" but "what has science done?" Assuming that all knew what science was and what science had done for us, especially during the last century, there followed almost always the long songs of triumph with which we recorded the progress of invention, and showed the immense advantages which it had conferred on human life. He was not going to enter on that at all. He thought it was possible to get a little tired of these songs of triumph, progress, and invention; they were infinite, or at least indefinite, and no doubt

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great discoveries remained before us. He wished to put the question, "What was science itself? What were its ends?" He wished to consider science in relation to higher thoughts and interests of men. That was a fresh subject, and it was one of enormous extent. Science meant systematic knowledge, and there were many questions in science which we could not answer. At the conclusion of his lecture the Duke alluded to the discovery of light as one of the most wonderful and teaching things of modern times.

An Electric Fire-Engine.—An electric car for fire-engines has been introduced by an American firm, and a brief description of it is published in the *Western Electrician*. The car consists of two motor-trucks, supporting between them a platform large enough to hold a regulation fire-engine. The extreme length is 30ft. 10½in., greatest width 8ft. 6½in., and height of car floor above the track 9½in. The total weight, including trucks and suspended floor is 14,000lb. The car can be propelled by motors mounted upon the axles, as is customary at present, or it may be drawn by an electric locomotive, or an electric car can be impressed in an emergency. To load on a fire-engine, the side channel beams are released from the front truck and lowered until the front end of the floor rests on the ground. The forward truck is then run ahead out of the way, the engine backed into place, and drawn on the platform by a winch on the rear truck. The front truck is then run back to its former position, and the channels raised to place by a windlass. In the course of a recent test it was demonstrated that the car could be run into position, uncoupled, the engine loaded on, and all made ready for a trip in 2¼ minutes. Better time was made in unloading, only 1¼ minutes being required to detach the forward truck and hitch the horses ready for a run.

The Rontgen Rays.—Under the heading of "The Annus Medicus, 1897," a general review of the progress of medical science for the year, the *Lancet* says that an account of the surgery for the past year would be incomplete without some account of the present use of the Röntgen rays. Though it is still doubtful what their exact nature may be, yet we can obtain them with more ease and certainty than before. An adjustable vacuum tube has proved very useful. Dr. J. Mackenzie Davidson has devised a very ingenious apparatus, which we have described, by which the exact position of an object photographed by the aid of the Röntgen rays can be determined within a few minutes after the negative is taken. It has been fully tested on the living subject, and has proved very accurate. It has become almost a routine practice to use the X-rays in cases of fracture or dislocation in which any doubt exists as to the exact lesion present, and skiagraphy has also been used to some extent. Dr. W. S. Hedley has shown that if paper or other flexible sensitised surface is used to obtain the skiagram, it must be kept quite flat and not bent round the limb, or distortions will be shown which do not exist. The Röntgen Ray Society, which was formed a few months ago, should, says the *Lancet*, advance our knowledge of the scientific and practical aspects of the rays.

Stratford Technical Institute.—The annual distribution of prizes and certificates to the successful students attending the Technical Institute was made at the Stratford Town Hall last week by Sir John Lubbock, who said he hoped and believed these technical schools would tend to develop and promote the commerce and especially the manufactures of the country. To their technical schools Sir Philip Magnus rightly ascribed the industrial success of the Germans, who pointed with pride and satisfaction to the fact that they had weighed their technical training against our material advantages in mineral wealth and had not found them wanting. At the same time, they must not undervalue what had been done, and he was not one of those who thought the training to be acquired in a technical school could be any substitute for that of the workshop. It could not replace, but might supplement. He should not, except in some exceptional cases, advocate the introduction of technical instruction into boys' schools, for they must remember manual instruction and technical instruction were two very different things. Science did not claim infallibility, but progress, for even at the present time there was no single substance in nature the properties of which were fully known to them. What they had discovered was an infinitesimal fraction of the revelations that remained for the patient student.

Telegraphists' Holidays.—The telegraphists have now found a real grievance, and one in which they are likely to have the sympathy of the public. A meeting was held the other night at the Memorial Hall, Farringdon-street, under the auspices of the P.T.C.A., in order to protest against the holiday arrangements now in vogue, and the following resolution was carried: "This meeting of telegraph clerks of the Central Telegraph Office, London, hereby expresses its intense dissatisfaction that the Post-master-General, despite the promise made in conjunction with Mr. Hanbury on August 10, 1897, has not devised some means of excluding the months of November, December, January, and February from the holiday sheets of 1898. This meeting reiterates the protest against the system which compels clerks to take their annual leave during the bleak winter months, and urges the Postmaster-General to give effect, at once, to his promise and sympathetic expressions." It certainly does not seem very humane to expect a man to take his holiday in the depths of winter, and, we suppose, an alteration of the system is not out of the question. It is, of course, a question of pounds, shillings, and pence, but if the case was fully laid before the public we do not think the money would be grudged, considering what we owe to telegraphists for their general efficiency. At the same meeting a petition was also adopted asking the Postmaster-General to direct that the months of January, February, November, and December should be deleted from the holiday sheets of 1898. If the telegraphists were wise they would press this grievance and let their other demands, which are hopelessly out of the question, fall to the ground.

Telegraphic Communication with the Continent. On Wednesday a deputation from the Liverpool Chamber of Commerce waited on the Postmaster-General to complain of the delays in the transmission of telegrams between Liverpool and the Continent. The Duke of Norfolk was accompanied by Mr. Lamb, secretary to the Post Office. Mr. Hemelryk explained the system of "time bargains" under which business in cotton and corn was carried on between Liverpool and the Continent, and pointed out that the rapid transmission of telegrams was highly necessary. He suggested that the present average period of 15 minutes between the handing in of a telegram at Liverpool and the time when it was depatched over the British wires should be reduced; and that all telegrams for Lille and Paris should be sent by direct private cable *vid* Havre. The service between Liverpool and Tourcoing, Roubaix, and Rouen, he said, was very bad. In the case of Rouen this was owing to slow transmission; while as to Tourcoing and Roubaix those two towns had only one direct wire between them to Havre, which was used alternately every half-hour by first one and then the other. While urging the Post-

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master-General to make representations to the French and German Governments to expedite matters on their side, he suggested the desirability of giving a telephone service to Havre, and thence to various cities in the North and North-West of France, including Paris, and of providing a new cable, with duplex instruments, between Liverpool and Hamburg. The Postmaster-General, in reply, promised to give the various points raised his most careful consideration. He specially undertook that a new cable should be available between Liverpool and Hamburg, and that duplex instruments should be provided for both it and the existing wire. He promised to consider the practicability of sending messages between Liverpool and Paris *viâ* Havre, instead of *viâ* London, and held out a hope that telephonic communication between Liverpool and Havre might be established.

Municipal Telephone Service.—The Highways Committee of the London County Council have prepared a report with reference to the telephone service of the Metropolis. It states that it will no doubt be remembered that, owing in great measure to the pressure brought to bear by the Council, the House of Commons in 1895 appointed a Select Committee on the subject, the reference being as follows: "To consider and report whether the provision now made for the telephone service in local areas is adequate, and whether it is expedient to supplement or improve this provision either by the granting of licenses to local authorities or otherwise." The Select Committee received evidence relative to the telephone service in London and other cities and towns; and Mr. W. H. Dickinson, who was then deputy-chairman of the Council, gave evidence on behalf of the Council of the defects of the present system, and submitted estimates of the cost of the establishment by the Council of an independent municipal telephone service for London. The Select Committee subsequently, in reporting on July 1, 1895, the evidence taken, stated that it had not, in view of the approaching dissolution of Parliament, had time to consider its report, and recommended that a committee on the same subject should be appointed in the next session to consider and report on the evidence already taken, and, if necessary, to take further evidence. The committee has not, however, been reappointed, and nothing further has been done by the House of Commons in the matter. Recently, however, the Glasgow Corporation having applied to the Postmaster-General for a license under the Telegraph Act, 1892, for a municipal service there, he considered that, to enable him to decide whether a license should be granted, an enquiry should be held in regard to the telephone service in Glasgow, in order that he might have the benefit of an independent and local investigation into all the points at issue. A commissioner accordingly held such an enquiry, his attention being particularly directed to three points as to the existing telephone service—viz., (*a*) efficiency, (*b*) adequacy, (*c*) charges—but his report has not yet been published. The committee are of opinion that it would be a public advantage that a similar enquiry to that which recently took place in Glasgow should be held respecting the telephone service in London, having regard to the complaints which had been made of the high charges prevailing and of the inadequacy of the system for the requirements of the public, and they therefore recommend: "That, with the view of obtaining an investigation with regard to the telephone service in London, similar to the enquiry recently held as regards that service in Glasgow, the Council do make an application under the Telegraph Act, 1892, to the Postmaster-General for a license empowering the Council to provide an independent municipal telephone service for the county of London." It will be very interesting to learn the fate of this recommendation.

Prof. Lodge's Lectures.—Large audiences have gathered at the Royal Institution this week to hear Prof. Lodge lecture on "The Principles of the Electric Telegraph." We gave a summary of the first two lectures in our last issue, and appended is a synopsis of Lectures 3 and 4. Lecture 3 first deals with signalling keys or transmitters. The signals received are usually either right and left motions, to be seen ("needle" or "spot of light"); or short and long motions, to be heard ("sounder"); or dots and dashes recorded on a strip of moving paper (Morse "tape"); or else right and left kinks in a line drawn on a similar strip of paper ("siphon recorder"), to be subsequently read. In all cases the alphabet is the same; right left, or dot dash, means *a*; right, or dot, means *e*; dot dot means *i*; left left left, or dash dash dash, means *o*; dot dot dash means *u*; and so on. Hence, words in any alphabetical language can be spelt out and sent by any operator if clearly written. Political speeches and general news are spread over the country by being punched on a strip of thick paper, $\frac{0}{0}$ for dot, $\frac{0}{0}$ for dash, which is then fed through a number of "automatic transmitters," each arranged so as to signal to a definite set of stations in the ordinary Morse alphabet. By means of the principle of synchronism a typewriter can be worked at a distance from its keyboard, and can give messages printed in ordinary type. On a somewhat similar plan, multiplex telegraphy—many messages travelling on a single wire—is possible. The sending of two messages on a single wire, either in the same or in opposite directions, called "diplex" or "duplex" respectively, is comparatively easy to accomplish and to understand. A combination of diplex and duplex is the quadruplex system, which enables four independent senders and four corresponding receivers to be worked independently of each other, two of each at each end of a single line. A current in a wire can have, at any one instant, only one definite strength and one definite direction; but changes in strength can give one signal and changes in direction can give another. The current being kept always running, a reversing key at A can work a polarised receiver at B, while an independent strengthening key at A can work another but unpolarised receiver at B, arranged so as to ignore weak currents. This is the diplex system. The duplex system depends on the use of differentially-wound receivers (or their equivalent), and an artificial line, in imitation of the real one, arranged to carry half the current direct to earth at each station. It is thus possible to signal simultaneously in opposite directions along one wire, although only one current can flow at one time, because a signal can be given just as well by stopping and diverting a current which would otherwise have been received, as by sending an opposite current. A battery put on at A by itself would signal to B only; similarly, a battery at B by itself signals to A only, but if both are put on together no current flows along the line at all, but the current of each is diverted through the artificial line and works the receiver at its own station—thus A receives signals (not current) entirely from B, and B receives signals entirely from A—Q E.F. The fourth lecture deals with ocean telegraphy: Telegraph cables—First cable, 1851, across the Channel—History of the Atlantic cable—First attempt, 1857—First cable, 1858—First permanent Atlantic cable, 1865—Early difficulties of ocean telegraphy—Instruments employed for cable testing and signalling—Fault-finding—Lightning guards. Lecture 5 will be delivered to-morrow (January 1), and Lecture 4 on Tuesday, January 4.

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NOTES ON ACCUMULATOR CONSTRUCTION.

BY DESMOND G. FITZ-GERALD.

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XLVII.

The first specific mention of the use of protoxide—and also peroxide—of lead, in lieu of the spongy lead and red lead first employed in lead secondary batteries, was made, I think, by Prof. S. P. Thompson in a paper read by him before the Society of Arts, November 23, 1881. "I have found," said the professor, "that almost any oxide or hydrate of lead will answer instead of red lead for the purpose of providing, as in the Faure cell, a material to be converted by a process of formation into the peroxide of lead. (The production of spongy lead is not here referred to.) Litharge answers well if sufficiently finely divided before being painted on. White lead will answer, but not so well. Litharge mixed with a small proportion of binoxide of manganese works well. The formation is rapid; but at first the E.M.F. is not so high as in the Planté cell: it rises, however, as the process of formation proceeds. The binoxide of manganese is not so strongly electro-negative a substance as the peroxide of lead. Its presence in the final state would lessen the E.M.F. But happily the manganese gradually dissolves into the acid when its function as an agent to assist the lead in peroxidising is fulfilled; and by changing the acid a few times it is finally eliminated. The most satisfactory cells I have yet tried were made by painting the lead plates with a coat of the brown oxide itself, which is obtainable in commerce, though its cost is about four times that of red lead or litharge."

XLVIII.

The binoxide, or peroxide, of lead, or plumbic peroxide (PbO_2) is a compound that would repay further study and investigation on the part of the electro-chemist. The difference between the peroxides obtained by electrolysis and those produced by various chemical processes, and the difference between those obtained with the anhydrous and the hydrated protoxides, need careful examination. The same may be said of the various hydrated peroxides. According to Frémy, the hydrated peroxide which has been erroneously termed plumbic acid has the composition $PbO_2 3H_2O$. Its potassic salt is K_2PbO_3, $3H_2O$. Plumbic acid would be H_2PbO_3. Other hydrates no doubt exist; and a compound termed perplumbic acid has the composition $2(PbO_3)$, H_2O. According to Maxwell Lyte, the formula for the peroxide obtained by his process described below is $PbO(OH)_2 = PbO_2H_2O$.

Two methods of obtaining the peroxide have already been described (XLI.). A mixture of peroxide and chloride of lead is manufactured on a considerable scale, and is often sold as the peroxide. It is obtained by passing a current of chlorine gas through the protoxide of lead diffused in water ($2PbO + 2Cl = PbO_2 + PbCl_2$). A less impure product, also containing lead chloride, is made by treating a solution of lead acetate ($Pb2C_2H_3O_2$) with "chloride of soda" ($Na_2Cl_2O = NaClO + NaCl$), the active agent in which is the sodic hypochlorite ($NaClO$). A very pure product (provided the lead salt be not in excess) is obtained by Wöhler's process, in which a current of chlorine is transmitted through the magma obtained by mixing a solution of four parts of plumbic acetate with one of 3¼ parts of crystallised sodic carbonate. The plumbic carbonate thus produced is gradually but completely converted into peroxide, which must be thoroughly washed. In this process acetic and carbonic acids are set free, the reaction being as follows:

$$Pb2C_2H_3O_2 + NaCO_3 + 2Cl + 2H_2O = PbO_2 + 2HC_2H_3O_2 + 2NaCl + H_2CO_3.$$

Mr. F. Maxwell Lyte has given much attention to the commercial production of lead peroxide. In his processes the production of lead chloride is obviated by the use of slaked lime (CaH_2O_2) in quantity sufficient to combine with the whole of the chlorine, thus

$$2PbO + 4Cl + 2CaH_2O_2 = 2PbO_2 + 2CaCl_2 + 2H_2O.$$

An extract from Mr. Lyte's patent specification may here be of use, the peroxide being manufactured from a cheap salt of lead—viz., the chloride—and from bleaching powder: "It is sometimes desirable to make the peroxide of lead of greater purity (than that produced by a previously-described process), and quite free from any insoluble substances which may be contained in the bleaching powder. In this case I proceed as follows: I make a saturated solution of bleaching powder, allow the insoluble matter to settle, and decant the clear liquor, which I test to find the proportion of available chlorine which it contains. I then mix this solution with good freshly-slaked hydrate of lime in the proportion of one equivalent of the hydrate of lime to one equivalent of chlorine. I make the magma of chloride of lead solution exactly as in the previous process (by treating the equivalent of $PbCl_2$ with four times its weight of boiling water), and I add the solution of bleaching powder and cream of lime very slowly to the solution of lead with constant agitation, taking care that the chloride of lead always remains in excess, even when the operation is completed. It is evident that by this mode of treatment the insoluble impurities of the bleach will be kept out, and the resulting peroxide will be more pure. In this case, however, I prefer, as in the last, to transfer the precipitate to a filter and wash it with water or dilute nitric acid."

Peroxide of lead has been used in the manufacture of lucifer matches; a mixture of five parts of the oxidant and one part of sulphur becoming ignited by friction, with production of lead sulphide and sulphurous anhydride. It has also been used for the purification of oils by the oxidation of the impurities.

Both peroxide of lead and minium occur as natural products; the former is termed *heavy lead ore*, and forms iron-black, lustrous, six-sided prisms.

XLIX.

Peroxide of lead is insoluble in water, and, generally speaking, in acids. Cold dilute hydrochloric acid, however, dissolves it in small proportion, forming a rose-coloured solution, from which it is precipitated unaltered by the fixed alkalies. If, however, the hydrochloric acid be hot or concentrated, plumbic chloride ($PbCl_2$) is formed, with evolution of chlorine. When heated with sulphuric acid, peroxide of lead is converted into the sulphate, with evolution of half its oxygen. Boiling nitric acid, as we have seen, has no action upon it. When gently heated (XLI.) it parts with one-fourth of its oxygen, becoming converted into red lead (Pb_2O_3). From a theoretical point of view, it is important to note that the latter compound requires a comparatively very high temperature for its decomposition. An energetic reaction, attended with the production of a high temperature, occurs when a stream of sulphurous anhydride (SO_2) is passed over the peroxide, sulphate of lead being produced ($PbO_2 + SO_2 = PbSO_4$). When a stream of ammonia (NH_3) is passed over the peroxide, a very interesting reaction occurs, nitrate of ammonia, water, and protoxide of lead being produced—

$$2NH_3 + 4PbO_2 = NH_4NO_3 \times H_2O + 4PbO.$$

When lead peroxide is fused (in a silver dish) with potassic hydrate, a compound is formed which may be dissolved in a boiling solution of the alkali. From this the compound $K_2PbO_3 3H_2O$ may be crystalised in colourless cubes. This potassic plumbate is decomposed by water, with precipitation of hydrated peroxide or the so-called plumbic acid (? $PbO_2 3H_2O$). By gently heating peroxide of lead in an alkaline solution of hydrated sesquioxide of chromium ($Cr_2O_3 7H_2O$), the yellow chromate of lead ($PbCrO_4$) is produced:

$$(2Cr_2O_3 + 6PbO_2 = 4PbCrO_4 + 2PbO).$$

L.

Let us endeavour, as pleasantly as may be, to discuss, and, if possible, to digest and assimilate some of our dry facts. If Pb_2O_3 be an unstable compound, how about PbO_2 in its isolated condition—as contrasted with its condition in a discharged peroxide element? Pb_2O_3 is attacked, with some difficulty as we have seen, by dilute sulphuric acid, and PbO_2 is not. But the latter is attacked—and, on a somewhat large scale, with startling violence—by sulphurous acid; and Pb_2O_3 is not affected by it. When mixed with

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a reducing agent, PbO_2 may become a dangerous compound—dangerous when treated with sulphuric acid, or exposed to friction or to heat; Pb_2O_3 under similar conditions is comparatively stable and inert. PbO_2, when heated, readily parts with one-fourth of its oxygen, and the resulting compound (Pb_2O_3) will withstand comparatively high temperatures. Both compounds, probably, are endothermic—*i.e.*, absorb, instead of evolving, energy in their formation; but PbO_2, like all powerful oxidants, exhibits the character of an endothermic compound in very high degree.

Unbending for a moment, and adopting the Socratic method of investigation—with a difference—we may endeavour to ascertain for which of the following bodies protoxide of lead has the greatest attraction—viz., O, PbO_2, or H_2SO_4.

We have seen that an affinity for oxygen is exhibited by protoxide of lead when heated to a certain temperature—

"But why at a certain temperature, neither more nor less?"

Indeed, I do not know.

"We may take it, then, that you do not understand much about these strange attractions of affinity."

Your surmise is more certainly true, even, than you imagine.

"But why should we discuss, then, what we both know so little about?"

Why? By Jupiter, because we know so little about it, and because we know that we know so little about it.

"How so?"

Would you wait to know all things before you commenced to learn some? And know you not the Eastern maxim: The man who knows not, and knows not that he knows not, is a fool; avoid him.

"To your first, assuredly not; to your second, yes. But if we followed the maxim to the letter, we should have to avoid many."

[My pupil might by some be regarded as rather flippant. But he is a discoverer. Observe that in two minutes he has discovered two truths which may be useful to him.]

To resume, then. At a certain temperature, a molecule of lead protoxide will combine with an atom of oxygen.

"Or two molecules of the protoxide will combine with one atom of oxygen. One or the other it cannot fail to be."

Your wit, most excellent pupil, outruns my method and saves our time. But do the two molecules simultaneously, or consecutively, enter into combination with the oxygen atom?

"I now perceive, from my notes of your discourse, that the certain temperature you speak of, at which the compound Pb_2O_3 is formed, is about 608deg. F., whereas the compound PbO_2 decomposes at about 440deg. F. It now appears to me that the combination of the two molecules must take place simultaneously."

Unless the attraction of PbO for PbO_2 facilitates the production of the latter compound, according to a law perhaps not yet formulated, but of which there are many examples. But can you not admit that two causes, both of which produce the same effect, neither more nor less, are equal and equivalent?

"Assuredly, if you can admit that a hypothetical phenomenon, which may not be possible, can be admitted hypothetically as a cause."

Why not, even if we cannot perceive by the eye that which may be clear to the reason? But in the present case, considering the compound Pb_2O_3, are you not well aware that, by the action of H_2SO_4, for instance, PbO can be removed from it, though not without difficulty, leaving PbO_2? And does it not then appertain to that which is formed by composition, and is naturally compounded, to be dissolved in the same manner in which it was compounded?*

"This, too, we may assume."

Then, if Pb_2O_3 be a compound of PbO with PbO_2, the former has a greater attraction for the latter, at the given temperature, than it has for oxygen?

"That is so; for the single molecule of PbO, under the existing favourable conditions, does not combine with O; but does combine in effect with PbO_2."

Then, since you cannot deny that the compound formed in virtue of the greater attraction is more stable than that which may be formed in virtue of the less, you would admit, even if it were not obvious, that at the given temperature the compound Pb_2O_3 is more stable than the compound PbO_2. But, further, since the compound Pb_2O_3, at the given temperature, or indeed at any other, may be decomposed by sulphuric acid, you must admit that the attraction of PbO for H_2SO_4 is greater than its attraction for PbO_2, and, *a fortiori*, greater still than its attraction for O.

"It appears clearly that it must be so. And indeed below the given temperature, as you have told me, sulphuric acid will expel from PbO_2 half its oxygen and combine with the residual PbO."

But cannot we go further? H_2SO_4 removes PbO from Pb_2O_3 at ordinary temperatures; therefore is it not clear that, at such temperatures, PbO has a greater attraction for H_2SO_4 than for PbO_2?

"Assuredly. But not therefore a greater attraction for H_2SO_4 than for O."

You will admit then that PbO has a greater attraction for O at ordinary temperatures than it has at 680deg. F.?

"I certainly will not admit that. But let me ask you: Is not the fact that I may add PbO_2 to H_2SO_4, and that the PbO in the former does not combine with the acid, a sufficient disproof of the conclusion which, I perceive, you have arrived at?"

Not so: are there not phenomena of inertia and unstable equilibrium, without entering into the domain of thermodynamics, which supplies a sledge-hammer to drive home my argument? You, my dear boy, may have affinities for things lofty and noble; but your inertia prevents you from fulfilling them.

"I think I perceive your drift. If so, by the same argument, you, my dear master, may have affinities for things base and ignoble, which your inertia, and present position of unstable equilibrium, fortunately prevents you from fulfilling."

Your logic no doubt is correct, whatever may be said of your other accomplishments. But, avoiding further personal illustrations, is the fact that the two measures of hydrogen and one measure of oxygen in this flask have not, so far, entered into combination a conclusive proof that there is no affinity between these two elements?

"I concede the point that there is no disproof in either case. And it is quite unnecessary to proceed to any explosive illustration. Is our discussion ended, and is there a cross-examination to follow?"

Neither. I wish you to become still better acquainted with the nature of this apparently stable, but really unstable, compound PbO_2. You have just admitted that PbO has a greater affinity for PbO_2 than for O, and a greater affinity for H_2SO_4 than for PbO_2; and you admitted at the outset that two molecules of PbO will combine with an atom of O at a certain favourable temperature and that one molecule will not. But suppose now, for the sake of argument, that you have but one molecule of PbO, and that you expose it to air at the temperature of 608deg. F. Will it not combine with oxygen to form the compound PbO_2?

"Assuredly not; since that compound is decomposed at a temperature of 440deg. F."

But will the combination with atmospheric oxygen take place at any other temperature?

"From experience, I may say that it will not."

Then has the single molecule of lead protoxide no affinity for oxygen?

"What can I say, except that it has none for atmospheric oxygen?"

Consider your position: two molecules of PbO manifest an affinity for one atom of atmospheric oxygen, and combine with it, yet one molecule has no affinity? Would it not exert half the attraction of the two molecules?

"What can I say? If it has an affinity, why should it not combine?"

My dear boy, I think I must venture again upon a

* Plato, "The Phædo," Section 62.

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personal illustration. If you had an affinity for a beef-steak, and could get it by climbing to the top of Mont Blanc for it, why should you not combine with it?

"Because, as I think, I am not quite up to the work. But what has this to do with the oxide and the oxygen? The latter is not at the top of Mont Blanc, but close at hand."

You are forgetting that a cubic inch of air under standard conditions contains 10^{23} molecules, and that the distance between these molecules is very great as compared with their size. The work to be done by lead oxide in combining with oxygen is that of condensing the gas into the solid form. As you attended the lectures by Prof. Dewar on the liquefaction and solidification of gases, you may be able roughly to compare this work with that of climbing Mont Blanc. May we not take it that the attraction between 222 grammes of PbO (the dyad gramme equivalent) is sufficient at the temperature of 608deg. F. to effect the condensation of eight grammes—the monad gramme equivalent—of O, but insufficient—the affinity being then greatly weakened—to bring into the solid form a second monad equivalent? For we know that one-fourth of the O in $2PbO_2$ is very loosely held in combination—how loosely we may be able presently to judge. Then the single molecule of PbO would be unable to combine with the atom of O in the ordinary gaseous condition.

"The explanation appears to me to remove all difficulties."

Now, taking pure oxygen, instead of that contained in atmospheric air, will 222 grammes of PbO combine at any temperature with 16 grammes of this oxygen?

"My experience enables me, I think, to say that it will combine with only eight grammes."

But if I take this eight grammes of oxygen, and expend energy upon it in such manner as to do the work which the attraction of affinity, when multiplied with the distance through which it can act—*i.e.*, the energy of affinity—is insufficient to effect, will this oxygen then combine with Pb_2O_3 to produce PbO_2?

"If you mean to convert the oxygen into ozone, then I think it very likely that it would convert Pb_2O_3 into $2PbO_2$. But what I know is that if you take the 16 grammes of oxygen converted into ozone, you can with it convert 222 grammes of PbO into PbO_2, for you showed me this conversion after you had oxidised silver by ozone. And a solution of chlorine in water, virtually liberating oxygen in a nascent or fluid form, will also, I know, convert PbO into PbO_2."

Then if we expend energy in, so to speak, forcing oxygen to combine with Pb_2O_3—no "forcing" is necessary in converting 2PbO into Pb_2O_3—this energy will be stored as potential work in the compound, and will again become kinetic when $2PbO_2$ liberates one-fourth of its oxygen, or becomes $Pb_2O_3 + O$.

"That I understand: the compound will be, as you have said, endothermic—absorbing energy in its formation and liberating it when decomposed, instead of being, like most compounds, exothermic—liberating heat in their formation and absorbing energy in their decomposition."

Then your knowledge will, I am sure, be most useful to you in studying the theory of the lead secondary cell. For you will understand, also, that by electrolytically presenting to an oxidisable body—such as spongy lead—solid oxygen in endothermic combination, we can produce an effect even much greater than could be obtained by presenting in the same manner free gaseous oxygen.

THE INSULATION OF ELECTRICAL TESTING INSTRUMENTS.

BY J. WRIGHT.

The importance of efficient insulation for testing instruments cannot be too strongly impressed on those who include electrical testing in their category of daily duties. Without it, accurate results are an unknown quantity, and, in fact, with some testing installations the writer has come across, it is a wonder that the users were able to obtain any results at all. When one comes to consider the extreme sensitiveness of that delicate instrument, the Thomson reflecting galvanometer, the necessity for efficient insulation comes as a matter of course.

These instruments are practically built on an insulating basis; nevertheless, their feet should be mounted on insulating pedestals of some description. A very good form for this purpose is that shown in Fig. 1, which represents a plan and cross-sectional elevation. It is a disc of hard rubber or ebonite about $\frac{1}{2}$in. in thickness, and in the upper face of which is turned a semi-circular groove or channel, A, about $\frac{3}{8}$in. width. Into this is poured hot, molten

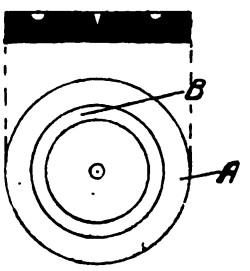

Fig. 1.

paraffin wax of the pure white variety. It is allowed to harden, and is then pared off flush with the ebonite. In the centre of the ebonite disc is turned a small conical depression to receive the point of the levelling screw of the galvanometer. These discs form a very effective insulation, but they require to be kept clean and free from dust, which by settling on the wax lowers its insulating properties. In order to ensure a clean surface on the wax, the groove, B, should be periodically scraped out and refilled with fresh wax.

The foot described above is sufficient for all ordinary purposes, but an insulator with higher insulating properties still has been designed, and is illustrated in Fig. 2, which

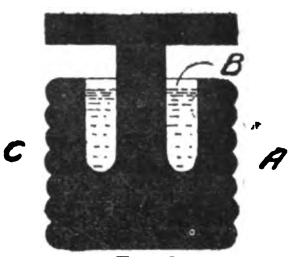

Fig. 2.

represents a cross-sectional elevation. A is, as before, a cylindrical block of ebonite, with a channel, B, turned in it to contain a resin oil. As will be seen from the figure, the channel is infinitely better protected in this case from dust than previously; the centre of the block, rising as it does in the form of a pedestal, practically covers in the whole of the oil-containing vessel. It will be noticed also that the exterior walls of the cylinder at C are ribbed, the object of such corrugations being to increase the area of insulating surface on the ebonite. The oil is introduced into the channel, B, of these insulators by means of a special syphon tube constructed for the purpose.

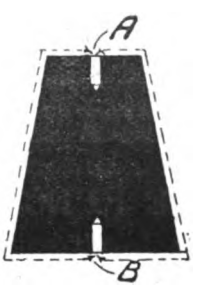

Fig. 3.

It must be borne in mind that all ebonite pillars and blocks used for the insulation of testing apparatus depend for their insulating properties on the area of their surfaces. Take an example, as in Fig. 3, which represents an ebonite cone of the form sometimes used to support the contacts of battery and galvanometer. Keys *a* and *b* represent screw

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holes tapped in the ebonite to take the fittings. The insulating surface between the metallic screws, *a* and *b*, will then extend over the exterior of the cone as shown by the arrows, so that to bore the screw holes completely through the centre of the block would be to rob it of 75 per cent. of its efficiency as an insulator, the surface then only extending from *a* to *b* direct, as well as running the risk of contact between the screws if not cut sufficiently short.

Where necessity compels the setting up of an installation of testing instruments in a damp locality, it is as well to cover the whole table or bench in the first instance with a sheet of guttapercha or ebonite. Wherever possible, a room should be selected which can be warmed by a dry heating process, and kept at as even a temperature as possible both day and night. It is a good plan to proceed as follows with regard to the fixing of such apparatus as keys and others which require permanent fixing. Instead of screwing them to the wooden base, which has the disadvantage of detracting somewhat from their insulating properties, let them be well secured by a layer of molten Chatterton's compound on the underside of their bases. This makes a capital cement for the purpose, and has the additional advantage of being proof against moisture.

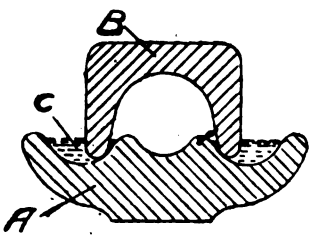

FIG. 4

As regards the testing battery, which is certainly not least in importance, this requires very careful treatment, especially if set up in a fixed position, as all the good points gained in other respects will be lost if the insulation of the battery itself be defective. They should be set up in a room apart from the instruments, which has the advantage of a dry atmosphere. A convenient number (say, 20 cells) may be mounted together, on dry, well-seasoned wooden shelves, open to the air on both sides, and covered over all with a coating of shellac varnish. Each shelf should be mounted on a set of insulators similar to those illustrated in Figs. 4 and 5, the former of which is the type generally employed for insulating a battery of accumulators. It consists (Fig. 4) of two portions, A and B, both made in thick green glass. The lower one, A, is a kind of circular tray, carrying a ring of insulating oil, C, and supporting at its centre the upper piece, B, which takes the form of an inverted cup, and supports in its turn the shelf to be insulated.

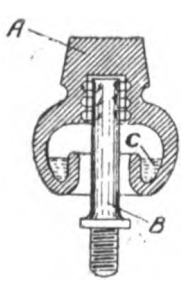

FIG 5.

The second form of oil insulator suitable for the purpose is that illustrated in cross-section in Fig. 5, and is manufactured by Messrs. Johnson and Phillips. A is the porcelain body, and B the usual insulator bolt, C being the oil channel. These are very efficient insulators, and the fact is clearly proved by the following experiment, which was performed by the writer on one of this type before the introduction of the oil. The porcelain body having first been thoroughly well warmed, it was immersed to within a ¼in. of the rim in water. The high-tension side of a step-up transformer was then connected on one side to the central bolt, and on the other to the water. A gradually increasing voltage was applied, the maximum being 15,000, but no impression whatever was made upon the insulator, which came out of the battle as sound as when it entered. Any cells showing a disposition to leak or "creep" should be at once removed and replaced by new ones, as they give rise in time to a pool of liquid electrolyte on the shelf which, if allowed to accumulate, not only promotes leakage from cell to cell, but is also liable to flow down over the supports and impair their insulating properties.

Another important point to be observed in the setting up of a testing installation is the class of wire used for connections. This should in all possible cases be guttapercha-covered, as surface leakage over the insulation will then be reduced to a minimum. If, however, no wire of this class be attainable, the ordinary vulcanised indiarubber-covered wire should be used, the ends having been in the first instance carefully prepared as follows: strip back the braiding by means of a sharp knife for some 3in., taking care not to injure the rubber underneath in any way. Next proceed to unlap the proof tape for the same distance. If any difficulty be experienced in getting the tape to leave the rubber, it may be overcome by saturating the tape with coal-tar naphtha. This may be effected by passing a rag soaked in naphtha backwards and forwards over the tape; it will then leave the rubber with ease, and the surface of the latter should then be scraped clean of any impurities. The copper conductor is then bared of rubber for a distance of about 1in. from the end, and the extremity of the rubber pared down after the manner of sharpening a lead pencil, thus exposing a clean surface of freshly-cut rubber. The ends having been thus far prepared, are immersed for the space of a few seconds in hot melted paraffin wax, which, when cool, forms an efficient insulating film against surface leakage. Rubber-covered wire prepared in this manner is very nearly, if not quite, as good for the purpose as guttapercha-covered conductors; the latter are, however, to be recommended in preference, as they are much less trouble to prepare, and are absolutely proof against surface leakage. This treatment of connecting wires also applies, of course, to all exterior leads used in connecting up the subject to be tested. It is not a bad plan to give the ebonite portion of testing instruments, keys, and other apparatus a periodical polish with a rag saturated in paraffin oil, any excess of the latter being afterwards removed by the application of a clean dry cloth. This not only removes any accumulation of dust and dirt, but also envelopes them in a film of liquid which has high insulating properties.

The matter of insulation in high-tension work, when voltages of 1,000 and upwards are employed, is of even greater importance, not so much in this case for accuracy's sake as in the risk to life and limb. The cases of transformers, high-tension switches, and recording instruments should, if metallic, be, if possible, earthed, and, if not, should at any rate be sufficiently protected to prevent personal contact. As regards the handles of high-tension switches, these should be constructed of fairly thick ebonite, and an element of safety is introduced by the addition of a disc of the same material some 3in. or 4in. in diameter around the handle of the active lever at the point where it merges into metal. Some high-tension switches, more especially those which are semi-automatic in their action, are provided with two cords, the act of pulling one or the other of which actuates the switch. Such methods are not to be advocated, however, as they have several drawbacks. In addition to the difficulty of effectually manipulating a cord, there is also the risk of breaking at a critical moment. The writer's idea of a switch for high-tension work is one with a long and well-insulated lever handle actuating a quick-break system, there being a certain amount of satisfaction in working such a piece of mechanism.

When the voltage exceeds 5,000 it is advisable to use oil-insulated transformers, which are far less liable to break down and give trouble, and even if they should "blow out" by any means, it as a rule only necessitates shutting down for a short period to allow the oil to settle and thereby clear the fault. The best oil for the purpose is thick resin oil of the consistence of treacle.

The use of rubber gloves in high-tension work is a thing to be avoided. It gives rise to a false feeling of security, and may lead eventually to carelessness. There is no absolute safety in handling a live lead through the medium

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of rubber gauntlets. One never knows from one minute to another how perfect the rubber may be. It is always better, therefore, if absolutely necessary to manipulate a live lead, to do so at the end of a substantial bar of ebonite, some 3ft. or 4ft. in length; or another plan is to slip a piece of ebonite tubing, about 1ft. long, over the lead, and utilise it as a handle by which to support the latter. When experimenting in high voltages, one is apt to be startled at first by the suspicious sound caused by static discharges across the highly-charged terminals of the transformer and other apparatus. It is not unlike the buzzing of a fly, and is, as before mentioned, somewhat alarming to the novice, who usually at once suspects a leak or a breakdown of some kind. It need not, however, be taken into consideration, as it is merely due to static effects and has no influence on the actual circuits.

In concluding this article, the writer ventures to hope that it may contain matter of interest to those whose duties are included under the title of "electricians."

LIGHTNING PROTECTORS.

The following are abstracts of papers read before the recent Sacramento Convention of the Pacific Coast Electric Transmission Association. We have preserved the headings of the papers, but have condensed the matter somewhat.

Lightning on Transmission Lines.

BY THEO. E. THEBERATH, M.E.

Before taking up the question of protection, the author touches briefly on the question of what lightning is and what are some of its properties.

He then points out that in experiments with condensers it has been found, as stated by Prof. Silvanus Thompson, "that if the terminals of a charged condenser are connected by a high resistance, such as a nearly dry linen thread, the charge simply dies away by a discharge which increases its strength at first, and then gradually dies away. If, however, the condenser is discharged through a coil of wire of one or more turns (the spark being taken between polished knobs to prevent premature discharge) the effect is of an entirely different character, for then the discharge consists of a number of excessively rapid oscillations or surgings. The first rush more than empties the condenser and charges it the opposite way; then follows a reverse discharge, which also overdoes the discharge, and charges the condenser the same way as at first, and so forth. Each successive oscillation is feebler than the preceding, so that after a number of oscillations the discharge dies away."

That lightning follows the above conditions has been demonstrated in various ways. The air, as a general rule, is charged positively with reference to the earth, but during storms negative electrification has been noted as well as severe disturbances in the atmospheric electricity. During this surging back and forth of the ether, all surfaces in the path of the moving ether become charged. If these surfaces are well insulated from the earth, such as the wires of a long-distance transmission circuit, we may have static discharges from the wires even when the primary discharge occurred some distance from the pole line. If the line is well insulated from the cross-arms and poles, as is necessarily the case with high-potential circuits, the strain is transferred to the insulation of the transformers or generators, and any weak spot in this insulation will allow the stored-up energy to rush to earth, with resulting damage to the apparatus.

It is therefore self-evident that all that is necessary to protect our apparatus is to provide an easier path to earth for this stored-up energy, and in this way relieve the line of the static discharge. A ground connection with a spark gap interposed is all that is required as far as the static electricity is concerned; but the gap once closed by an arc formed by the static discharge will allow the dynamic current to follow in its path, and a short-circuit will result if the discharge has taken place from both wires of the circuit.

While the means for relieving a line of its static charge is a very simple problem, the elimination of the short-circuiting of the dynamic current is not so easily accomplished. Many ingenious devices to accomplish the opening of the short-circuit produced, have been invented and placed upon the market. Some of these depended upon moving parts, but owing to the fact that lightning is not an hourly occurrence which would keep them limbered up, they were generally found out of order when the time came for action. The requirements for a good lightning arrester are as follows:

1. It must offer an easy path for the passage of the static current.
2. The spark gap must be small enough to allow the charge to dissipate itself before reaching a potential which would endanger the insulation of the translating devices.
3. It must prevent the following of the dynamic current.

With reference to the first requirement it has been found that in all experiments with static electricity, in order to get good results, the spark-gap surfaces should be clean and bright. As soon as the surfaces become blackened and pitted it is found necessary to raise the potential considerably, in order to get the charge to leap across the gap. It is very essential, therefore, that the arrester be so constructed that a large sparking surface is presented, so that the care and necessity for inspection is reduced to a minimum. This property is a most desirable feature for arresters in connection with high-voltage circuits, and which are not desirable subjects for constant handling when the current is on the line.

In the selection of the proper spark gap it is necessary to take in consideration the quality of the insulation of the translating devices, the distance through which the static discharge can take place, and at the same time providing against the establishment of an arc by the dynamic current. If the insulation of the translating devices is poor in connection with too large a spark gap, the translating device may act as a better lightning arrester than the instrument intended for that purpose.

Lightning arresters with moving parts have been entirely abandoned by nearly all manufacturers, and it is therefore unnecessary to dwell upon their construction. The style of arresters which are giving the best results at the present day on alternating-current circuits are of the non-arcing metal type. The special feature of this type of arrester is the use of metallic cylinders or spheres, placed side by side with an air-space or sparking gap between them. The number of cylinders or spheres and air-gaps are proportioned with reference to the difference of potential of the dynamic current used on the line. The cylinders or spheres are constructed of a metal whose oxides are intended to produce non-conducting vapours. The metals which possess this property are of the well-known chemical group of antimony, zinc, and cadmium. Zinc, on account of its being the least expensive of the group, is commonly used, and, in fact, ordinary brass possesses all the properties of the so-called non-arcing metal. It has been found in practice, however, that the non-arcing metal will arc at times and cause a short-circuit on the line. This may have been due to the use of too much copper in the original mixture, or it may have been the result of several discharges having passed between the same points. Under this condition the surfaces adjoining the spark gap may have been reduced to a copper surface, and the resulting vapour having conducting instead of non-conducting properties. To avoid the above conditions, it was found advisable to turn the cylinders after a discharge had passed over the gap so as to present new surfaces. Short-circuiting has also resulted from insufficient insulation between the terminal points for the line connections. In some of the arresters the terminal connections are placed on a marble or porcelain slab with its surface in a horizontal position. This arrangement allows the accumulation of dust and dirt upon the surface, and a short-circuit between the terminals may be the result. The danger of short-circuiting the terminals is generally encountered in the use of a single arrester on 1,000 or 2,000 volt circuits; as in this case the potential strain of the circuit is brought at the two extremities of a horizontal surface of marble, which acts as a dust-collecting shelf.

Arresters using the non-arcing metal principle have been

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constructed in various ways with reference to the shape of the surface presented to the spark gap. The universal custom of using metal balls as discharging surfaces in all experiments with static electricity led to the construction of an arrester composed of a number of spheres or balls of non-arcing metal mounted on insulating material, with spark gaps between them. While this style of surface is well adapted for use in connection with purely static discharges, it is absolutely useless where a static discharge is liable to be followed by dynamo current. The sphere presents only two points as the shortest distance between their surfaces. A single discharge will blacken these points, and the second discharge must be of a higher potential to either overcome the greater resistance of the oxidised surfaces or the resistance of the greater air-gap between the clean or unoxidised surfaces.

The arrester using parallel cylinders has an advantage over the sphere in the fact that the air-gap is of the same length for the whole length of the two parallel elements of the cylinders, and a greater number of discharges can pass over the air-gap before the resistance of the gap is increased by the complete oxidisation of the surfaces.

An arrester has been designed recently which consists of a series of concentric cylinders with flaring tops; the cylinders are held in place by perforated porcelain caps. The air-gaps between the parallel sections are of such length that the E.M.F. necessary to spark the gaps is less than the E.M.F. necessary to rupture the insulation of the system. The arrester consists of two portions, each being held in place by separate porcelain pieces. The line terminals are connected to the centre post in the centre of the larger porcelain caps. The insulation of the terminals is very high with this arrangement, and it is impossible for the accumulation of dust or bugs to start an arc between the terminals.

It is very apparent that with concentric cylinders the greatest surface is presented to the sparking gap, and as larger number of discharges can be taken across the gap before it becomes necessary to change the cylinder. The air-gap is of the shortest length at the bottom end of the cylinders, and at the point of flare the space between the conical surfaces gradually increases. The static discharge will leap across the gap at the narrowest point, and the natural draught of air set up by the heat of the arc causes an upward travel of the arc along the increasing air-gap, until the interruption of the dynamo current takes place.

This arrester combines the non-arcing principle with a natural air blast to rupture the arc. Three concentric cylinders are used with three air-gaps, forming a unit for 1,000 volts, and for the higher voltages a number of these units are connected in series.

In connection with the lightning arresters, it is advisable to insert self-induction coils in the line between the point of attachment of the arresters and the apparatus to be protected. Owing to the fact that lightning discharges are of a pulsating nature of very high frequency, it has been found that a small amount of self-induction, in the shape of a few turns of wire, will offer an impedance sufficient to force the discharge to take place to earth over the path of the lightning arresters instead of the path through the apparatus.

The introduction of self-induction in an alternating circuit is an undesirable feature, as it assists in lowering the power factor. The objection to the use of impedance coils has been removed in a novel way in one of the recent installations of the Stanley Electric Manufacturing Company. In this case two self-induction coils are connected in opposition to each other in the same leg of the circuit. This is found to practically eliminate the self-induction as far as the dynamo currents are concerned, but at the same time offering high impedance to the current of the static charge. This method is better and safer than the one used by Bradley, which consists of two coils, one in each leg of the circuit, and so arranged that the outgoing and returning current neutralises the self-induction in the coils. This is a difficult arrangement to insulate for high voltages.

Lightning protection should be installed at each end of a long-distance transmission line and at the terminal points of all its branches. If the line passes through a section of country where lightning is of frequent occurrence, it would be well to protect the line at the most exposed points.

The old saying that "An ounce of prevention is better than a pound of cure" applies admirably to the case of protection against lightning discharges. If it were possible to keep the earth, and other surrounding objects in the neighbourhood of the pole line, constantly discharged, or, in other words, prevent the clouds from charging the line and surrounding bodies with a difference of potential, all danger of damage by lightning would be eliminated. A barbed wire, well grounded, strung over the top of the poles, will assist in keeping the ground and the line discharged, but this should not be depended upon as the only method of protection. A plentiful supply of line arresters, well placed on the distribution circuits, will afford protection to the transformers scattered along the line.

Owing to the oscillatory and surging nature of the charge on the line it has been found that nodal points are established, and that the discharge is somewhat selective in its nature. For this reason it has been found advisable to arrange the banks of lightning arresters on high-potential circuits in such a way that several paths are offered. As an example of this, consider two impedance coils connected in opposition to each other and in series with one wire of the circuit. From the point of connection between the two coils and their extreme ends take off three taps to three 1,000-volt units, then connect these three units to two, and then continue with single units of sufficient numbers to equal the voltage of the system. Then connect the ground terminal of the last unit to a good earth by means of a galvanised iron strip, clamped between porcelain cleats. The advantages of a galvanised strip are, that a flat surface is a better conductor for static charges, and the flat iron ribbon offers resistance to the passage of the dynamo current when mounted in the way specified as above.

Lightning at Sacramento.

BY C. W. HUTTON.

According to some recent estimates, the losses to electric companies, due to electric discharges, are between £60,000 and £90,000 annually. Although the subject of lightning and methods of protection has received a great deal of attention in the past 10 years, the above figures would tend to indicate that there is still considerable room for improvement. The fact that there are so many electric transmission plants that have sprung into existence in the past two years with their long, exposed lines, high potentials, large powers, and with the immense amount of money that is invested in step-up and step-down transformers that are directly but unavoidably connected to these long, exposed lines, makes the subject of protecting the apparatus against outside influences of still greater importance.

The function of a lightning arrester in any electric installation is to relieve the conductors of any excessive electric potential differences that may exist between them and the earth, and at the same time prevent an excessive flow from one conductor to the other, should there be a simultaneous discharge over any two conductors differing in potential.

In the case of a distributing circuit, where apparatus is promiscuously connected along its entire length, a single set of arresters at one end or at both, no matter how perfect in construction and operation they may be, would not of necessity protect the connected apparatus.

The only effective way to protect a distributing circuit is to have enough arresters connected and distributed along the line that for all conditions some of them shall be found at the crests, where the disruptive discharges take place. It has been found by experience that the ends of the circuits and the ends of the branches are the parts subject to the greatest danger of burn-outs. At one plant in the city of Columbus, Ga., where a great deal of trouble was experienced from lightning discharges, it was found that in every instance where a transformer was connected at the end of a branch or circuit, it would invariably be burned out in the first storm. Bearing in mind that the ends of the lines were the parts most affected, the difficulty was

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remedied by running the lines one or two spans by the transformer and tapping in a lightning arrester at the end. Even the arresters had a hard time of it, and a great many of the older type were burned out. Since substituting a later and improved type of arrester, and cutting in choke coils between the transformer and the line, no burn-outs have occurred.

In the case of the transmission lines, the conditions are somewhat different, as the apparatus is usually all at the ends, except the poor insulators, and, for aught we know, those poor insulators may be in the same condition that the country was a year ago—perhaps protection would exert a stimulating influence. Who knows but that during damp weather, while these high potentials are being generated in our long overhead lines by simple disturbances of the atmosphere, many insulators are punctured, and in the midst of the first storm the current takes advantage of the weak insulators, the pins are burned off, and the insulators topple over. We say that these insulators broke down under a strain of 10,000 volts. Who knows but that it was subjected to perhaps several times that amount. It would appear, however, that the ends of the lines are points that need the most protection, and, as far as I know, as at present constructed, all transmission lines are protected at the ends only.

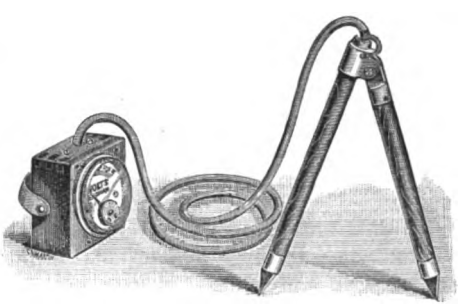
The experiences of the Sacramento Electric, Gas, and Railway Company with lightning have been very trifling; five shut-downs are all that can be charged to lightning effects. Three of these occurred before the installation of the arresters at either end, and the effect of two of these was simply to throw the synchronous motors out of step, and in the early days of the plant the slightest disturbance of any kind was the signal to shut off the current and find out by telephone if everything was all right at both ends. No damage was done on the occasion of two of these shut-downs, and there was but a few minutes' delay each time. The third one, however, caused a two hours' delay. The lightning came in, and in some inconceivable manner jumped from the high-tension to the low-tension side of the step-up transformers without even leaving a visible trace, and then went down the back of the generator board and burned off all of the voltmeter and synchronising switching apparatus, and the plant was shut down two hours to make repairs. Since the installation of the arresters, there have been two shut-downs. These occurred before any resistances had been cut in series with the arresters, and when a discharge took place, the heavy current that followed dropped the voltage to such an extent that the motors, while under load, would fall out of step, but, as in the former cases, no damage was done, and only a few minutes' delay was the result. Since the installation of the arresters and the resistances complete, very little trouble has been experienced.

On the afternoon of August 18 last and the morning of the 19th, quite a number of discharges took place, and especially on the morning of the 19th there was quite a severe storm, and the discharges took place in quick succession, there being as many as 14 in 30 minutes. The only effect, however, was simply to wink the lights and cause some slight churning in the speed. A voltmeter card was taken showing the effect of these discharges. Of course, the throw of the needle was considerable, and would not, therefore, show accurately the drop of potential, but it shows how effectually the arresters took care of the discharges.

On the night of October 5 of the present year, the plant experienced an ugly shut-down, but its cause, I think, cannot be attributed to lightning. The lightning arresters, however, were very badly burned. The trouble happened in this way. The synchronous motors fell out of step, and the arresters flared up terribly; flashes came out of the telephone, and communication with Folsom was broken. When this happens, the man in charge at the generators is instructed to keep current on the lines if possible, so he kept pumping into the lines for about 10 minutes, and seeing that something unusual had happened he finally shut down. During the trouble, however, the dynamo tender at the Sacramento end commenced pulling the high-tension switches, and in so doing an arc was formed that burned off one set of wires that ran into the switchboard from the north pole line. After current was cut off the telephone worked all right, and the man at Folsom was told to start up on the three remaining circuits, as there are four complete circuits altogether—two on each pole line. Still there was trouble on the lines, and word reached the station that a wire was down in a certain street and was making clinkers out of the gravel. In the meantime some of the arresters and resistances suffered severely. Some of the arrester balls were fused together and the resistances burned out. This is accounted for from the fact that, when everything is intact, there are two resistances and two arresters in series between any two wires; and in this case, with one wire on the ground, the arrester and resistance connected to this line would be shunted, leaving only one arrester and one resistance with the full potential of 10,000 volts across it; the consequence was that the arrester could not break the arc that formed, and the result was as indicated. The two circuits, one of which was grounded, were on this line of poles, and were cut out, and we were ready to start on the one remaining circuit on the other pole line. We were delayed, however, as all the telephone apparatus of three distinct lines was knocked out and we were shut down one hour and ten minutes, instead of 35 minutes, as we would have been had the telephone worked properly. The cause of the line burning off was that some twigs of a tree had blown over against the wires, and it is my opinion that an arc was sprung between two neighbouring wires, causing one of them to burn off. It is hard to say certainly that it was a "short" that burned off the wire. It may have been done simply by the twig coming in contact with the wire alone, but the neighbouring wire shows quite a burn, and when the lights first went down they seemed to hover for a few seconds, and it looked as though there was a "short" through some very high resistances. It is, therefore, presumed that a "short" did the mischief, and not the mere grounding of the wire by a damp twig.

CELL TESTING.

A portable voltmeter to measure the voltages of the cells in a battery of accumulators is not in itself a novelty, but the design of a really suitable instrument is. Such a voltmeter is now being placed on the market by the Edison and Swan United Electric Light Company, Limited. The illustration herewith shows the exterior view of the apparatus. The instrument has a spring control, so that it can be used in any position. It is fitted with a leather strap, which passes over the back of the hand, thus enabling the instrument to be held practically in the palm of the hand, whilst contact with the cells is made



by an adjustable fork fitted with spears on each leg, which are pressed on to the lead poles of the cell. The spears are connected to the instrument by means of a flexible cord covered in indiarubber tubing, and the whole of the instrument and spear is covered with a non-corrosive paint so as to prevent damage by acid, vapours, etc. By means of this apparatus, the separate voltages of a whole battery of accumulators can be quickly and accurately ascertained. Above all, the apparatus is designed to withstand the corroding atmosphere of the bathing room, which has been responsible for the failure of many previous types.

Prize Competition.—An international prize competition for the construction of a tramway, to be worked by electrical or other power, between Zumarraga and Zumaga is advertised. The length of the line is about 29 miles. Specifications are to be obtained from, and papers addressed to, the Mayor of Aspeitia, Spain.

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

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1898.

To Our Readers We Wish a Happy and Prosperous New Year.

The close of a year is pretty generally a time for stock-taking and for taking balances. It would, however, serve no good purpose just at present to enquire too closely into the trade for the year that has past. Commencing with a favourable outlook, the clouds of a prolonged engineering strike overshadowed the latter half of the year, and are still heavy with forebodings for the New Year. The unfortunate part of the affair is that the men continue to imagine their places in the shops will remain open for ever. Gradually but surely the places are being filled, and though the dislocation of trade was very great for a time in certain instances, orders are being filled. The Duke of Argyll puts the whole case very pithily in his letter to Mr. John Ogilvy, of Dundee. He says: "If the refusal of the employed does really turn on this (the exclusive control of the management of their enterprises), they are fighting against nature and against justice." Optimists imagined that the late Mr. Forster's Education Act would, at a cost of not more than threepence in the pound additional rate, bring about a kind of millennium, where the lion of labour and the lamb of capital would lie in peace and quietude side by side for ever. That millennium has not come, but many ratepayers have the consolation of paying about four times the amount estimated by Mr. Forster. The Duke of Argyll touches this educational point when he says, "I have only one suggestion—more knowledge of the natural laws which determine 'value' in all things, 'labour' not excepted." The determination of the engineers not to accept the terms offered shows that their views on the subject are certainly not the views of men who may be said to look upon the matter from an external and an impersonal standpoint.

We have said thus much upon the topic of labour *v.* capital because a glance through the Stock Exchange quotations will show a peculiar state of things. The quotations for the ordinary shares of almost all our manufacturing electrical concerns show anything but a flourishing condition. The output, however, is tolerably large, hence the low price of shares must indicate that the profits upon that output are too low. Of course, there are a dozen points to be considered if a close analysis of the why of this is to be considered, but the broad facts only concern us—not watered capital, founders' shares, management, and such like details. These broad facts are that, generally, the share quotation is below par. Surely on this and on the knowledge that at least the materials used are as cheap or cheaper here than in other countries, when we find competitors taking orders which our firms have tendered for, we must come to the conclusion that the labour question, and none other, is at the root of the evil. Trade competition among manufacturers has something to answer for, no doubt, and in the case, say, of electric tramway work a slowness to grasp the position may have let in competitors who under other conditions might have been kept out. Referring to tramway

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work reminds us that Glasgow ought to be congratulated on its last appointment. We understand that Mr. Chamen, whose experience in both electric lighting and in tramway work is extensive, has received the Glasgow appointment. If we mistake not, the experience of Mr. Chamen has been obtained during many years' engagement with Messrs. Crompton and Co.; from, in fact, the very commencement of this era of electric development. He has been actively and responsibly engaged in every phase of the development, and thus has obtained an almost unique experience that should be invaluable in his new sphere of work, in which we wish him every success.

The period of the year for which we write must be answerable for these somewhat desultory remarks, and we conclude, as we commenced, by wishing each reader "Health and prosperity."

CORRESPONDENCE.

"One man's word is no man's word
Justice needs that both be heard."

INSTITUTION OF ELECTRICAL ENGINEERS.

SIR,—The tables given (p. 814) in your report of the special meeting of the Institution have been rendered unintelligible owing to the initials "E.P.S." having been mistaken for an abbreviation of Mr. Epstein's name. I notice that the figures I gave have been supplemented by two values due to Prof. Ayrton; to these I have added two additional data derived from that gentleman's report on the Epstein accumulator.

Table.	Name of accumulator.	Normal or safe rate of discharge. Amperes. / Lb.	Specific capacity. Amp.-hrs. / Lb.	Minimum weight— Per h.p. Cwt.	Minimum weight— Per h.p. hour. Cwt.
1	E.P.S. (price lists) L23	0·193	2·14	18·1	1·63
	E.P.S. (price lists) T11	0·66	2·2	5·3	1·60
	E.P.S. (price lists) K	0·35	1·17	10	3·00
	Epstein (report of Alabaster and Gatehouse), Nov., 1894	0·615	1·856	5·7	1·9
	Epstein (report of Prof. Ayrton), July, 1892	1 nearly $\left(\frac{50}{53·5}\right)$	2 (nearly)	(?) 3·8*	(?) 1·76*
2	Tommasi cell, February, 1895	0·454	10		
		0·9	9	1·7	0·55
		2·7	7 (time 2·6 h)	(? 1·3)	(? 0·50)
		3·41 (Maximum for starting and on inclines, 6·82)	5·1 (time 1·5 h)		
3	E.P.S. Faure-King (? Faure-Tommasi) cell (Time, 5 hrs.)	0·9	4·5	3·9	0·78

* Prof. Ayrton's figures.

It should be understood that I by no means guarantee the values which I have derived and deduced from various reports of the working of the Tommasi accumulator. But a comparison of Tables 1 and 3 will show that they are to some extent confirmed by the greatly improved results obtained with the very similar cell constructed by the E P.S. Company, and called by them the Faure-King cell. This, it should be observed, is designed to run for a much longer period than the Tommasi cells in question. It is curious that, throughout the discussion on traction by accumulators, the Tommasi cell—the prototype of that used for cab traction in our streets—should not have been once referred to, excepting in my communication.—Yours, etc., DESMOND G. FITZ-GERALD.

Mr. E. Wythe Smith forwards us the following table of the traction effort on roads with an iron-tyred phaeton. The results should be read with his remarks on Mr. Epstein's paper:

	Lbs. per ton. A.	B.	C.
Asphalte	22	23	22
Wood (good)	22 to 29 (clean)	31	30
Wood	38	—	—
Macadam (good)	52	50	49
Macadam	60	51	50
Macadam (soft)	97 (new)	51	54
	—	(80 new)	68

Figures in the same line refer to the same road. Column A contains the results of experiments on heavy, muddy days. Columns B and C were taken when the mud was more of the pea-soup order.

INSTITUTION CIRCULAR.

SIR,—It will probably interest many of your readers to know that a private and confidential communication which has been sent to all members and associates, home and foreign, of the Institution of Electrical Engineers, has been very liberally responded to, so far as replies have been received. I shall, however, be glad, through the medium of your journal, to ask any members or associates who have not yet replied, to be good enough to do so at their earliest convenience; and in any event to favour me with their autographs for the proposed album, if they have not already done so. For obvious reasons, you will understand why I do not give details as to names in connection with this matter; but, on behalf of the Executive Committee, of which I have the honour to be secretary—Yours, etc., HENRY EDMUNDS.

ALTERNATING-CURRENT ARC CIRCUITS.

SIR,—In your issue of December 24, p. 818, there is a statement concerning the Edmunds automatic switch, which is said to switch off auxiliary incandescent lamps at daybreak by running a momentary *reverse* current through the lamps. I should be glad to learn how a *reversed* alternating current differs from the familiar ordinary alternating current, in order that a plain man may understand the way in which the thing is done.—Yours, etc.,
J. RUNNEL.

[The remark appears in the answer to Question 17, p. 818. Perhaps the writer of the answer would like to explain more about the switch.—ED. *E. E.*]

THE CHEMICAL TRADE.

SIR,—We observe from to-day's issue of your paper, under the heading of "Gloomy Prospects in the Chemical Trade," that "the salt-cake makers, bleach workers, and other employés at the chemical works of Bowman, Thompson, and Co., Lostock, near Northwich, have received notice that after January 1 a reduction of 10 per cent. will be made in wages. Several branches have refused to accept the reduction, and claim that they are now receiving less than employés at Widnes and Runcorn."

We unfortunately cannot take exception to the fact that chemical trade prospects are gloomy, but that the effect of this is such as your issue indicates we most strongly repudiate. It is not a fact that we have given notice of a reduction of 10 per cent. from January 1. No notice whatever has been given. Still less a fact is the statement that several branches have resolved to resist this.

In the interests of that good-will and feeling that has always existed between the employés and ourselves, we think it right to repudiate this, but in doing so, we do not think we should be doing justice to the loyalty of our men if we simply give you the bare denial, without giving you particulars of both the business perception and sympathetic spirit exhibited by the men (one that is certainly the excep-

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tion), which to our mind has probably been the cause of your paragraph.

Recognising the state of trade, and that others had made very considerable reductions (as high as 15 per cent.) in the district, our manager put before the men that, considering the amicable spirit in which we had always worked together, and the state of the trade, it would help to cement the friendship and be better appreciated if they came forward with a small voluntary offer. This was done, in as few words as we give it to you, after which the departments held meetings, with the result that almost to a man they came forward with an offer of a reduction of 5 per cent. to take effect on January 1. Amongst the men were some 60 unionists, and, be it said to their credit and good sense, they came forward and made the same offer as the rest, and that unanimously.

We feel quite confident that if all firms were able to bring about the good feeling that exists between our men and ourselves, such lamentable occurrences as the present engineers' strike would be out of question.—Yours, etc.,

BOWMAN, THOMPSON, AND CO., LIMITED.

Northwich, December 24, 1897.

AN EXPLANATION.

SIR,—In view of the difficulty under which English manufacturers are working, we trust you will give us space for the following very brief remark:

The red, white, and blue drums, which have been crowding most of the railways and many of the thoroughfares of the principal towns in England, are red, white, and blue, not by reason of any French Republic extraction, but because these have been the Jubilee colours of this year of grace. We emphatically deny that any cables ever sold by us have ever been made in France, or anywhere but in England.—Yours, etc.,

MERVYN O'GORMAN, Manager,
The Fowler-Waring Cables Company, Limited.

North Woolwich, London, E., Dec. 28, 1897.

BROCKIE-PELL ARC LAMP, LIMITED.

SIR,—In your notice of this company's meeting on the 20th inst., our noble chairman is reported to have said that "after legal proceedings," etc. This is a mistake, as no such words were used, and the company has not been involved in any legal proceedings since it was formed. By correcting this error in your next issue you will oblige.—Yours, etc.,

BROCKIE-PELL ARC LAMP, LIMITED.
(Bennett Pell, Managing Director.)

London, E.C., December 30, 1897.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We shall also in future give *two shillings and sixpence* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared, and should be written on one side of the paper only. Questions may be sent at any time.

QUESTIONS.

24. Compare the relative advantage of hand and mechanical stoking for central stations, with special reference to economy and the smoke produced.—A. D. J.
25. Describe, with sketches, what you consider to be the best system of engine governing.—J. POWNALL.

ANSWERS.

Question No. 19.—What is the general type of ammeter or voltmeter you consider most suitable for giving accuracy when placed on switchboards at central stations?

Best Answer to No. 19 (*awarded* 10*s.*).—There are three types of instruments—(1) electromagnetic, (2) electrostatic, (3) hot wire—in general use.

The electromagnetic types of instruments are those in which an electric circuit acts upon a magnetic circuit produced by a magnet or another electric circuit, and in which either the magnetic or the electric portion moves. In this type of instrument the readings are affected by stray magnetic fields, and for this reason the readings are not absolutely accurate if the instrument is placed on a switchboard. It must be remembered that there are certain types of these instruments in which the disturbing effects are very small; for instance, the Weston and kindred types. In these instruments a very strong permanent magnet is used with a very small air-gap, in which a coil moves. As the magnetic circuit is strong and very complete, outside fields have very little effect. The coil and spring controls have to be of fine wire, so these instruments are not suited to measure large currents; they make very good voltmeters, and are employed to measure currents by the fall of potential along a resistance through which the currents pass. Again, almost any of the electromagnetic instruments may be made fairly independent of outside influences by enclosing them in an iron case. The soft-iron instruments are included in this class.

The electrostatic instruments are unaffected by magnetic fields, and work equally well with alternating and continuous currents. By their very principle they can only measure differences of potential, so, although very good as voltmeters, they will not do for ammeters. They are not sensitive enough for use with the potential method of measuring currents. I should recommend that at least one of these instruments be kept on the switchboard as a standard instrument.

The hot-wire instruments are unaffected by magnetism, are independent of the periodicity of alternating currents, and work equally well with continuous currents. They are very good as engine-room voltmeters; and the Cardew "instrument" is greatly used for this purpose. They "stick" rather, and should be carefully and regularly checked. They use too much energy to be of use for measuring currents by the fall of potential methods, and there are objections to using them for measuring main currents, as the wire must heat to give a deflection, and there will be a fair drop of pressure in the circuit.

I should use an electrostatic voltmeter on the switchboard as a standard, and either a Weston or hot wire type for the rougher engine-room work. For ammeters I would use on the feeders a good soft-iron instrument with alternating currents, and a Weston, or similar type of "potential" ammeter, for continuous. For the dynamos, where owing to the vibrations of the needles when running in parallel the readings cannot be taken accurately, there is no need to have an accurate instrument, but it must be strong. An ordinary soft-iron instrument will do for this work. One would not care to be too dogmatic on this subject, and therefore the subject has been treated as generally as possible, and also to comply with the terms of the question.—W. FENNELL.

Answer to No. 19 (*awarded* 2*s.* 6*d.*).—The kind of instrument which must be used on a switchboard depends upon the system, whether it be continuous or alternating current. Many continuous-current instruments cannot be used on an alternating switchboard, and *vice versâ*. There are a few, however, which may be used for both systems. The voltmeters are the only instruments which need to read accurately, because the pressure of the 'bus bars, and therefore of the machines, must be kept within certain limits, according to Board of Trade regulations. The ammeters need not read accurately, a rough gauge of the current flowing being all that is wanted, so as not to overload the machines too much. The output of the station is not taken from the readings of the switchboard instruments, but from special wattmeters, so that the ammeter is merely an indicator. Instruments can be generally divided into two classes—electromagnetic and electrostatic. All ammeters are of the former class, voltmeters being of both classes. As accuracy is not an essential requirement of switchboard ammeters, almost any decent modern make will do. Of voltmeters, I think that the best electromagnetic one is the Weston. The ordinary type is made for continuous currents. The action is caused by the passing of a small current through a movable

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coil, which is controlled by two springs, and suspended in the field of a permanent-magnet system. They waste very little energy. It is not wise to use electromagnetic meters in an alternating-current system, because of the inductive effects of the current, which cause inaccuracies in the readings. The most suitable instruments for this system are electrostatic, of which Lord Kelvin's are the best. They have no closed circuit through them, and a very small amount of energy is wasted in them—practically none. There is also very little error due to friction, the moving parts being supported on knife-edges instead of on pivots, or in the vertical multicellular pattern by means of a fine-wire suspension. In the high-tension voltmeters there is a pair of fixed vanes with a movable one between. The low-tension ones have several vanes, or are "multicellular," because of the small potential available. Electrostatic meters may be used on both alternating or continuous current systems.—T. A. LOCKE.

Answer to No. 19 *(awarded* 2*s.* 6*d.).*—Accurate switchboard instruments must fulfil several conditions to enable them to be read accurately by the attendants—mere accurate calibration is of little use unless *accurate readings* can be easily taken from them under the usual conditions of working, and also when the load may be varying rapidly and erratically. The following are the most important points to be considered :

1. Accuracy and permanency of the calibration, and the absence of errors that may be due to residual magnetism, etc.

2. Insensibility to vibration from engines and to slight differences in level if by any chance shifted.

3. Dead-beatedness—a most important point, particularly in alternate-current parallel working. Many instruments with a slightly fluctuating load will become unreadable, owing to the pointer swinging over a large portion of the scale.

4. A large and clear scale, that the instrument may easily be read from a distance; also the pointer should be close to the scale that errors of parallax may be avoided, if the observer does not stand exactly in front of the instrument when taking the reading.

Taking all these necessary qualifications into consideration, which come out in actual working very forcibly, I think the preference should be given to the Weston type of instruments, so largely used in America, and which are being largely adopted in this country. They have all the above qualifications to a large degree; and some makers are introducing illuminated dials, thus remedying what was, perhaps, their only fault. The permanent magnets seem to remain very constant with age, and the instruments usually absorb only a small amount of energy. For very high potential some form of electrostatic voltmeter is more satisfactory, the chief objection to these being that they are very little dead-beat, and the scale is usually small and of short range.—A. D. J.

Question No. 20.—Give reasons for and against the use of flywheels with tramway generators.

Best Answer to No. 20 (*awarded* 10*s.*).—With an engine the flywheel has two functions to perform. In the first place, it is necessary to have a certain amount of inertia in the rotating parts of the engine to carry the reciprocating parts over the dead centres. The other function of the flywheel is to store energy sufficient to cope with fluctuations in the demand which may occur too rapidly to allow of the engine governor compensating for them. The flywheel must slow down while giving out energy, and upon the limits of speed imposed and the quickness with which the governor acts depend the variations in speed which will occur with a given kind of load, the flywheel being of a fixed size.

In applying these principles to tramway work, the conditions of load are very important. In the first place, it must be remembered that heavy currents are switched on and off suddenly—too suddenly for the governor to cope with immediately. The result is that unless there is a very heavy flywheel the variations in speed will be enormous. It is admitted on all hands that the voltage on the trolley wire must be kept reasonably constant, and it is for this reason evident that some inertia or store of energy must be provided somewhere. There are several ways of providing it: (1) by means of a flywheel on the engine, (2) by means of a flywheel on the dynamo, (3) by means of a battery in the station, and (4) by means of a battery on the line, and even in the car. By the two last means the sudden rushes of current are to a large extent kept from the engine and dynamo, being supplied by the battery. The advantages of these methods are that the engine can run at its economical load, there need be no very large margin of power in the engine and dynamo, and the shocks are entirely kept away from the engine parts. The disadvantages of these methods are that batteries are more expensive than flywheels and require attention, the cost of upkeep is heavy, and they waste energy. The advantages of the flywheel are obvious. It is cheap, efficient, and requires no attention. The disadvantages are that the flywheel may put very heavy strains on the working parts, that large flywheels sometimes burst with appalling results, that there is trouble with bearings owing to the heavy weights, and the engine friction is reduced.

If the flywheel is decided upon, the question arises, Where should it be put? There is no doubt that it should be placed, not on the engine, but on the dynamo. It should be, in fact, the dynamo armature. By this means, as the shock due to a rush of current must come through the armature, the energy is supplied direct to the armature conductors without passing through the crankshafts, etc. The next best place to put the flywheel is between the engine and dynamo in a direct-coupled plant, and on the driving pulley with a belt drive. The very worst place to put it is on the other end of the shaft from the dynamo in a direct-coupled plant, although it is often done. By this means the energy from the flywheel to the armature has to be sent through the whole length of shaft, through cranks, etc., thus greatly increasing the risk of breakdown. There is, in some quarters, a strong feeling in favour of very small flywheels in traction plants. It is argued, quite plausibly, that it is wrong to supply this stored energy to the circuit; use a very good Corliss valve gear with a quick-acting shaft governor, and all will be well. The engine cannot do more work than its maximum, and therefore cannot hurt itself, as every engine should be able to do its maximum power for an indefinite period. Now, although this is very good from the engine-maker's point of view—and I agree with it—it is not good from the voltage point of view, and in these days of combined lighting and tramway plants, it is very important that steady voltage should be kept.

Summing up, I should say, do not have very large flywheel capacity; provide for the rushes of energy by means of batteries suitably placed. If a large flywheel is used, make it the generator armature and so avoid breakdowns. Use the very best quick-acting expansion governors and high-speed engines, and so avoid the need of large flywheels.—W. FENNELL.

Answer to No. 20 (*awarded* 2*s.* 6*d.*).—There is no well-defined rise and fall in the demand for power in a traction station; the rapid and enormous changes of load which occur are, as a rule, both unexpected and sudden. These variations of load are caused by the extra power required in starting a car, in getting it round a sharp curve; or they may be due to two or more cars starting at the same time, or to the starting on a steep gradient. The whole of these changes must be taken by the engines that are running, unless a battery of accumulators be on the mains, as is the case on the Leeds, Douglas-Laxey, and other systems, so that the variation of load shall be more gradually imposed upon the station. The advantage of a large amount of stored energy on sudden sharp peaks of the load curve is very great. The flywheel tends to maintain a constant speed whenever a sudden alteration of load calls for a readjustment of the governor. It takes time for the best automatic expansion governor to alter the steam distribution, and in that time the energy of the flywheel tends to keep the generators running with a minimum alteration of speed, which is the main thing to be aimed at in a power station, where

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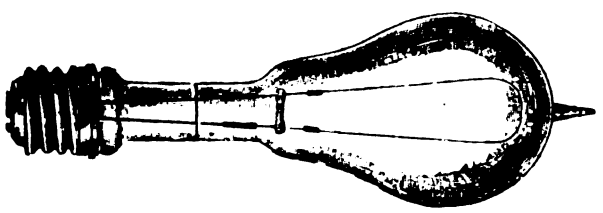
the voltage should be as nearly constant as possible at the switchboard. Average practice points to the advisability of a flywheel of such dimensions that it will carry the full load of the generator for three or four revolutions with a variation of about 5 per cent. in the speed. The generators on the Hartlepools tramways are driven by Willans high-speed compound engines, coupled direct to the crankshaft, and running at 450 revolutions per minute. Each set is equipped with flywheels of the usual disc pattern, and of no greater weight than is generally used with these engines for electric lighting purposes. The engines, however, are provided with automatic variable cut-off gear, which, I believe, has proved to be well adapted to hold in check the sudden and heavy variations in load to which the plant is subjected. There is no doubt that a combination of the automatic cut-off, with a suitably proportioned amount of flywheel effect, would prove both reliable and economical.—E. J. SUMMERHILL.

RENEWABLE INCANDESCENT LAMPS.

The incandescent lamp illustrated below is the invention of a Mr. Charles Howard. The description and drawing of the same were kindly sent us by Dr. Richard Mayer, of Vienna. Dr. Mayer considers that the developments of the incandescent lamp since its invention by Edison may be divided into two classes. Firstly, the efficiency of the lamps has been greatly improved; the lamps have been cheapened, and the processes of manufacture changed from laboratory experiments into a commercial industry. In consequence of the large number of lamps now used, it is worth while to enquire if it is desirable and practicable at the present stage of the industry to renew burnt-out lamps.



With regard to the efficiency of the filaments heated by electrical energy, Dr. R. Mayer does not consider that two watts per candle will be improved on, as Mr. Moissan's experiments as to the maximum temperature obtainable in a vacuum seem to point to this figure being the limit, even if other substances than carbon are tried as the filament. On the other hand, the carbon filament necessitates a vacuum and the use of a small quantity of platinum. This quantity, however, is so small that there is not much hope in this direction of the cost of a lamp being appreciably lowered by new inventions. Dr. Mayer considers that improvements should be looked for not so much in the first principles of the lamps as in efficiency of detail. The current consumption is the great consideration, and this must be reduced, even at the expense of a short life. The filament is really the part of the lamp which determines its life, and Dr. Mayer argues from this that if the cost of renewal was practically determined by the cost of renewing the filament, instead of the cost of a new lamp, a saving would be effected. This is the object of Mr. Howard, who, we may add, is not the first to attempt lamp renewals. The essentially new feature of the lamp is the tube between the socket and bulb. Platinum wires are, as usual, fused into the glass at the closed end of this tube. As soon as the glass is passed through, nickel wires are jointed on to the platinum. At the end of these wires are constructed clips in the form of tubes, into which the ends of the wires carrying the filaments are slipped. The nickel wires connected to the filament are connected by a glass bridge to give the required stability, and this bridge is used to hold the filament by when placing the ends into the two sockets. The method of renewing the filament in a burnt-out lamp is then as follows: The glass tube is parted at the line seen in the illustration, and the useless filament is removed from the two sockets. A new filament is slipped in place, and then the glass tube is again connected and the lamp is exhausted. The lamp thus consists of three essential parts—*i.e.*, the socket with glass tube and two projecting wires, the filament with metal connecting wires and glass bridge, and, lastly, the bulb of the lamp. It is claimed that these can be made interchangeable, as is undoubtedly possible to a certain extent; but this interchangeability cannot be carried very far. The true value of the idea can only be gauged by trial to ascertain the cost of renewal as compared with the present cost of a new lamp. The want of compactness of the lamp owing to the length of tube might, in our opinion, be avoided to a large extent.

CHEAP TELEPHONE LINES.

The following article, which appears in the *New South Wales Railway Budget*, is interesting as showing how poor the insulation of a telephone line must be before the instruments are useless. It must be remembered, however, that the climate is the ruling factor in such lines as described below, and that what may be possible in Australia may be wholly impracticable here.

The Railway Commissioners have a great *penchant* for adopting inventions where there is economy to be gained, and an interesting instance of the adoption of modern ideas in a minor way has recently taken place in connection with telephone communication.

At the present time, the common idea of the telephone is that of the ordinary telegraph poles, with wires stretching overhead; but the Commissioners have recently experimented with telephones, with wires, in the first place, between the rails and in the other along the railway fences.

The first of the two instances referred to is the practically poleless line which has been laid from Nyngan Junction to Hermidale, on the Cobar branch, a distance of 28 miles.

Starting from Nyngan, there is about a mile of telephone line to Nyngan Junction, whence the circuit is continued by means of a No. 6 iron fencing wire in the centre of the track. This wire rests at intervals in a groove across the top of a hardwood block measuring 4in. long by 2in. high by 1½in. wide, a cap of the same wood holds the wire down, and two 4in. iron wire nails through cap and block into the sleeper secure the whole so firmly that it needs the deliberate use of very heavy tools to loosen it. The blocks, which were designed with a view to cheap production, were made in the interlocking workshops, and were dipped in a preparation of Stockholm tar, resin, etc., to increase their durability and insulating properties. The maximum distance between any two blocks is about 100ft., but the spacing was often regulated by the curvature of the line and the weight of the ballast. In fact, contact with the ballast was in some instances unavoidale; and although the clean broken porphyry will constitute an excellent insulator in all but the worst of wet weather, it has been considered advisable to arrange for the ballast to be lowered in these places as opportunity offers. The wire was erected as high as was deemed wise in consideration of the line being unfenced and the presence of cattle on the route. At crossings of roads or beaten tracks the wire is brought up to a pole on each side and connected by an overhead hard-drawn copper wire at the regulation height. The telephone at Hermidale makes earth by means of two copper plates placed vertically in the ground, and presenting a total of 48 square feet of contact surface, while that at Nyngan utilises the water-supply pipes. Having made every provision to secure a low circuit resistance, the comparatively poor insulation resistance is further taken into account by specially winding the coils of the generators for a heavier current than usual, so that considerable current may be lost along the line and yet sufficient remain to ring the distant bell. Up to the present the line has given entire satisfaction. Observations will be taken of its behaviour under all variations of temperature and weather, and if the results warrant the expectation of sufficient reliability under local conditions for railway

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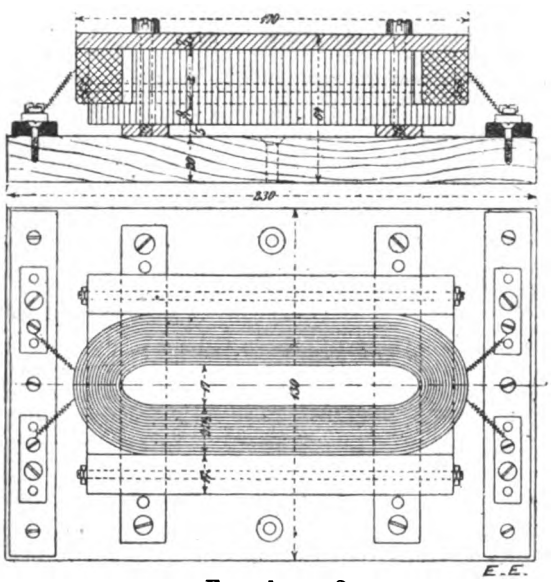
purposes, it is the intention of the Commissioners to extend the line on to Cobar in a similar manner.

Of equal interest is the recent use by the Commissioners of the wire of the fence for telephonic purposes between Walla Walla and Corowa. This is a means of communication that may, however, be largely taken advantage of in the future for railway and other purposes. One naturally begins to wonder whether the rails themselves might not under certain circumstances be utilised by means of a suitable telephone, and whether, indeed, what with return currents on the rails of the fast-increasing electric railways and tramways, and the use of gas and water mains for telegraphic and telephonic requirements, we are not rapidly approaching the time when it will be impossible to lay down a hundred yards of metal for any object whatever that will not be complacently appropriated by electrical engineers for the purpose of conveying current. In fact, they are already treading on one another's toes, and it has taken some very weighty legal proceedings to decide which had the better right to the use of that for which neither had paid.

A TELEPHONE TRANSFORMER.

The researches recently made by Dr. Reding with regard to the efficiency of transformers included tests of a telephone translater, or transformer, designed and used by the



FIGS. 1 AND 2.

Wurtemburg Government Telegraph Department. This instrument (illustrated in Figs. 1, 2, and 3) has lately been considerably altered. It consists of a number of sheet-iron stampings 1·2mm. thick. These are held together by insulated bolts having nuts at each end for clamping

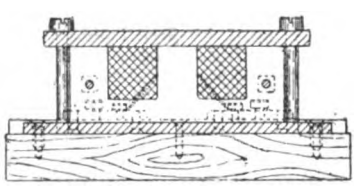


FIG. 3.

the plates together. The upper and open side of the magnetic circuit is closed by a strong iron plate held on by bolts passing into the base of the instrument. The two coils now used are each wound with 1,600 turns of ·25cm. diameter copper wire, having about 200 ohms resistance. In the first apparatus only about 1,200 turns of a heavier wire having a total resistance of 100 ohms were employed. The present type is said to have the advantage over the old circular type, that the coils are easily replaceable in case of damage by lightning, as the iron plate at the top only has to be removed to give access to the windings. There are about 40 of these transformers now in use, and three years' experience has proved that they are reliable and most useful. In the former instruments the iron plates were insulated from each other by paper, but now the oxidised surface of the plates on a coating of shellac varnish is found to be sufficient. The above illustration and description is taken from the *Elektrotechnische Zeitschrift*. The most noticeable feature in the transformer seems to us to be that an unlaminated iron plate is used to close the magnetic circuit. From the nature of the vibration in a telephonic circuit we believe that this plate is absolutely useless, and perhaps harmful. It would be better to leave the magnetic circuit open, and to hold the coils in place by a wood top.

LOWESTOFT ELECTRIC LIGHTING.

REPORT BY MR. W. C. C. HAWTAYNE.

Acting on instructions given by the Lowestoft Town Council, Mr. W. C. C. Hawtayne has sent in a report on the electric lighting of the town, of which the following is a *résumé*:

The Board of Trade returns, made up to the end of last September, show that up to that time 283 provisional orders had been granted for electricity supply undertakings, of which no less than 202 has been granted to local authorities. When it is considered that no genuine movement towards this work was made till after the passing of the Electric Lighting Act of 1888, these figures are sufficiently remarkable, but when on closer examination it is found that of the orders obtained in 1889 nine are held by companies, and only one by a local authority, while of those applied for last year for the establishment of new works 42 have been given to local authorities and only one to a company, the growing importance of the movement in the eyes of local authorities is most clearly demonstrated. Electricity supply undertakings are now proving successful in so many towns that there is no longer reason to doubt that with careful management they can be made most remunerative. It is an ascertained fact that, with one or two exceptions, every such undertaking in the kingdom under municipal control that has been at work for more than three years is now yielding handsome sums annually towards reduction of town rates. Another fact that goes far to prove public confidence in the future of these undertakings is that within the last year or two no less than eight local authorities have purchased or agreed to purchase the works of companies supplying electricity in their districts. The Corporation of Sheffield are trying to force the local company to sell them their undertaking, and have offered them £200 for every £100 of their capital, plus 5 per cent. for each year the works have been in operation.

In applying for the provisional order it has been necessary to describe two areas to be lighted, one being the whole of the district controlled by the Corporation, and throughout which mains will eventually be laid for all purposes. The other being what is often called the "compulsory area," not strictly speaking an "area," but a number of the principal streets in which the Corporation undertake to lay mains for private supply within a period of two years from the granting of the provisional order.

It is wise not to make this area too large; it is demanded by the Board of Trade in the interests of the town, and is meant to show the *bonâ fide* nature of the undertaking. Sometimes those whose premises lie outside the compulsory area get the idea that they will be incurring a certain risk for the benefit only of those inside the area. This is not the case, for, though an undertaking of this sort must have a commencement, there is nothing to hinder the Corporation from covering the whole district with mains long before the two years for lighting the compulsory area has elapsed. At Harrow, for instance, the company found it to their advantage to run their mains a long way outside the compulsory area before they commenced to supply current at all.

The streets already advised to be scheduled in the compulsory area are: London-road; High-street, from London-road to the town hall; London-road South from the Swing Bridge to Carlton-road; Marine-parade; Wellington-esplanade; Kirkley Cliff, to Carlton-road; and Wellington-road, from London-road South to Wellington-esplanade.

Mr. Hawtayne supposes that it is the Council's intention to light the sea-front by electricity—the effect would certainly be very fine and would undoubtedly prove a great attraction. He had therefore included for this in his estimates. He suggests that from the pier to Carlton-road, 14 lamps, each of 2,000 nominal candle-power, be erected, giving a total illumination of 28,000 candles along the promenade, instead of as present. He also suggests that similar lamps be erected from the railway station to the pier. He proposes that all the existing gas lamps in the

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streets traversed by the mains should be adapted for electric light. He considers that within a few years the equivalent of 16,000 lamps of 8 c.p. will be in use at Lowestoft, and of this number he estimates that 8,000 will be taken up in a comparatively short time. Of this latter number it may be safely assumed that not more than one-half (or 4,000) will ever be alight at one time, and he considers that works ought to be established capable of dealing with this number of lights, together with the public lighting referred to above. The works erected should be arranged for easy enlargement. The works at first should have a total plant capacity of 250 kw. He is of opinion a high-tension alternating system should be adopted. By this system, current is generated at a high pressure and carried to certain points in the district, where it is reduced by means of transformers or converters and fed into a system of low-pressure mains to which the consumers' service lines are attached. The great advantage of the system is that it can be profitably employed to supply the most scattered districts, and the generating station can be placed, if desired, at a considerable distance from the area to be supplied.

As to a destructor, there is a growing need of a destructor at Lowestoft. This method of disposing of town refuse is far and away preferable to any other, and its advantages to a town like Lowestoft, catering for holiday people, cannot be over-estimated. The waste heat produced by a destructor could be used for generating electricity, and is so used at many places, and Mr. Hawtayne sees no reason why a combined electricity and destructor works should not be put down at Lowestoft. Makers of destructors are prepared to guarantee 11b. of steam generated for every 11b. of refuse destroyed at the average town. The refuse collected at Lowestoft is, however, of very low calorific value, and he very much doubts if anything like good results could be obtained. He believes that the cost of destruction would be something like 1s. 6d. per ton. The fairest way of treating the matter would be to arrange that in the combined works all cost of refuse destruction over and above the cost of steam raising for electricity supply should be charged to the sanitary department. The erection of a destructor would add about £3,000 to the cost. He is quite sure that, taking everything into consideration, the Corporation's land known as "Smith's Marsh" will be the most suitable spot for the site of the works. If a destructor be erected it can be placed well back without a possibility of annoyance to the neighbouring householders, and the refuse carts from the busiest part of the town can easily be brought here without coming in sight of the main thoroughfares.

Dealing with the question of cost, Mr. Hawtayne estimates it at £20,000 without a destructor, and £22,400 with a destructor. As to revenue he recommends that 6d. per unit be charged for lighting. Sixpence would be the equivalent of gas at 3s. per 1,000 cubic feet, and he estimates the total revenue, charging £350 for public lighting, at £3,950. He estimates the working cost at 3d. per unit, and calculates a gross profit, when 8,000 lamps are used, at £1,652. 19s. per year, which after repayment on capital and interest at 5½ per cent. would, according to his calculation, leave a profit available for the reduction of the rates of £585. 9s.

From the figures given, Mr. Hawtayne thinks the committee will see that were such an undertaking once started at Lowestoft, and put into full working order under the control of the ratepayers, each one of whom would become, as it were, a shareholder in the undertaking, a substantial profit would undoubtedly be realised, and he therefore strongly advises the committee to recommend the Corporation to retain their powers, when obtained, in their own hands, and to put their provisional order into effect with all reasonable despatch.

LEGAL INTELLIGENCE.

THE DUBLIN ACCIDENT.

The case of the man who had received an electric shock in the Dublin streets, and claimed damages from the Corporation, was referred to briefly in our last issue. We are now able to give the following fuller report of the evidence, for which we are indebted to the *Dublin Evening Mail*. Personally, we think that the plaintiff was exceedingly lucky to get the £20 awarded.

On the 21st inst. the Recorder, sitting in Green-street Court House, Dublin, had before him the case of Thorpe *v.* the Dublin Corporation. The plaintiff, a commission agent's clerk, residing in Marlborough-street, sought to recover damages from the Corporation on the ground that, as he alleged, he had sustained serious injuries through their negligence or that of their employés. It will be recollected that on the evening of October 30 the plaintiff was standing close to one of the electric lamps at the corner of Nassau-street and Grafton-street when he suddenly received a shock which threw him prostrate upon the ground, inflicting upon him injuries which rendered it necessary that he should temporarily abandon his employment and place himself under medical care.

Mr. Andrew Todd, LL.D. (instructed by Mr. Philip Smyth) appeared for the plaintiff. Messrs. Macinerney, Q.C., and Philip White (instructed by Mr. Ignatius Rice) represented the Corporation.

The **Plaintiff**, Charles Thorpe, in answer to **Dr. Todd**, deposed that he was a clerk to a commission agent. On October 30, in the evening, he was passing along Grafton-street, and when at the electric lamp at the corner he stepped on the iron plate on the ground, when he got a terrific shock. He felt like as if he was struck by hundreds of needles, and when he opened his mouth he could not shut it, and he was made to dance about.

The Recorder: I would advise the public to take note of this dancing board.

Witness, continuing, said he had never been the same since. He had been attended by Dr. Fegan. When he was injured he was taken to the electric light station. He had been out of work since.

Cross-examined by **Mr. Macinerney**: I was in the employment of a betting-man, a commission agent named Hayes, at £2 a week.

How long were you out of employment?—For six weeks.

And you think the ratepayers ought to be asked to pay a betting-man's clerk for being out of employment?—Yes, when the Corporation is responsible.

Who were the men who brought you to the hospital or electric station?—One was a man named Bishop and another a man named Darling.

When examined at the hospital, what did the doctor say?—Mr. Fawcett said, "You ought to get cash out of this."

Did he say anything else?—Yes, he told me I ought to go home.

Did you go home?—Yes, but the man Bishop brought me to the bar of The Savoy for some rum.

What hour did you get home?—It was nearly eleven.

This was on a Saturday?—Yes.

Who did you go to on Monday?—To an attorney. I tried to keep on my legs as well as I could on Sunday, but felt excruciating pain, and being frightened I went to an attorney.

Did he advise you to go to a doctor?—Yes; he advised me to go to Surgeon M'Ardle.

Did the Corporation send Dr. Louis Byrne?—Yes.

Did he examine you?—Yes; but he jeered at the case, and seemed to take the view of the electrical engineer more than anything else.

Did he examine you and say there was nothing the matter with you?—Yes.

Did Dr. Meldon say the same thing?—Yes; I believe they did afterwards when these two doctors examined. Dr. Bryne gave me a more severe cross-examination than The MacDermot could do.

William Darling was examined by Dr. Todd, and said he was employed as principal draughtsman at the Ordnance Survey Office. On the evening in question he was passing along Grafton-street, and when he approached the plaintiff he saw the latter making a gasp and a plunge forward, fall on the ground, and perceived him shaking all over. A man named Byrne tried to pick him up. He also got a shock. Witness said, "Don't touch him; he's full of electricity."

Dr. Todd: Did you take the plaintiff's arm?—No; I had felt the shock myself.

The Recorder: You kept yourself isolated?—Yes.

And where did you go?—To Slattery's public-house, and then to the electric station, where we were told they were perfectly aware the light had gone wrong, but they were doing their best to remedy it.

Dr. Todd: Where did you go then?—To the police station, where the plaintiff's face was covered with a cold perspiration. They then went to Mercer's Hospital, where they were seen by a student.

Were you under the influence of drink?—No; it was an impudent falsehood for anyone to suggest it.

The Recorder: Where was this stated?

Dr. Todd: It was stated in an affidavit by the student that "the companions of the plaintiff appeared to have taken drink."

The Recorder: The witness is quite right in repudiating the suggestion.

Witness said he was a perfectly sober man, and on this day he had only taken three glasses of porter from three o'clock. He felt occasionally even now the effects of the shock which he received on that occasion himself. He had no interest whatever in the plaintiff or the result of this action.

Frank Bishop, examined by **Dr. Todd**, stated that on this occasion he saw the plaintiff dancing apparently on an iron plate beside the electric lamp. He was swirled round and was about to fall when he caught the last witness by the arm, and he also appeared to receive a shock.

Dr. Fegan said he examined the plaintiff in St. Vincent's Hospital, and found that without any will or exertion of his own his muscles contracted in a most peculiar fashion. That was on November 4 A week later he examined him again in the hospital, and he found his temperature 101·8. His condition was abnormal on both occasions. He had contraction of the large abdominal intestine, and he turned an ashy grey. On Sunday last his pulse was 117, the normal beat being 75 per minute. His nervous system was very much deranged. A severe electric shock would account for his condition.

To **Mr. Macinerney**: Witness did not think that Dr. Louis Byrne and Dr. Meldon gave the plaintiff a thorough examination.

Did you agree with Dr. Meldon and Dr. Byrne?—No; I kept my own counsel.

Did the plaintiff say he went about his work as usual after the accident?—I do not know.

Does not the electricity in the case of a shock pass out of the body more quickly than anything else?—Yes; and the effects remain behind.

Might not some of the symptoms you perceived in the plaintiff be produced by other causes, such as hysteria?—No doubt.

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Plaintiff recalled, said he never before was sick for a day, save with a cold or a toothache.

This closed the plaintiff's case.

Mr. Macinerney said that it was a remarkable fact that this alleged occurrence took place in the most crowded part of the city, and yet no one ever had received a shock on this spot, though thousands had passed over this spot.

The **Recorder**: Do you ask me to believe that this man did not get a terrific electric shock?

Mr. Macinerney: I will prove it by a great body of evidence.

The **Recorder**: You will examine Dr. Meldon—a "great body of evidence"—but I have distinct evidence of the fact given, and unshaken.

Mr. Macinerney: We will prove that what is alleged was impossible.

The **Recorder**: The man fell. He received a shock.

Mr. Macinerney: We deny that, and it will be sworn to.

The **Recorder**: There are some people who would swear anything in negative. Certain facts have been proved here, and I will have it out with any one who tries to show the contrary.

Mr. Mark Ruddell, examined by **Mr. Philip White**, said he had technical charge of the electric light system.

The **Recorder**: Did anything go wrong with it on this night?—Yes, something went wrong. There was a failure of the cables—the insulators of the cables failed—and we cut off the supply. That night the plaintiff called at the electric light station and complained, and asked for compensation, but witness told him he should go to the City Hall. Plaintiff was then very dirty.

Dr. Todd: Were the cables improperly laid?—No.

Are you not applying for a loan to relay them?—Yes.

Why?—For economy.

The **Recorder**: Economy solely?—Yes.

Has it nothing to do with insufficiency of supply?

Dr. Todd: Is it not a fact that the light has failed repeatedly in College-green and Grafton-street?—Many scores of times.

The electricity escapes into the earth?—Yes.

Dr. Austin Meldon, examined by **Mr. Macinerney**, deposed that he examined the plaintiff, after a consultation with Dr. Fegan, and found the temperature normal, and he came to the conclusion that he was not injured, and the plaintiff stated that he was perfectly well that night. The impression he carried away was that the man got a nervous shock and a great fright.

The electric shock itself would not produce this effect?—If it was too strong it would destroy the nerve, just as it would a wire—it fuses it—but if it passes along it, nothing happens.

Has he got any injury?—No, not to the brain or spinal chord.

Dr. Todd: You believe he got a shock?—Yes.

Were his sympathetic nerves injured?—I did not find that; but he got a slight electric shock.

If you stepped on this thing and got an electric shock, would it not frighten you, and injure your sympathetic nerves?—I think not.

Dr. Louis Byrne, examined by **Mr. White**, said he saw the plaintiff on the Tuesday following the Saturday evening of the occurrence, and thoroughly examined him. He saw nothing but a scratch or two. On a subsequent day he saw plaintiff with Dr. Meldon and Dr. Fegan. He believed that the injury, if anything, was temporary and passing.

To **Dr. Todd**: Witness was instructed by the law agent to see the plaintiff.

Do you agree with Dr. Meldon that he got a shock?—I could not say he had, and I could not say he did not get a shock.

Prof. Barrett, examined by **Mr. Macinerney**, stated that he had studied this case and the system of electricity laid down, and in his opinion it was incredible and inconceivable that any injury could be caused by the conditions that existed at the time of the alleged occurrence, assuming that the Board of Trade regulations were at the time carried out. It was incredible that one man catching another who stood on this place could have been affected by an electric shock.

The witness **Darling** was recalled, and said he felt the shock on the footpath, that he lost his senses, and was thrown out into the street. Another man who touched the plaintiff, thinking he had an epileptic fit, received a shock himself.

This closed defendants' case.

Mr. White submitted that, even assuming the plaintiff had received some injuries, they were of the most trifling character.

Dr. Todd said the case of the defence appeared to be the ridiculous one that the whole of this thing was an invention, and that in face of the evidence of Dr. Fegan, one of the most eminent doctors in the city. If this occurred by the "act or default" of the defendants they were clearly responsible. The witnesses of the Corporation admitted that something was wrong that night.

The **Recorder** said that he felt certain that if this case was before a jury they would find against the defendants, for they would hold that the Corporation had not done all that they should have done to keep this electrical current and machinery under proper control. Prof. Barrett swore that what had been alleged could not have occurred if the conditions of the Board of Trade were properly fulfilled, and that this thing did occur was beyond all doubt. The electric system in Dublin, although good, was not by any means perfect, as they all knew. He, therefore, held that sufficient control was not exercised, and he was confirmed in that by the fact that the Corporation was applying for the means of an improved supply or system. It was astonishing how in courts they heard people swearing other people out of their senses. There was not a shadow of a doubt on the evidence that this thing took place. The action and conduct of the plaintiff throughout proved that he was not intriguing or malingering or attempting deception. This young man at the corner of Nassau-street, and two others, strangers apparently to each other, met, and the plaintiff stood upon this iron plate and was turned almost into a Christmas harlequin—that he felt something like the pricking of needles. It was a mercy that he was not killed. It was dramatically one of the most remarkable incidents that had occurred in the city. He was told that what had been deposed to was impossible to have occurred. He did not care a fig for what scientists might say in view of proved and certain facts. He did not, however, believe that the plaintiff was much injured. He believed that he received a shock, followed by nervous excitement. In conclusion, he considered that the plaintiff would be fairly treated if he made a decree for £20, and £3. 3s. for the attendance of Dr. Fegan.

Dr. Fegan: I attended him eight times.

The **Recorder**: I cannot allow more, having regard to the fact that he could have attended at the hospital. I will make the decree for £25 altogether.

THOMAS PARKER, LIMITED, AND THEIR WORKMEN.

Thomas Parker, Limited, electrical engineers, of Wednesfield-road, Wolverhampton, were summoned at the Wolverhampton Police Court on Wednesday, before the Stipendiary, Mr. N. C. A. Neville, by two of their former employés—Thomas Godwin, commutator builder; and Frederick Bailey, mica gauger—each claiming £2. 12s. in lieu of notice.

Mr. A. Turton appeared for the men, and Mr J. E. Underhill represented the company.

It was stated that the men were discharged on November 17 without notice, and without any wages in lieu thereof. Bailey admitted having played cards in the shop with another man during working hours, and he and Godwin stated that no complaints had ever been made against them. They denied attempting to intimidate other workmen not to do so much work for the wages they received. They earned £1. 6s. per week each, and the money claimed was in lieu of a fortnight's notice. They were both society men.

Mr. Underhill said the men were discharged because they were interfering with other men, and trying to limit the work that was being turned out in a particular shop.

Alfred Boden, a non-society man, stated that Bailey had spoken to him frequently about doing too much work.

Mr. Turton (to witness): There are several non-society men in the workshop?

Witness: I believe so.

Mr. Turton: And that causes all the strife.

Witness: I cannot say that. The witness added he was not influenced by what Bailey said, for "it went in at one ear and out at the other."

Other witnesses were called, who alleged that Bailey and Godwin both complained to them about working too hard. Bailey was credited with the remark about an employé, "Wait till our society is strong enough, and we'll have the —— out."

The **Stipendiary** said there was no doubt that any person working for an employer who did any act, which it had been suggested Bailey did, in trying to prevent other workmen from doing what they considered was their fair share of work was acting in direct contravention of the interests of his master, and he was immediately liable to be dismissed for such conduct. The allegation against Bailey had been clearly proved, and he (the stipendiary) considered the defendants were justified in dismissing him at a moment's notice. In his case there would be a verdict for the defendant. In Godwin's case the facts had not been proved so strongly as he thought was necessary to be shown in order to deprive him of his fortnight's wages. There would, therefore, be a verdict in his favour for the amount claimed.

COMPANIES' MEETINGS AND REPORTS.

LONDON ELECTRIC OMNIBUS COMPANY, LIMITED.

The report of the London Electric Omnibus Company, Limited, from May 18, 1896, to November 30 last, laid before the ordinary general meeting on Thursday last, says the *Financial Times*, states that the capital account stands at £112,864, which includes 80,000 fully-paid deferred shares issued to the vendor, ranking for dividend after a preferential dividend has been paid on the ordinary shares, and £20,000 paid in cash and ordinary partially-paid shares also to the vendor. The expenses have been increased owing to the lack of facilities for the building and equipment of omnibuses to the contract made by the vendor as to the engagement of the engineer, to the development of the "Sola" accumulator, and to other causes. The amount of capital at the disposal of the directors not being sufficient to enable them to commit the Company to the expenditure necessary either for the purchase or lease of suitable premises, they have had to contract for the several portions of the omnibuses with various firms in different parts of the kingdom, the engineer then putting the parts together in London, under great difficulties, in the cramped and insufficient premises which were alone at the disposal of the Company. But though this course was dictated by prudence, it became manifest that it would be better to find some company which would undertake to build all the vehicles which the Company required, and which would contract for their delivery fully and electrically equipped in London. This being so, the directors have during several months past been negotiating for, and assisting in, the formation of the Electric Street Car

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Manufacturing Syndicate, Limited, which was registered on December 3; a contract has been made between the Company and the syndicate by which, amongst other things, it has been agreed that Major Flood Page shall accept a seat on the Board of the latter, and Mr. Thomas Parker, M.I.C.E., M.I.E.E., the well-known electrical engineer, and managing director of Thomas Parker and Co., Limited, of Wolverhampton, shall accept a seat on the Board of this Company; this will materially strengthen the directorate, as this gentleman has a large experience of electrical manufacture. The directors had hoped to be able to announce that they had succeeded in bringing about the formation of another syndicate for the purpose of manufacturing and working the "Sola" accumulators, with an interchange of directors, as in the case of the Street Car Manufacturing Syndicate This expectation has been frustrated owing to a claim made by the trustee in Mr. Marshall's bankruptcy, which has stopped all progress being made in the formation of the "Sola" syndicate, until the question of title thus raised shall have been decided. The directors have not lost confidence in electric street traction; but, in their opinion, it is advisable that the vehicle should be manufactured by one company or firm, such as the syndicate at Wolverhampton, and delivered in complete working order in London; and it is desirable that a syndicate should be formed for dealing in a similar way with the 'Sola" accumulator; and that at least sufficient working capital should be provided in lieu of that which the vendor and his associates have failed to pay when due. There are no debentures there are practically no debts, and the foundation of a successful business has been laid. The fact that in the short time the Company has existed very little business has been done is what has happened in almost every new enterprise, electrical and otherwise. All that is required is that the shareholders should work together, that a comparatively small amount of money should be provided for the immediate purposes of the business, and that there should be some alteration in some of the details of the Company. There is no reason for panic, least of all for winding-up the Company, as has been suggested. If the vendor and his associates had paid the money due on his partly-paid shares, the Company would have had ample funds for immediate requirements. In order to arrive at the best method of raising the necessary funds, of dealing with the deferred shares, etc., the directors wished that a committee of shareholders should be appointed at the meeting to consult with them on the position and requirements of the Company.

ELECTRICAL COPPER COMPANY, LIMITED.

The first annual ordinary general meeting of the shareholders of this Company was held on the 29th inst., at the offices, 14, Sherborne-lane, E.C., under the presidency of Mr. H. M. Matheson, the chairman of the Company.

The **Chairman** said the Company being an industrial one, with machinery of a very special character to be constructed, a little more time had been required to get into working order than was originally contemplated. Besides the experimental works in the neighbourhood of Paris, works had been erected at Widnes (Lancs.), where at least 30 tons of manufactured copper could be turned out weekly. Difficulties had been met and overcome, defects in the plant had had to be remedied, economies had to be introduced, and those works were now turning out copper sheets in execution of orders to the complete satisfaction of customers. The quality of the copper had been pronounced by all to be very superior, and the series of tests made by the eminent firm of Kirkaldy and Son had demonstrated its exceptionally high mechanical properties. In a very few weeks' time 30 tanks would be in operation at Widnes, which would further reduce costs, and bring them to the point that would ensure profitable working. Several important firms were anxiously waiting for the profitable working to enable them with confidence to go forward to work the process under licenses. At the Brunoy works, which were at first merely experimental, excellent work was being done in the manufacture of special sheets suitable for engravers and other purposes. In the course of the work at Brunoy certain additional mechanical details had been elaborated, and had been covered by supplemental patents. The subscribers to the preference shares of £100,000 issued in May, 1896, undertook to subscribe the remaining £50,000 preference shares prior to June 30 last. The money not being required so early, the fulfilment of this obligation was postponed until December 31, and the £50,000 had since been all taken up and paid in full, as an addition to the working capital. The report of accounts were received and adopted.

CONTRACTS FOR ELECTRICAL SUPPLIES

CONTRACTS OPEN.

Reus (Tarragona, Spain).—The Government will shortly advertise for tenders for a telephone system for the province.

Guernsey.—The States of Guernsey require several hundred creosoted telegraph poles, for particulars of which refer to our advertisement columns.

Bradford.—The Corporation require tenders for the construction and delivery of two steam-engines for their electricity works at Valley-road, for particulars of which refer to our advertisement columns.

Salford.—The Town Council invite tenders for the supply of 300 yards of portable tramlines and 12 side-tipping trucks, to carry 20 cubic feet. For particulars apply to the Borough Engineer, Town Hall, Salford.

Tarifa (Spain).—Tenders are advertised for the lighting of the town for 20 years. Specifications are to be obtained from, and tenders addressed to, the Municipal Authorities of the above town, province of Cadiz, Spain. Tenders by February 1.

Reus (Spain).—Tenders are invited for the electric lighting of the town. The deposit is 2,500 pesetas. Specifications are to be obtained from, and tenders addressed to, the Municipality of the town, province of Taragona, by 2 p.m. on December 31 (to-day).

Novorossisk (Russia).—Tenders are invited for the construction, etc., of an electric lighting installation for the town. The deposit is 5,000 roubles. Specifications may be obtained from, and tenders addressed to, the Municipal Authorities of the town by March 1 (13).

Lous-le-Saunier (France).—Tenders are invited for the construction of a tramway (two lots). The total estimated cost is £13,800. Specifications are to be obtained from, and tenders addressed to, the Prefect of the Jura, at the above place, by 2 p.m. on January 6.

Morley (Yorks).—The School Board invite tenders for supplying and fixing lightning conductors to the various buildings at Bridge-street Board Schools. Sealed tenders, endorsed "Conductors," to be sent to Mr. R. Brown, clerk, School Board Offices, Morley, by December 31 (to-day).

Bedford.—Tenders are invited for building offices and store-rooms at the electricity works. Particulars can be obtained on application to the Engineer at the Electricity Works. Sealed tenders to be delivered at the offices of Mr. T. S. Porter, town clerk, Town Hall, Bedford, by January 10.

London.—Several second-hand electric motors are required, about 10 h.p. or above; speed about 700 revolutions per minute, and suitable for working off 100-volt circuit. Quote with full particulars, illustration, name of maker, and earliest delivery, to Box XX, *Electrical Engineer*, 139-140, Salisbury-court, E.C.

Novorossisk (Russia).—Tenders are invited for the construction, etc., of an electric tramway. The deposit required is 5,000 roubles. Specifications, etc. (in French), are to be obtained from, and tenders addressed to, the Municipal Authorities, Novorossisk (Russia), by March 1 (13). The time has been extended from November 15.

Torrente (Spain).—Tenders are advertised for electric lighting of the town for 16 years. The estimated cost is 2·75 pesetas per light, and the deposit required is 5 per cent. Specifications are to be obtained from, and tenders addressed to, the Municipal Authorities of the above town, province of Valencia, Spain. Tenders by 11 a.m. on January 10.

Huddersfield.—The Corporation invite tenders for the extension of the electricity supply station. Specifications, drawings, and quantities may be seen, and forms of tender obtained, on application at the offices of the Borough Electrical Engineer, St. Andrew's-road, Huddersfield. Sealed tenders, endorsed "Tender for Electricity Works," must be delivered, free of charge, addressed in handwriting of tenderer or his agent, to the Town Clerk, Town Hall, Huddersfield, by January 4.

Tarragona (Spain).—The Secretary of State for Foreign Affairs has received a dispatch from her Majesty's Chargé d'Affaires at Madrid, transmitting copy of a Royal order inviting tenders for the construction and working of a telephone system in Tarragona. Sealed tenders will be received at the office of the Civil Governor of the province of Tarragona for 40 days, counting from Dec. 11. Further particulars of the conditions of the tenders may be inspected at the Commercial Department of the Foreign Office any day between the hours of 11 and 6.

Wolverhampton.—The Public Works Committee invite designs and tenders for motor-vans for street scavenging and the conveyance of road materials. Outline specification and form of tender can be obtained on application to Mr. J. W. Bradley, C.E., borough engineer and surveyor, Town Hall Wolverhampton, Firms tendering do so at their own cost in every respect. Drawings and a full description of the motive power, capacity, and other particulars, addressed to the Chairman of the Public Works Committee, to be delivered by February 7.

Worthing.—The Electric Light Committee of the Town Council invite particulars and conditions under which any person, firm, or company is willing to instal and maintain the electric light in the borough for a term of years, with power to the Corporation to acquire the undertaking upon agreed terms and at stated periods. The provisional order of the Board of Trade, which is in the usual form, may be inspected, and a plan of the town, showing the compulsory area and other particulars, obtained, on application at the Town Clerk's Office, Liverpool-road, Worthing.

Canterbury.—The Corporation are prepared to receive tenders for the provision and erection, complete, of refuse destructors for the city, to be worked in conjunction with the electricity works about to be established. General site plan and arrangements proposed, together with description of works and general conditions of contract, may be obtained on deposit of £1. 1s., returnable on receipt of a bona fide tender, by application to the City Surveyor, 28, St. Margaret's street, Canterbury. Tenders, on printed forms, to be lodged with Mr. Henry Fielding, town clerk, by December 31 (to-day), at 12 noon.

Guipuzcoa (Spain).—The Secretary of State for Foreign Affairs has received a despatch from her Majesty's Consul at Bilbao, reporting that the Provisional Board appointed in connection with the electric tramway which it is proposed to lay from Zumarraga to Zumaya, in the province of Guipuzcoa, invite plans and tender, to be received by February 28, for the construction and equipment of the line. Further particulars of the conditions of the tenders for the above-named tramline and branch, which together measure

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30 miles, may be inspected at the Commercial Department of the Foreign Office between 11 and 6.

Bedford.—The Electric Light Committee are prepared to receive tenders for the supply and erection of the following plant: (Section A) one 420-b.h.p. double-acting compound enclosed engine; (B) one 250-unit alternator, with stationary armature. Specifications, with terms and conditions of tender and contract, may be obtained at the offices of Mr. T. S. Porter, town clerk, Town Hall, Bedford, on payment of a fee of 5s. for each section. Tenders, sealed and marked "Electric Lighting, Section A or B," must be delivered to the Town Clerk by January 10.

Leicester.—The Sanitary Committee invite designs and tenders for motor vehicles for the collection of house refuse. The motive power, capacity, and all other particulars are to be described in a full specification, accompanied by drawings and delivered at the office of Mr. E. George Mawbey, C.E., borough engineer and surveyor, Town Hall, Leicester, addressed to the Chairman of the Sanitary Committee, by January 31. The loaded wagons would have to ascend an incline of 1 in 20, turn in a limited space, back and tip over a beam about 14in. high by 12in. in width, and when empty descend a road having a gradient of 1 in 15. The Committee do not bind themselves to accept any proposal, and firms tendering must do so at their own cost, no fees being allowed for the preparation of drawings, etc.

Gloucester.—The Electricity Supply Committee are prepared to receive tenders for the supply and erection of the following plant on the low-tension system, for the municipal electricity works: (Section A) boiler-house plant—Lancashire boilers and accessories, mechanical stokers, feed pump, injector, economiser, electric motor; (B) engine-house plant—steam dynamos and accessories; (C) overhead travelling crane; (D) switchboard and instruments; (E) accumulators; (F) mains—insulated cables and trenching; (G) public lamps—arc and incandescent street lamps and lamp-posts; (H) meters—the whole bound up in one specification. Tenderers are at liberty to tender for either section, but not for part of a section. Specification, with terms and condition and forms of tenders, may be obtained at the offices of Mr. Robert Hammond, M.I.E.E., consulting engineer to the Corporation, Ormond House, Great Trinity-lane, London, E.C., on payment of £3. 3s., which sum will be refunded on the return of the specification filled up with a bona fide tender. Duplicate copies of the specification £1. 1s. each, not returnable. Tenders (sealed and marked "Tender for Electricity Works") must be addressed to Mr. Geo. Sheffield Blakeway, town clerk, Guildhall, Gloucester, and be delivered by January 18.

Bootle (Lancs.).—Tenders are invited by the Corporation for the supply and erection of (1) Lancashire boilers and Green's economiser; (2) engines, dynamos, switchboard, condensers, condensing and feed-water pumps, balancing transformers, boosters, piping, tanks, crane, meters, wiring of electricity supply works, and alterations and additions to wiring at town hall; (3) secondary batteries and accessories; (4) feeder and distributing mains (solid system), potential leads, network and surface boxes, and service connections; (5) running of the electricity supply works for period not exceeding three years. Specifications, drawings, and form of tender can be obtained at the office of Mr. J H. Farmer, town clerk, Town Hall, Bootle, on payment of £5. 5s. (or £1 1s. per section), which will be returned on receipt of a bona fide tender. Any further information can be obtained from the consulting engineer, Mr. Thomas L. Miller, M.I.E.E., 7, Tower-buildings N., Water-street, Liverpool. Contractors may tender for any section or sections, but not for part of a section, and contractor for No. 2 section must also tender for Section No. 5. The contractor whose tender is accepted will be required to enter into a formal agreement under seal, with sufficient and approved securities, for the fulfilment of contract. Sealed tenders, endorsed "Tender for Electric Lighting," and addressed to the Chairman of the Watch Committee, must be sent in by 12 noon on January 10.

Madras.—Tenders are invited for the utilisation of water flowing from the Periyár Lake for purposes other than irrigation and not incompatible with the use of the water for drinking. The irrigating season extends over nine to ten months, during which time the discharge is likely to be from 1,100 to about 500 cubic feet a second, according to the demands for irrigation and the available quantity in the lake. Subject to the risk of interruption by accident or drought, supply can be given throughout the irrigation season. No supply can be guaranteed at other times, but, so long as water is available, the Government will be prepared to issue it in such daily quantities as may seem to it advisable with reference to the time which is likely to elapse before the supply is replenished by the setting in of the rains. The fall from the tunnel to the foot of the hills is approximately 900ft., and the distance measured along the course of the stream about 6,800ft. One cubic foot per second falling 900ft. is estimated to produce over 60 effective horse-power. Intending lessees should state the quantity of water required in cubic feet per second and the annual rent offered for each cubic foot per second. No rent will be charged for the first year from the date of the concession; for the second year the charge will be one-fifth, and an additional charge of one-fifth will be made every year until the full rent is reached. The whole or part of the concession may be surrendered on a year's notice being given. Lessees will construct at their own expense, on plans to be approved by Government, all the weirs and other works required to divert the water from the river below the tunnel. For further information, application may be made to the Chief Engineer for Irrigation, Madras, by whom tenders will be received up to July 1, 1898.

BUSINESS NOTES.

Shipley—The refusal of the gas company to lower their price of gas has given a new impetus to the electric light movement.

Bury St. Edmunds.—The Town Council have applied to the Local Government Board for power to borrow £20,000 for the purpose of erecting electric lighting works.

Annan.—A motion that it be remitted to a committee to consider the advisability of introducing electric light into the burgh, has been agreed to by the Burgh Commission.

Melton Mowbray.—A special meeting of the Urban District Council is announced for the purpose of considering the provisional order of the proposed electric lighting company.

Middlesex.—It appears that the British Electric Traction Company's tramway scheme for a line from Acton, through Ealing to Hanwell, has been abandoned by the company.

Portsmouth.—Colonel J. T. Marsh, R E., Local Government Board inspector, has held an enquiry into the application of the Corporation for permission to borrow £21,000 for purposes of electric lighting.

Date Remembrancer.—We have received from Messrs. W. H. Willcox and Co. a wall calendar, which they call by the name and title of a "Date Remembrancer." The name, however, does not detract from its utility.

Calcutta.—The Municipal Commissioners have decided on an installation of electric light. The new engines at Mullick's Ghat pumping station will be worked day and night, as electric lighting will be cheaper than ordinary lighting.

Salford.—Colonel W. Langton Coke, M.I.C.E., an inspector under the Local Government Board, held an enquiry last week into an application of the Salford County Council for sanction to borrow £13,000 for the purposes of electric lighting.

Inverness.—The *Glasgow Weekly Mail* says "the announcement recently made in the daily Press that the office will be opened to the public for trunk telephone communication within a week is incorrect, as the date has not yet been fixed."

Middlesbrough.—The Streets Committee have resolved to ask the Mutual Telephone Company of Manchester, who are desirous of extending their services to Middlesbrough, their terms for connecting all the municipal offices in the town.

Aberdeen.—The Churches Committee of the Town Council have approved of the plans of the proposed restoration of St. Mary's Chapel, and remitted to the city architect an application for the introduction of electric light in the West parish.

Kirkcaldy.—At a joint meeting of the Kirkcaldy Tramways and Town Council Committees the proposal to introduce tramways for Kirkcaldy and district, to be worked by the overhead system of electric traction, was unanimously approved of.

Cardiff.—By the Bill deposited by the Cardiff Corporation for next session, it is proposed to raise upwards of £700,000 for the purpose of carrying out powers sought by the Bill. Of this sum, £261,500 is for the construction of new tramways.

New Firm.—Messrs. Thos. H. Toy and Co. announce that on January 1, 1898, they will commence business at 17 South-street, Finsbury, E.C., as importers and dealers in all descriptions of glass and metal supplies connected with the electric, gas, and oil trades.

Paddington.—At the last ordinary meeting of the Vestry a letter was read from the Municipal Electric Supply Company submitting terms upon which they are prepared to supply electricity to the parish. The communication was sent to the Works Committee.

Radstock.—The Urban District Council have agreed to a report of the General Purposes Committee, stating that in their opinion the cost of electric lighting would be so great that they were unable to recommend the Council to adopt that method of lighting for Radstock.

Lecture Assistant.—As seen by an advertisement in another column, the City and Guilds of London Institute, Central Technical College, Exhibition-road, London, S.W., are advertising for a lecture assistant in the physics department at a salary of £100 per annum.

Grant Under Light Railways Act—It is stated that the Lords Commissioners of the Treasury are prepared to make a special free grant of £18,000 in aid of the Tanat Valley Railway from Oswestry to Llangynog. This is the first grant which has been made under the Light Railways Act.

National Liberal Club.—We understand that in consequence of frequent complaints of insufficient illumination in the big rooms the whole building has been overhauled, with the result that the Buildings Committee of the club have decided to spend something like £2,000 in replacing the existing wires by new.

Govan.—An offer from the Municipal Electric Supply Company to carry out all the provisions in the provisional order granted by the Board of Trade, and to supply electric light at 2d. per unit after the first hour at 7d., the streets at 2½d., and to consumers at 3d., is under the consideration of a sub-committee of the Council.

Electricity and the Stage.—The proprietors of the Lyric Theatre, Hammersmith, write to the *Daily Mail* that the stage was lit on Boxing Night for the first time with electric light entirely, and as the connection for the arc lamps was only just

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completed as the curtain went up, it was impossible to attain perfection at the first production.

Morocco Bound.—We have received from the Brush Electrical Engineering Company Walker's No. 1 Diary, published by John Walker and Co., Limited, Warwick-lane, London, E.C.; and a similar almanac, entitled "Appointments, 1898," from Messrs. Dargue, Griffiths, and Co., Limited, specialists in warming, ventilating, and lighting, Lord-street, Liverpool.

Halifax.—At a meeting of the Chamber of Commerce, the President, in alluding to a circular from the New Mutual Telephone Syndicate, Limited, said it was probable that before very long the telephone system would be under the Government, and it would be very much better that they should have a system thus controlled than that they should offer any encouragement to any rival companies.

Coventry.—A discussion took place at the last City Council meeting with reference to the use of motor power for the Corporation dustcarts, and it was said that £1,000 would be saved to the city yearly by this means. The city surveyor in a recent exhaustive report had made a suggestion in this direction, but the Council did not enter on the question whether they should go in for such means of locomotion.

Fenton.—On the recommendation of the General Purposes Committee, it has been resolved by the District Council to approve the application of the North Staffordshire Tramways Company to the Board of Trade for an order under the Tramways Act, 1870, to construct additional tramways in the district. The Council have also resolved not to oppose the application of the British Electric Traction Company to the Light Railway Commissioners for an order authorising light railways in the district.

Blackpool.—A meeting of ratepayers has been held to discuss the omnibus Bill, in which the Corporation are embodying a number of improvements proposed to be carried out in this popular seaside resort. The proceedings throughout were of a noisy character, and strong opposition was manifested, especially towards the proposal to construct a tramway along the middle walk from the westerly end of Cocker-street, along Central-road and South Shore works. A resolution in favour of the same was defeated.

Luton.—At the last meeting of the Town Council, Councillor Wilkinson was elected chairman of the Electric Lighting Committee for the ensuing year. The Town Clerk reported that he had received from Mr. Albion T. Snell, C.E., his report upon the subject of the electric lighting of the borough. The report was received. In consequence of the voluminous and technical nature of the report, it was resolved to have 50 copies printed, and that the committee meet to consider the same, with the assistance of Mr. Snell.

Lancaster.—In consequence of the advertisement for a pupil at the electricity works, the Electricity Committee have appointed two pupils for two years, at an annual premium of £25 each, subject to the first three months of such pupilage being satisfactory to the committee. The surveyor has submitted applications for a supply of electricity to several premises in Moor-lane, and it has been resolved that the engineer canvass the neighbourhood in order to ascertain if others are likely to require a supply of electricity.

Chatham.—Another meeting on the question of the introduction of electric trams into the district was held last week under the presidency of the Mayor of the borough, Mr. G. H. De la Cour. It was pointed out that it was intended to cover 14½ miles of roads at an outlay of £200,000. The following resolution was carried: "That this meeting having heard the explanation of the proposed electric tramways, is of opinion that the same will be a great boon and of great advantage to the prosperity of the district and its inhabitants."

Glasgow.—The Corporation have appointed Mr. W. A. Chamen, of Messrs. Crompton and Co., London, as electrical engineer of their electricity department. The holder of this appointment, besides possessing practical experience in all matters relating to electricity, must be specially qualified to prepare designs and specifications for and to carry out the construction of generating stations and the laying down of mains and all other works necessary for the production and distribution of current for lighting and motive power, and to take the entire general management of the department.

Bournemouth.—An "Unrepresented Ratepayer" writes to the *Bournemouth Guardian* complaining of the action of the Town Council in passing resolutions shelving the tramway question, and suggests to the proposed electric tramway company that they invite the people of Bournemouth to sign a petition for or against the proposed scheme. The resolutions referred to read: (1) that in the opinion of the Council it is not desirable for the Council to construct, or allow others to construct, tramways within the borough; and (2) that the town clerk be instructed to take the necessary steps to oppose any application for powers to construct tramways within the borough.

Liverpool.—A deputation from the Chamber of Commerce waited upon the Postmaster-General on the 29th inst., in order to complain of the delays in the transmission of telegrams between Liverpool and the Continent. A telephone service between Liverpool and Havre, with facilities for the switching on of Havre to the various cities in the North-West of France, was also asked for. The Postmaster-General promised to give the various points raised his most careful consideration. He promised that a new duplex wire should be made available between Liverpool and Hamburg, and said that if it were found practicable, telephonic communication would be established between Liverpool and Havre.

Manchester.—The Manchester Carriage and Tramway Company's Bill contains a long series of provisions to enable the company to work the whole of their system by electrical power, subject to the assent and regulations of the Board of Trade. Power is sought to construct seven generating stations upon lands already in the possession of the company, and used as tramsheds, stables, offices, and outbuildings. The Bill also proposes to repeal Section 39 of the Manchester Suburban Tramways Act, 1878, which prohibits the carrying of goods and animals on the tramways by that Act authorised, and in lieu of that section power is taken to convey heavy traffic, at rates set out in a schedule attached to the Bill between the hours of eight in the evening and eight in the morning.

Liverpool.—At the last meeting of the Lighting Committee a deputation from the Tramways Committee, consisting of Sir Arthur Forwood (chairman), Messrs. Oulton (deputy chairman), Williams, and Burgess, waited on the committee with reference to the lighting by electricity of the experimental line of tramway. It was agreed that the suggestion of having central poles with electric lamps in Prince's-avenue be adopted. Consideration of the question of having side poles was adjourned.—An addendum to the report of the Electric Lighting Committee referring to the scheme propounded for the installation of the electric light in the Mill-road establishment, at a cost of nearly £7,000, has been adopted by the West Derby Board of Guardians.

Rowley Regis.—At the last meeting, the Urban District Council had under consideration a motion to take any action deemed necessary with regard to an application about to be made to the Board of Trade by the Midland Electric Corporation for Power Distribution, Limited, for a provisional order under the Electric Lighting Acts, 1882 and 1888, to produce and supply electricity for motive, public, and private purposes within the district of the Council; also to take action on any similar application or applications from any other promoters should notice of the same be given. The Chairman said he was not at liberty to say much on the subject, but he believed steps would probably be taken which would lead to only one body of promoters coming before them. If that were so, it would be for the good of the district.

Bradford.—At the last meeting of the Tramways, Baths, and Team Labour Committee of the Corporation, a deputation was received from the Bradford Tramways and Omnibus Company, Limited, with respect to the leasing of the intended new tramlines to Eccleshill and Great Horton. In accordance with the requirements of the statute, the committee have invited tenders from the company, but are not compelled to accept any tender. The deputation attended to make enquiries into various matters connected with the tender. It was intimated to them that, with regard to the Great Horton line, unless some exceptionally favourable terms were offered by the company, the committee would advise the Council to undertake the management of the line themselves, the feeling in that direction at the last election being practically unanimous.

Carlisle.—Colonel Durnford, Local Government Board inspector, held an enquiry on the 21st inst. with reference to the application of the Corporation to borrow £30,000 for the purpose of carrying out electric lighting works in Carlisle. Prof. Kennedy (the electric lighting engineer) described the scheme by plans and maps, and stated that the Corporation would themselves put up the arc lamps in the streets, but would not supply the lamps for private consumers. They would only take the mains to the doors of the consumers. In reply to the Inspector, the Town Clerk said a number of people were ready to take the light, and the Corporation would also take the light for their public buildings. The estimated amount to be expended was about £26,300, and that would leave a balance of £3,700 for contingencies, extension of mains, and road work.

Bromley.—At the last Council meeting a letter was read from Messrs. Todd and Lamb stating that their company would repay all expenses should the approval of the Board of Trade not be given to the electric light order. They had supplied the Board of Trade with information which would satisfy them that the transferees were able to fulfil the responsibilities that would devolve upon them. (The above paragraph appeared in our last issue under the heading of "Burnley.") Since then the Board of Trade has replied to the Council's letter, and sent a draft of transfer at the same time, requesting that the Council would furnish them with copies of the draft deed, and calling attention to a letter sent by the Board to Messrs. Todd and Lamb. The letter stated that before approving of the transfer the Board required to know whether Messrs. Todd and Lamb had subscribed £5,000. This matter was referred to the General Purposes Committee.

Death of a Dundee Electrical Engineer.—The death occurred at Dundee on the 22nd inst. of Mr. Walter Hughes Brownlee electrical engineer. Mr. Brownlee, who on the introduction of the electric light to Dundee was appointed engineer of the local installation, was a young man of brilliant parts. He was an associate member of the Institution of Electrical Engineers, London. His theoretical knowledge was acquired under Prof. Ewing, University College, Dundee. He gave special attention to practical electricity, and received a considerable amount of laboratory and other training in electrical measurement. Altogether his college career was a distinguished one, and he obtained many certificates and prizes. He was also associated with the late Prof. Carnelley and Dr. Andrew Thomson in the chemical department of the college. After leaving college he was engaged in practical engineering work in Glasgow. Amongst the installa-

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tions carried out under his supervision were those at the Britannia Engine and Boiler Works, Dundee, belonging to Messrs. J. and H. Whyte and Cooper; at the Dundee Sawmills, belonging to Bell and Sime, Limited; and at the Ashton works of Mr. J. K. Caird.

Stockport.—Colonel Durnford, R E, held a Local Government Board enquiry on the 23rd inst. into an application of the Corporation for permission to borrow £25,000 for the purposes of electric lighting. Mr. T. Webb, chairman of the Gas and Electric Lighting Committee, attended, with other members and officials of the Corporation, and also Mr. Shoolbred, of London, the engineer for the electric lighting scheme. The latter presented particulars showing that it is intended at first to supply the leading business thoroughfares of the borough with the electric light, which would be at the disposal of private consumers. The buildings at the central station, etc., would cost £3,000, which, with £11,200 for generating plant, brought the total cost at the station to £14,200. The estimates for the distributing plant in the town were: feeding mains for the central station, £3,000; distributing networks in the streets, £2,000; street boxes, crossings, trenchings, etc., £1,500; house service, meters, and contingencies, £1,500; engineers' and other fees, parliamentary and similar expenses, £2,800—total, £25,000. It appears that the proposal to adopt the electric light is popular in the town, as there was no opposition offered at the enquiry.

Poplar.—The motion to rescind a previous resolution disallowing further visits of the Lighting Committee to other towns (as previously referred to by us), came again before the Board of Works at its last meeting. Mr. Clarkson, in moving the adoption of this, expressed the regret he felt that at a previous meeting, when there were but few members present, and without notice to him, a motion had been passed curtailing the operations of the committee. He thought the action of the member who had been instrumental in this was deserving of censure. The committee were most anxious to arrive at a proper conclusion on this most important question, so that they might give the Board advice on which definite and satisfactory action could be taken. They had obtained some information and were now desirous of visiting Hanley and Bradford to inspect the installation in use there, which would not be by any means the holiday trip some members seemed to think it. The question before the Board, and which the committee were asked to advise upon, was as to the best course to be adopted in regard to electric lighting. The committee had had the services of an expert, and now wanted more information before giving advice on a matter that might involve an expenditure of £150,000; therefore it was important they should get a full grasp of the subject, so that they could say whether it would be best for the Board to lay down an installation, or hand the order over to the company seeking to supply the district with electric light. The motion was carried.

Walsall.—Last week the members of the Electric Lighting Committee, with other members of the Town Council, attended at the Grand Theatre, on the invitation of Mr. W. H. Westwood, to witness the advantages electric illumination possesses for stage effects and general safety over the previous illuminant—gas. General surprise and satisfaction were expressed. The installation extends throughout the whole of the theatre, including the passages and the stage, which is illuminated by red, white, and green lights which can be manipulated from a switchboard by a method which is simplicity itself. The electric searchlights, which are introduced in place of the old fashioned limelights, preclude all possibility of danger from explosion. On the stage alone there are 180 lights. There are also four battens of 30 lights at the top, each of 32 c.p., and as a special type of lamp is used it is calculated that the light is multiplied by two by means of the reflection which forms the feature of this particular lamp, which is made by Edison and Swan. There is also a distributing board arranged with separate lines governing each row of lamps. The centre of the theatre will be illuminated with a huge electrolier, consisting of hammered iron relieved with copper, and the light is switched on from the stage. It is estimated that one batten of electric white lights gives as much light as the whole of the four battens of gas which have just been displaced. The mains are by Messrs. Johnson and Phillips, of Charlton, Kent. The contract has been carried out by Messrs. Fellows Wheatcroft, and Co., electrical engineers and contractors to the Corporation, Cross-street Walsall.

Southampton.—The Electric Lighting Committee reported to the Council at its last meeting that according to the resident engineer the output for October was 17,991 units, an increase of 5,043, or 38 per cent. over the number sold in October, 1896. He had commenced the work of strengthening the mains between the generating station and Portland-street, as instructed by the committee. The copper strip he had obtained from the Birmingham Battery Company. He had received letters from the secretary, Royal South Hants Infirmary, and others, relative to the supply of the electric light to their premises. The engineer was instructed to report upon the approximate quantity of coal required, the town clerk to advertise for tenders for the supply for a period of about six months. It was resolved, if the Governors of the Royal South Hants Infirmary would take a sufficient number of lights, that the committee would undertake to lay the necessary main, and the service line to a distance of 20 yards therefrom, and that if the number of applicants for electric light to Ordnance-road and St. Mark's-road warranted the expenditure of the extension of the main, the committee would recommend the Corporation to carry out the additional works. A letter from Messrs. Kincaid, Waller, and Manville enclosed specification relative to the lighting of the new station, and it was resolved that the specification be referred to the sub-committee, with power to advertise for tenders from local tradesmen for carrying out the work. Mr. Manville was requested to report upon the desirability or otherwise of the wiring of premises of consumers by the Corporation on the lines adopted by the Free Wiring Syndicate, and also upon the penny-in-the-slot system.

London Government.—The memorial to the Prime Minister and the President of the Local Government Board praying for the introduction of a Bill for the creation of metropolitan municipalities of dignity and importance sets forth, amongst other things, that Paddington (which took the initiative in the municipal movement) is greater in population than Croydon, Preston, Brighton, or Huddersfield (all municipal boroughs), and that its ratable value is higher than that of Sheffield, Bristol, Bradford, or Newcastle-upon-Tyne. The memorial has been signed by 11 of the 39 vestries and district boards of works governing locally the metropolitan area—namely, Paddington, Marylebone, St. Pancras, Lambeth, Hammersmith, Chelsea, Kensington, Westminster, St. James's (Westminster), Hampstead, and Deptford. They have a total population of 1,379,876, and a total ratable value of £12,296,751. An important change in the administration of the local government of the City will come into force on January 10, when the Commission of Sewers, which was chosen by the Corporation under the City of London Sewers Act, 1848, will cease to exist. The special committee is about to issue a report bearing upon the change. It will recommend that in the place of the moribund body there shall be created by the Corporation a public health department, which will transact the duties that have been faithfully discharged by the Commission of Sewers. This important transfer will invest the Corporation with vital powers it never before possessed. Probably the new department will consist of four committees, and the whole of the legal work will be conducted by the City solicitor and the comptroller. It will be suggested also that after January next the Court of Common Council shall sit weekly instead of fortnighly. While the Corporation will henceforth be municipally stronger, an immense amount of additional work will be thrown upon its broad shoulders.—*The Times.*

PROVISIONAL PATENTS, 1897.

DECEMBER 20.

30065. Improvements in key switch holders for incandescent electric lamps. Jan Meines Huisman and Henry Charles Gover, 62, St. Vincent-street, Glasgow.

30085. Improvements in electrical contact devices. Brisbane Doyle and Horace Vyse Thirkell, 45, Southampton-buildings, Chancery-lane, London.

30089. An improved process for preparation of an electric paste accumulator. Emil Kosel, 73, Albert-street, Regent's Park, London.

30135. An improvement in vehicles driven by oil-engines in connection with electric motors actuated by accumulators. Alexander Leslie Fyfe, 22, Southampton-buildings, Chancery-lane, London.

DECEMBER 21.

30157. Improvements in and connected with the manufacture of electrical cable or conductor conduits. Arthur Musker and Frederich John Pickering Cheesbrough, 15, Water-street, Liverpool.

30205. Improvements in coin-controlled mechanism for electric and other meters. William Frank Browne, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

30211. Improvements in and relating to insulating blocks for electric conductors. William Phillips Thompson, 322, High Holborn, London. (Johann Jungbluth, Germany.) (Complete specification.)

30221. An improved electric fuse and machine for the manufacture thereof. Nicolaus Schmitt, 19, Holborn-viaduct, London. (Complete specification.)

30246. Improvements in arc lamps for projection. John Stuart and John Henry Barton, 47, Lincoln's-inn-fields, London.

30247. An improved centreing motion for arc lamps and limelight jets. John Stuart and John Henry Barton, 47, Lincoln's-inn-fields, London.

30256. Improvements in electrical resistances. Augustus John Marquand and Frederick Gwilyn Treharne, 1, Queen Victoria-street, London.

30259. A method or methods for controlling a mechanism or mechanisms by means of electric or electromagnetic waves of high frequency. Ernest Wilson and Charles John Evans, 64, St. John's-park, Blackheath, London.

DECEMBER 22.

30264. Improvements in and relating to windings for polyphase machines. The British Thomson-Houston Company, Limited, and Henry Metcalf Hobart, 70, Chancery-lane, London. (Complete specification.)

30275. Improvements in dynamo-electric machines. Thomas Edgar Weaver, 19, Newbridge-street, Wolverhampton.

30295. The automatic locking lever and lifting lever combination for electrical lifts, cranes, or other machinery. C. E. B. Holt, 10, Piece Hall-yard, Bradford.

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30321. An improved switching apparatus for preventing self-induction sparks from being formed during the operation of disconnecting and reversing electro-motors. Ernst Egger, 40, Chancery-lane, London.

30341. Improvements in and relating to electric smelting furnace. William Antrobus, District Ice Works, Dukinfield, Cheshire.

30347. Improvements in electrical arc lamps. Emile Prosper Léon Mors and Louis Clement Alexis Pottier, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Acts, 1883, Sec. 103, November 3, 1897, being date of application in France.)

30364. Improvements in phase transformers for electric currents and the application of the same to monophase electric motors. Edmund Basil Wedmore, 20, Queen-square, Bloomsbury, London.

DECEMBER 23.

30393. An electro-mechanical dancing marionette figure in combination with rubber rotating sphere for advertising purposes and such like. John George Knight, 14, Harcourt-road, Dublin.

30441. Improvements in primary and secondary galvanic batteries. Charles Ludwig Rudolph Ernest Menges, 45, Southampton-buildings, Chancery-lane, London.

30445. Apparatus for simultaneously connecting a number of pairs of electric conductors. Siemens Bros. and Co., Limited, and Ernest Holmes, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

30447. Improvements in supplying electrical energy to railways worked by alternating currents. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens and Halske, Actien-Gesellschaft, Germany.)

DECEMBER 24.

30470. An improved electricity meter shelf-fixing or box and main connection board or box combined. Frederick William Edmund Jones, 24, Claremont-road, Leamington.

30476. Improvements in and connected with electric traction. Henry William Handcock and Alfred Herbert Dykes, 1, Victoria-street, Westminster, London.

30494. Improvements in the armatures of induction motors. William Lloyd Wise, 46, Lincoln's-inn-fields, London. (The Maschinenfabrik Oerlikon, Switzerland.)

30544. Improvements relating to the electric welding of tubes and to apparatus therefor. Otto Parpart, 45, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1896.

27558. Electrical signalling apparatus for railways. Andrews.

28392. Method of and apparatus employed in controlling gas valves by electrical energy. Boardman.

29498. Distribution of electricity from a common generating plant for supplying simultaneously current both for traction and for lighting or lighting and power. Blackburn and Moore.

29923. Electric clock alarm and time indicator for billiard-rooms, hotels, and other places. Laing.

30088. Electric clocks. Whitehead.

1897.

1204. Method of preparing positive plates for secondary batteries. Handcock and Dykes.

1627. Apparatus for the electro-deposition of metals. Cook.

1771. Electrically-driven sheep-shearing or hair-clipping machines. Baines and Norris.

1849. Electric railways on the conduit system. Balfour and Smith.

2536. Galvanometers. Brown.

2558. Measuring apparatus for rotary-phase currents. Siemens Bros. and Co., Limited. (Siemens and Halske.)

2643. Electric arc lamps. Burnand.

2709. Electro-deposition of copper and other metals. Heys. (Dumoulin.)

3115. Electrically-propelled agricultural implements. Schimpff.

3177. Adjustable holder or rest for telephone receivers. Marchant.

11714. Holders for electric glow lamps. Gover and Proctor.

14253. Alternating-current meter. Raab.

21462. Street boxes of electricity mains, tramways, cables, or analogous road receptacles. Wilkinson.

22240. Electric arc lamps. Brockie.

22772. Dynamo-electric machines. Thompson.

23239. Automatic telephone exchanges. Thompson. (The Strowger Automatic Telephone Exchange.)

23310. Electrical igniting devices for distant gas lamps or burners. Klinger.

24129. Electrical transformers. The British Thomson-Houston Company, Limited. (Moody.)

25210. Method of and means for transmitting electric currents in tramways. Röhser.

TRAFFIC RECEIPTS.

Bristol Tramways.—The traffic returns for the week ending December 24 were £2,726. 9s. 7d., compared with £2,138. 10s. 7d. for the corresponding period of last year, being an increase of £587. 19s. 0d.

Dover Tramways.—The traffic receipts for the week ending December 25 were £87. 12s. 8d. The total receipts up to the same date were £1,780. 11s. 3d. The mileage open at present is 2½ miles.

Birmingham Tramways.—The traffic receipts for the week ending December 25 were £3,176. 19s. 11d., as compared with £3,020. 5s. 7d. in the corresponding week in 1896, being an increase of £156. 14s. 4d.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended December 26 amounted to £1,341, as compared with £1,304 in the corresponding week of the previous year, being an increase of £37.

City and South London Railway.—The returns for the week ended December 26 were £1,055, compared with £972 for the corresponding period of last year, being an increase of £83. The total receipts for the half-year 1897 amounted to £25,115, compared with £25,075 for the corresponding period last year, being an increase of £40.

South Staffordshire Tramways.—The traffic returns for the week ending December 24 were £664. 6s. 5d., as compared with £529. 9s. 4d. in the corresponding week of the previous year. The aggregate receipts so far this year were £32,205. 9s. 11d., as compared with £31,120. 7s. 4d. in the corresponding period in 1896.

S.D. Tramways, Dublin.—The traffic receipts for the week ending December 17 were £366. 6s. 10d., as compared with £414. 10s. 0d. in the corresponding week in the previous year, being a decrease of £48. 3s. 2d. The number of passengers carried was 63,574 in 1897 and 63,798 in 1896. The aggregate returns up to date are £15,035. 8s. 3d., as compared with £15,853. 18s. 1d. last year, being a decrease of £818. 9s. 10d. The mileage open is the same as last year—viz., eight miles.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	11½
Brush Company, Ordinary	3	1⅞-2¼
—— Non. Cum., 6 per cent. Pref.	2	2⅛-2⅜
—— 4½ per cent. Debenture Stock	100	109-113
—— 4½ per cent. 2nd Debenture Stock	100	103-105
Callender's Cable Company, Debentures	100	108-113
—— Ordinary	5	7-8
Central London Railway, Ordinary	10	9¾-10⅛
——	6	5½-6
—— Pref. Half-Shares	1	1-1⅛
—— " "	5	4⅛-4¼
Charing Cross and Strand	5	12½-13⅛
—— 4½ per cent. Cum. Pref.	5	6-6½
Chelsea Electricity Company	5	10½-11
—— 4½ per cent. Debentures	100	115-116
City of London, Ordinary	10	26-27
—— Prov. Cert.	10	25½-26½
—— 6 per cent. Cumulative Pref.	10	17-18
—— 5 per cent. Debenture Stock	100	131-136
City and South London Railway, Consolidated Ordinary	100	66-68
—— 4 per cent. Debenture Stock	100	138-140
—— 5 per cent. Pref. Shares	10	15½-16
—— " " " '96	10	13½-14½
County of London and Brush Provincial Co., Ordinary	10	13¾-14
—— 6 per cent. Cum. Pref.	10	15½-16
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2 2½
—— 5 per cent. Debentures	—	89-94
Edison and Swan United Ordinary	3	2¾-3
—— 5 per cent. Debentures	5	4¾-5⅛
Electric Construction, Limited	2	2⅛-2⅜
—— 7 per cent. Cumulative Pref.	2	2⅛-2⅜
Elmore's Copper Depositing	1	⅛-¼
Elmore's Wire Company	2	⅛-¼
W. T. Henley's Telegraph Works, Ordinary	10	20-21
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	110-115
House-to-House Company, Ordinary	5	9-10
—— 7 per cent. Preference	5	11-11½
India Rubber and Gutta Percha Works	10	23-24
—— 4½ per cent. Debentures	100	103-107
Kensington and Knightsbridge Ordinary	5	14½-15½
—— 6 per cent. Pref.	5	8⅛-8⅜
London Electric Supply, Ordinary	5	2⅛-2⅜
Metropolitan Electric Supply, Limited, Ord. No. 101-50,000	10	18½-19½
—— " " " 50,001-82,500	10	18-19
—— 4½ per cent. First Mortgage Debenture Stock	100	119-123
National Telephone, Ordinary	5	6¼-6⅜
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	14-16
—— 5 per cent. Non. Cum. Third Pref., No. 1-119,234	5	6-6½
—— " " " 119,235-250,000	4	4⅛-5⅛
—— 3½ per cent. Deb. Stock, Red.	100	104-109
Notting Hill Company	10	17½-18½
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8-8½
—— £4½ shares	4½	7-7½
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal	—	145-147
—— 4½ per cent. First Shares Mortgage Debentures	100	105-107
South London Electric Supply, Ordinary	2	2⅛-2⅜
St. James's and Pall Mall, Limited, Ordinary	5	17-18
—— 7 per cent. Pref.	5	10-11
—— 4 per cent. Deb. Stock, Red.	100	103-106
Telegraph Construction and Maintenance	12	36-39
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	8	12¾-13
Westminster Electric Supply, Ordinary	5	16-17
Yorkshire House-to-House	5	8-8½

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